

# Report of the Pyrite Panel

June 2012





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# Letter to the Minister for the Environment, Community and Local Government

Mr. Phil Hogan T.D,  
Minister for the Environment, Community and Local Government,  
Custom House,  
Dublin 1.

27 June 2012

Dear Minister,

Re. Report of the Pyrite Panel

In your letter of 22 September 2011, you asked us to look at the issues that have arisen due to reactive pyrite occurring in a significant number of houses in the area of north County Dublin, Kildare, Offaly and Meath.

It is now my pleasure, on behalf of my colleagues, Noel Carroll and Malcolm Edger and on my own behalf, to submit our report to you.

In the timeframe in which we had to operate, we have endeavoured to comply with your request and look at how the problem arose, suggest remedies for the problems and make suggestions to ensure that similar problems might never arise again. We trust that you will find the report helpful to you and that it may provide you with a comprehensive framework for dealing with what is a hugely difficult problem for many people, particularly the homeowners affected.

In the course of our work, the Panel got an insight into the very serious problems that arose due to the presence of reactive pyrite in the hardcore used as infill under the floors of houses. While house construction was generally perceived as a low risk activity, what has happened in the case of pyrite clearly illustrates the devastating problems that can arise on a huge scale when a number of conditions coalesce to form the perfect storm. Many of the physical effects of the pyrite damage are clearly visible for everybody to see but, even if the remediation work is successfully undertaken, an indelible mark has been left on the lives of homeowners and families - and the past few years have been a nightmare for them.



We have provided a comprehensive set of recommendations and we would ask you to consider them as complementary to each other. From our experience of many reports submitted to Governments in the past, we have seen significant delays from the time the reports have been submitted to the time the recommendations are implemented, if indeed they are implemented. We consider that, in this case, the people affected have had to live with this problem for far too long and they deserve to have the issues addressed as a matter of urgency. Therefore, we would strongly urge you and your colleagues in Government to commit to implementing the recommendations as a matter of urgency.

On behalf of the Panel, I would like to acknowledge the assistance we received in undertaking our task from the many individuals who gave willingly of their time and expertise to assist us. The report details the names of individuals and organisations who assisted us and I would like to acknowledge their assistance. In this Report, the Panel has sought to accurately reflect the submissions and statements made by those organisations and individuals which have engaged with the Panel. The Panel accepts no responsibility for the statements made by others and incorporated in this Report.

I would also like to acknowledge the significant support we received from staff from your own Department - Marion Kiernan (Secretary to the Panel), Sarah Neary, John Wickham, Oliver O'Brien and their many colleagues who were always very helpful and willing to assist us.

From a public policy perspective, what happened with pyrite should not have happened and there are important lessons to be drawn from the experience. We hope that this report and the recommendations we have made in it will not only assist you in dealing successfully with the specific problems caused by pyrite but that they may help prevent such a problem ever arising again.

Yours sincerely,

Brendan Tuohy  
Chairman, Pyrite Panel



# Executive Summary

## Background to the pyrite issue

The issue of pyrite heave first came to the attention of the Department of the Environment, Community and Local Government<sup>1</sup> in mid-2007 by way of representations from politicians and in media coverage. Initially it was thought that the problems were confined to a number of private housing developments in the Fingal County Council area where the sub-floor hardcore fill was reported to contain a naturally occurring mineral known as “pyrite”. However, it soon became clear that the problem was more widespread and it later transpired the problem of pyrite heave was evident in five local authority areas, Fingal, Dublin City, Meath, Kildare and Offaly.

Between 2005 and 2007, HomeBond, Menolly Homes and Ballymun Regeneration Ltd, independently investigated abnormal cracking in dwellings and, in the case of the latter, a community building. Attempts to remediate the cracks, based on proven methods for settlement, were unsuccessful. The cracks reappeared. By early 2007, testing had confirmed high levels of the mineral pyrite in the hardcore beneath ground floor slabs. The oxidation of pyrite, its expansion and resultant heave is almost universally regarded by experts as the main cause of the damage to the buildings concerned.

A number of legal actions has been through the courts and the Panel understands others are in train. In one of the cases, a settlement was reached through mediation following on 150 days at hearing. Two other cases have been adjudicated on at the High Court and are now on appeal to the Supreme Court. In the case of James Elliot Construction Limited (JEC) –v - Irish Asphalt Limited, Mr Justice Charleton, found, on the balance of probabilities that the damage to the building came about as a result of pyrite. He further held that the hardcore material was not fit for the purpose for which it was bought and was not of merchantable quality. Irish Asphalt Limited disputes these findings and has appealed the judgment to the Supreme Court.

HomeBond and Premier Guarantee were the two main providers of structural defect guarantees/ warranties for purchasers of new homes prior to 2007. They arranged for the carrying out of remediation to dwellings where, subject to the terms of their respective schemes, they were satisfied that pyritic heave had occurred and there was resulting damage.

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1 Formerly Department of the Environment, Heritage and Local Government

## Executive Summary

However, on 31 August 2011, HomeBond issued a letter to the homeowners covered by the HomeBond Warranty Scheme stating that, taking into consideration legal opinion, expert technical advice and the decision of Mr Justice Charleton in the case of James Elliot Construction (JEC), they did not consider that they were liable for damage arising from pyritic heave and consequently they would not progress claims for damage resulting from reactive pyrite. Premier Guarantee continue to process claims for damage associated with pyritic heave.

In the wake of the decision by HomeBond to withdraw cover for damage associated with pyrite, the Minister for the Environment, Community and Local Government, Mr. Phil Hogan, T.D, announced the setting up of a three person Independent Panel, in September 2011. The remit of the Panel was to explore options for an agreed resolution to the problems caused by the presence of reactive pyrite in the sub-floor hardcore and to make recommendations that might help to prevent a similar situation arising in the future

### Pyrite in rocks

Pyrite (Iron Sulfide  $\text{FeS}_2$ ) is a naturally occurring mineral comprised of the elements iron and sulfur. In general, pyrite may be described as either being reactive or non-reactive. Reactive pyrite is not usually visible to the naked eye. This is the form that is predominantly responsible for the pyritic heave in Ireland. Pyrite is a fairly ubiquitous mineral and it occurs most commonly in sedimentary rocks such as argillaceous (clayey or shaley) or carbonaceous (coaly) rocks.

Five (5) quarries were identified to the Panel as possible sources of hardcore used in dwellings displaying signs of pyritic heave. One of those quarries has been named in court proceedings and the Panel is aware that legal actions have been initiated in relation to some of the others. The identification of the individual quarries is not considered essential, but, based on the evidence, it is worth pointing out that damage arising from pyritic heave is not limited to one quarry, one geological structure or one rock type. The Panel understands that all (except one) of the quarries identified to it are now closed.

The panel concluded that, at the time, there was not an effective testing and inspection regime in place in quarries to identify the presence of pyrite or to ensure that the hardcore material being supplied was of an acceptable quality.

### Pyritic heave in dwellings

Pyrite itself is not a problem but when it is exposed to moisture and oxygen a series of chemical reactions can occur. In such conditions, pyrite will oxidise to form sulfuric acid ( $H_2SO_4$ ) and other products. The acid may in turn react with other minerals found in the rock. If calcium carbonate is present in the rock, it will react with the sulfuric acid to form calcium sulfate ( $CaSO_4 \cdot 2H_2O$ ) in the form of gypsum. Gypsum, formed in the manner described, has a significantly greater volume, approximately twice that of the source pyrite. The growth of its crystals, in between the laminations of weak rock, has the effect of prising open cracks and causing further expansion.

When this expansion occurs in hardcore that is well compacted and confined between the rising walls and ground floor concrete slab (e.g. in a dwelling) it may result in:

- the cracking of floors, internal partitions and external walls;
- outward movement of external walls; and/or
- the heaving of ground floors and bulging of internal partition finishes.

The Panel acknowledges that, in Ireland to date, the rate of presentation of pyritic heave ranges from 2-9 years, much faster than documented occurrences of pyritic heave in Canada. This may be due to a combination of the type of pyrite present in Ireland, the mild climate or the exposure of hardcore to inclement weather prior to use. The depth of hardcore and degree of compaction also appear to influence the extent of the damage due to pyritic heave.

Over the last five years in Ireland, while there has been a wealth of expert knowledge developing on pyrite the Panel accepts, at face value, that design professionals and the construction sector at large, were unaware of the problems associated with pyritic heave prior to 2007. Pyrite does not appear to have been covered in any detail in the engineering or architectural courses and there was a lack of information on pyritic heave or on the possible damage it can cause.

### Containing the pyrite problem in 2007

In the summer of 2007, following confirmation of pyritic heave in certain buildings, information was disseminated by HomeBond, Fingal County Council and the Department of the Environment Community and Local Government to industry stakeholders, builders, developers, building control authorities and quarries. As a result, the various quarries which had been supplying pyrite-contaminated hardcore appear to have stopped doing so.

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### Specifications for hardcore

Prior to 2008, there were two specifications commonly used when ordering hardcore, namely the HomeBond specification and the specification for road sub-base materials (Clause 804). It appears to the Panel that the hardcore used where pyritic heave had occurred was unlikely to have met either of the specifications.

In mid-2007, NSAI convened its Aggregates Panel which agreed that new guidance, particularly for hardcore, should be incorporated into an existing Standard Recommendation SR21:2004 Guidance on the use of IS EN 13242:2002 - *Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*. The work commenced in October 2007 and an amended version (SR 21:2004+ A1:2007) was published in December 2007.

The main aim of the amendment to SR21 was to limit the presence of a reactive form of pyrite in hardcore, used under concrete ground floors and which may give rise to swelling or sulfate attack

### Construction activity and practices in relation to hardcore

The economy in Ireland grew rapidly between 1995 and 2007. The construction sector was a major contributor to this growth. The residential sector represented approximately 65% of overall construction output. The number of dwellings completed increased by nearly 88% between 2000 and 2006, peaking at 93,000 housing completions in 2006.

This level of growth and expansion created an unprecedented demand for construction materials. Extracted stone products were used extensively in construction projects of all types. The volume of quarried stone products nationally increased threefold between 1993 and 2007, to a peak of approximately 130million tonnes per annum.

During this period, in Fingal, north Dublin, Meath and some adjacent areas, it appears that non-premium aggregates were supplied to meet demand, particularly in residential construction. It also appears that some of the materials contained reactive pyrite which subsequently caused extensive damage to a significant number of houses.

Unlike aggregates for sub-floors in building construction, the testing requirements and controls in place for aggregates used in concrete, concrete products or road materials would appear to have limited aggregates with reactive pyrite being used in such materials.

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In relation to the delivery of hardcore to sites, practices varied considerably from project to project. Hardcore may have been delivered either directly by the quarry company or by a haulier, or in other cases the ground works (including the sub-floors) were subcontracted to one or more subcontractors. As a result, hardcore from many different source quarries may have been used on one site. This may partly explain why only some dwellings in an estate present with pyritic heave.

It was suggested to the Panel that unacceptable practices built up during the construction boom in relation to documentation of such materials, which means that there was often not enough documentation to establish from where fill in a particular dwelling came.

### Scale of the pyrite problem

The Panel endeavoured to establish the scale of the problem by estimating the number of ground floor dwellings that may have pyritic hardcore. Of the 74 estates identified to the Panel, the total number of ground floor dwellings is 12,250. Approximately 850 of these have made a claim with a guarantee provider and approximately 1,100 have been remediated or are in the process of being remediated (on 12 estates). Therefore, in considering the extent of possible future exposure to pyritic heave, the Panel is of the view that, taking the most pessimistic view, there may be approximately 10,300 more dwellings with reactive pyrite present in the hardcore.

The Panel understands that no claims have been made to guarantee companies on 23 of the identified estates nor is the Panel aware of substantial evidence to support the view that there are pyrite problems in these cases but, in an effort to provide an estimate of the possible maximum exposure, the figure is included. There are many reasons why not all ground floor dwellings on the identified estates will develop pyritic heave. For example, there may be more than one builder or subcontractor involved in an estate, each using different quarries (or indeed each using a number of different quarries) or the dwellings may have been constructed under different weather conditions that allowed oxidation of the pyrite to commence.

Representatives of the structural defect guarantee companies who spoke with the Panel indicated that there is, understandably, a contagion phenomenon amongst homeowners on suspected estates. Generally, the number of pyrite-related complaints exceeds the number of formal claims made by approximately 25%. In addition, the structural defect guarantee companies have stated that not all claims have been proven to have pyrite related damage.

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While the remit of the Panel was confined to private housing, it also looked at the possible broader scale of the problem in public projects. Most of the organisations contacted reported that they had no incidence of pyrite problems. The Department of the Environment, Community and Local Government reported that three local authorities, (Fingal, Dublin City and Meath) had identified approximately 850 social and affordable units across 18 developments where there were suspected or confirmed cases of pyritic heave. The Department of Education and Skills identified three suspected cases of pyrite in schools.

### Building control system

The building control system in Ireland is based upon the Building Control Acts of 1990 and 2007 (No. 3 of 1990 and No. 21 of 2007). The Acts provide for the making of Building Regulations and also the legislative basis for the system of enforcement. Traditionally, Building Regulations in Ireland dealt with hardcore in a general way through fitness for purpose and performance of the elements of a building. Prior to 2008, Technical Guidance Document C stated as follows: *“The hardcore bed should be at least 150mm thick and should be broken stones, broken brick or similar suitable material well compacted and clean and free from matter liable to cause damage to the concrete.”*

However, following the discovery of pyrite in hardcore in mid-2007 and the amendment to SR 21:2004 in December 2007, the guidance to the Building Regulations was amended to refer to SR21: 2004+A1:2007. This provided more detailed guidance on hardcore and prima facie evidence of compliance with the Building Regulations.

The Panel reviewed the building regulations in other jurisdictions. It concluded that the overall regulatory framework in Ireland, prior to the identification of the pyritic heave problem, could be compared favourably with that in the UK and in other jurisdictions. Once the pyrite problem was identified, further guidance was provided in the Technical Guidance Documents.

There are currently thirty seven (37) designated building control authorities made up, primarily, of city and county councils. They have various powers as set out in the Building Control Acts including the power to carry out inspections, enforce the regulations and the taking of prosecutions for breaches of regulations.

In relation to inspections carried out by building control officers, the Panel considered that it was unreasonable to expect that the unprecedented issue relating to pyrite in hardcore



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could have been identified by building control officers or other building professionals during normal inspections of construction sites at the time.

This report documents the response of Fingal County Council to the discovery of pyrite in hardcore supplied and used in the Fingal area. The approach it adopted, in addition to actions by others, was successful in containing the use of contaminated hardcore from mid-2007.

The County and City Managers' Association (CCMA) outlines an approach to enforcement based on dialogue, encouragement and cooperation. According to the CCMA, this approach has been pursued successfully in enforcement generally. Unfortunately, where this has not had a successful outcome, the 5 year time limit for prosecutions may have passed and enforcement may not now be possible.

### Stakeholder activity

The Panel is aware that, to date, some 1,100 dwellings have been remediated or are in the process of being remediated by various stakeholders. However, many of the agreements being reached between the parties involved are subject to confidentiality clauses and this limits the information in the public domain. In addition to remediation works resulting from mediation or arbitration processes, remediation works have been undertaken, by a number of different stakeholders, including warranty companies and insurance companies. Individual builders and a number of individual homeowners have also undertaken remediation work at their own expense.

The withdrawal by HomeBond of cover for defects caused by pyritic heave (in August 2011) has left the homeowners who were covered by their warranty in very distressing situations. They had a reasonable expectation, understandably, that under the terms of the HomeBond Warranty Scheme, structural defects, including serious defects due to pyritic heave, were covered and that their homes would be remediated either directly by the builder or by HomeBond. While the Law Society raised concerns about the HomeBond Warranty Scheme in a practice note in July 2000, it mainly dealt with security for deposits and limits of liability. It was not envisaged that the exclusion clauses in the Warranty Scheme would be used in the circumstances in which they have.

The Panel is keenly aware that many homeowners face significant barriers to finding a resolution to the problem of pyritic heave, particularly in cases where HomeBond is

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declining cover and the builder refuses to undertake the remediation work or is no longer trading. Many of the key stakeholders have stepped back from constructive engagement with homeowners and have not actively pursued any co-ordinated strategy to find solutions for homeowners.

In the opinion of many of the groups and individuals with whom the Panel engaged, those identified as having responsibility should pay for the remediation, (i.e. vendors, builders/ subcontractors, quarries and insurance companies) and the State should not bear the cost. No organisation came forward with any proposals for how that should be done or, indeed, made any offer of funding for the remediation.

The insurance industry only engaged in a limited way with the Panel and this was disappointing as it has a key role in the resolution of the pyrite issue. It was mentioned to the Panel that some insurance companies are declining insurance cover for homes affected by pyrite, even in cases where a dwelling itself is not affected but some other dwellings in the estate may be affected or even where remediation works have been successfully carried out. The Panel was concerned to learn of this restriction and considers that it is not helpful to the resolution of the problem.

The Irish Banking Federation and the main mortgage providers engaged with the Panel and, while they were empathetic to and understanding of the plight of homeowners affected by pyrite, they did not suggest any co-ordinated proposals to assist homeowners to undertake remediation works. The Banks consider that there is already in place a range of forbearance measures to deal with borrowers who are experiencing financial difficulties and these are sufficiently flexible to deal with pyrite-related difficulties. They indicated that, up to March 2012, they have had only a small number of requests relating to pyrite issues and those had been dealt with within the framework of existing support mechanisms.

### **Technical solutions for assessing damage to individual dwellings**

A number of assessment methods have been developed by private companies and national bodies, to establish whether or not a building has been, or is likely to be, damaged by pyritic heave due to the presence of reactive pyrite in the hardcore under the ground floor slab. The Panel reviewed four examples. While some similarities emerged in terms of the procedures to be carried out, significant differences seemed to occur when it came to the suite of laboratory tests that should be carried out and the conclusions that could be drawn from these.

### Technical remediation methods for dwellings

At present, the only recognised remediation method for pyritic heave is the complete replacement of the ground floor slab and the hardcore beneath. Such work, in a completed dwelling, is a major intervention and requires the dwelling to be evacuated and the ground floor cleared for between 6 to 16 weeks. The report sets out the scope and sequence of this work and provides an example of good practice in relation to the appraisal, sign-off and certification.

There is a number of alternative remediation methods under development to address the problem of pyrite in hardcore that could eliminate the need to fully remove the hardcore infill beneath the floor slab. Given the potential for this method to provide a more cost effective and less intrusive solution, further research and development of these methodologies should be encouraged. However, the Panel concludes that any such alternative method of remediation would have to be independently tested to a suitable standard and certified by an approved body, such as the National Standards Authority of Ireland before it could be accepted as an industry standard.

### Recommendations

The Panel makes twenty four (24) recommendations in this report and it also includes an implementation plan at Appendix 17 which identifies the body which the Panel considers should assume primary responsibility for implementing each of the recommendations. In undertaking its work, the Panel considered that the four issues, outlined below, needed to be addressed:

- Identify the scale of the pyrite problem in private housing;
- Identify technical solutions for the remediation of pyrite damaged homes;
- Identify possible funding options for the remediation work;
- Review the robustness of the existing system to protect homeowners in the future.

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The recommendations are based around these four areas as set out in Table 1 below

<b>Table 1 Summary of the Panels recommendations</b>			
<b>1. Categorisation and remediation approaches</b>	<b>2. Proposals for a resolution of the pyrite problem</b>	<b>3. Reducing burden on affected homeowners</b>	<b>4. Review and propose measures to strengthen the provisions to protect consumers.</b>
<p><b>Recommendation 1</b> Development of a testing protocol</p> <p><b>Recommendation 2</b> Guidance on approaches to remediation</p> <p><b>Recommendation 3</b> Development of a method statement for remediation works</p> <p><b>Recommendation 4</b> Certification of dwellings</p>	<p><b>Recommendation 5</b> Insurers and mortgage providers</p> <p><b>Recommendation 6</b> Responsibilities of stakeholders in the construction industry (including quarrying sector)</p> <p><b>Recommendation 7</b> Immediate engagement by builders/ developers/ insurers to facilitate remediation</p> <p><b>Recommendation 8</b> Engagement by construction industry representatives</p> <p><b>Recommendation 9</b> Re-engagement by HomeBond in facilitating remediation</p> <p><b>Recommendation 10</b> Engagement by the Insurance industry</p> <p><b>Recommendation 12</b> Role of Government</p> <p><b>Recommendation 14</b> Establishment of a Resolution Board</p>	<p><b>Recommendation 11</b> Funding by mortgage providers</p> <p><b>Recommendation 13</b> Exemption from proposed property tax</p>	<p><b>Recommendation 15</b> Specification for hardcore</p> <p><b>Recommendation 16</b> Requirements for quarries supplying hardcore</p> <p><b>Recommendation 17</b> Enforcement of Building Control legislation</p> <p><b>Recommendation 18</b> Mandatory certification system</p> <p><b>Recommendation 19</b> Registration of builders</p> <p><b>Recommendation 20</b> Statute of Limitations</p> <p><b>Recommendation 21</b> General Insurance issues</p> <p><b>Recommendation 22</b> Home Insurance issues</p> <p><b>Recommendation 23</b> Continuing Professional Development and Education</p> <p><b>Recommendation 24</b> Dissemination of Information</p>

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In summary, the thrust of the recommendations is to address the pyrite problems for the affected homeowners by recommending immediate and comprehensive remediation for the dwellings that are experiencing damage due to pyritic heave. In respect of the other dwellings that have pyrite present in the hardcore but have not experienced damage due to pyritic heave, on-going monitoring is suggested while allowing for the development of alternative less disruptive and less costly methods of remediation. In the meantime, should any of these dwellings begin to experience pyritic heave, they should be remediated immediately.

To enable a system of classifying affected houses, new national standard tests are required to be developed for identifying the presence of pyrite in buildings and classifying the buildings accordingly as either 'red' (requiring immediate remediation), 'amber' (requiring on-going monitoring or they can be remediated by some of the alternative methods, once proven) or 'green' (requiring no further action).

There is need for a method statement for remediation works and standardised certificates for certifying the remediation so that houses are classified in a manner that allows them to be sold with such certificates. These certificates should then be acceptable to the banks, insurers and others involved in conveyancing and there should be no restrictions imposed on such dwellings.

There are suggestions for the builders (and/or their structural defect guarantee provider or insurer) to immediately engage with the homeowner to remediate the damage due to pyrite. HomeBond should consider its letter of 31 August 2011 and re-engage with homeowners as soon as practicable. The Insurance Industry Federation and the relevant insurers should engage in the process of finding solutions to the pyrite problem.

The Government should ensure that strong leadership is provided to influence the engagement of the construction industry and related players in facilitating a resolution of the pyrite problem. A Resolution Board should be set up by the Government to handle cases which cannot be dealt with by other means. This should not be funded by the Exchequer but could be funded by, for example, a levy on the construction/quarrying sector or other means.

In respect of paying for the remediation, it is accepted by all with whom the Panel met, that it should be paid for by those who have responsibility for the problem. It is recognised that

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this inevitably remains a contentious issue. The construction and quarrying industry should elaborate on their ideas as to how this could be done quickly and how it could be paid for (including how the construction/quarrying industry and their insurers could contribute financially). The banks/mortgage providers should reassess their current position and consider providing mortgage funding for the remediation work on the homes for which they have provided mortgages.

In respect of enforcement of Building Regulations, building control authorities should consider whether they can use the enforcement provisions in the Building Control Acts, 1990-2007 to require builders to remediate pyrite-damaged dwellings. The Minister for the Environment, Community and Local Government should also consider providing relief from the proposed property tax for dwellings where damage has been proven to be due to pyrite heave.

There is a set of recommendations to assist in preventing a pyrite-related or similar problem in the future, including the following: a specification for hardcore for under concrete floors in buildings; testing and certifying hardcore material produced by quarries and for its traceability; and easy availability, in digital format, of data related to products used in residential construction.

In respect of enforcement by building control authorities, they should adopt a risk-based approach to inspection and enforcement; take enforcement action for serious breaches of Building Regulations; require evidence of periodic testing and certification of hardcore used on sites and the Minister for the Environment, Community and Local Government should consider extending the 5 year time limit for prosecutions. The guidance provided by the County and City Managers' Association in respect of inspections and enforcement should be reviewed and amended.

Consideration should be given to mandatory certification of compliance with Building Regulations, together with recognition of the importance of inspections, product certification and site supervision; mandatory registration of builders with specific requirements for adequate insurance, demonstrated technical competence and financial capacity and the public availability of this information through the internet.

There should be a review of the Statute of Limitations in respect of latent defects and for a number of insurance issues, including a minimum cover for house insurances; on-going

## Executive Summary

review of the standard limits for Contractor's All-Risk and Public Liability; consideration given to project-related insurance and removal of any additional restrictions on pyrite-affected dwellings. Government needs to address the broader issue of how to establish a system that would provide protection for the public, in the case of urgent and serious problems to a large number of people (such as happened in the case of pyrite), without having to resort to prohibitively expensive, time-consuming and uncertain legal actions being undertaken by each individual.

In relation to Continuing Professional Development of construction professionals, a course should be developed to deal with pyrite and pyrite heave and a part-module should be provided in third level construction, design and engineering courses that deals with pyrite and pyritic heave.

The Department of the Environment, Community and Local Government should take the lead in establishing a more effective and efficient method for dissemination of information to ensure that important information reaches relevant people in a timely manner (including using the internet) and with a suitable feedback loop to ensure that the information has been received and acted upon. The National Standards Authority of Ireland should provide a single, publicly accessible information point with up-to-date information on standards.

This Report contains a comprehensive set of inter-related recommendations and the Panel recommends that they are implemented in their totality. The successful implementation of the recommendations will require one body, possibly the Department of the Environment, Community and Local Government, to have overall responsibility for, monitoring, coordinating and managing the implementation of the Report's recommendations in a timely manner. The implementation process needs to be focussed on achieving positive outcomes for homeowners quickly and effectively and systems need to be put in place to monitor and report publicly on progress.

This Report contains some recommendations which are designed to ensure that the risks of similar problems occurring in the future are kept to a minimum. The homeowners' concerns should be central in any future considerations by ensuring that they are addressed rapidly and comprehensively, preferably without having to resort to litigation.

The Panel trust that the implementation of these recommendations will reduce the possibility of problems like those that have arisen with pyrite, happening again





# Chapter 1: Introduction

## 1.1 Setting up of the Pyrite Panel

In September 2011, Mr. Phil Hogan, T.D. Minister for Environment, Community and Local Government announced the establishment of an independent Panel to address the issue of pyrite contamination in hardcore material used in the construction of private housing stock. The remit of the Panel was to identify possible options to address the problem caused by pyrite and in particular to try to facilitate a resolution of the problem for homeowners whose homes have been affected by pyrite. The Panel was also asked to make recommendations that might help to prevent a similar situation arising in the future.

The Panel was chaired by Brendan Tuohy, a former Secretary General in the Department of Communications, Energy and Natural Resources and the other members of the panel were Noel Carroll, a former Senior Adviser in the Department of the Environment, Community and Local Government<sup>2</sup> and Malcolm Edger, a Chartered Civil Engineer and former Director of PH McCarthy Consulting Engineers.

## 1.2 Background

In mid-2007 the issue of pyrite first came to the attention of the Department of the Environment, Community and Local Government<sup>3</sup> by way of representations from politicians and in media coverage. In the early stages, the problems appeared to be confined to a number of private housing developments in the Fingal area of Dublin, where the under-floor hardcore filling was reported to contain a natural occurring mineral known as pyrite and this was causing the floors to heave and was resulting in cracks in walls. However, it soon became clear that the problem was more widespread and was a complex issue.

By 2011, it was clear that an extremely difficult situation had developed for many house owners whose homes were affected by pyritic heave. There was a lack of clarity in relation to information on pyrite and its impact and, in the absence of this information, many theories abounded. Additionally, estimates of the number of houses affected varied widely. Figures from 20,000 to 60,000 were regularly mentioned but there was no apparent evidential basis for these figures other than possibly the estimated level of extraction of material from quarries suspected of supplying materials containing pyrite.

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2 Formerly Department of the Environment, Heritage and Local Government

3 Formerly Department of the Environment, Heritage and Local Government

### 1.3 Approach adopted by the Panel

At its first meeting on 21 October 2011, the Panel agreed the broad parameters of the task they had been asked to undertake and the methodology they would employ to complete it. The Panel was keenly aware of the challenge of its assignment and recognised the very difficult situation faced by the many homeowners whose homes were affected by pyritic heave and who, in many cases, were experiencing significant difficulties in securing a resolution of their problems through the available channels. This position was confirmed in subsequent meetings with homeowners. It was not within the Panel's remit to apportion liability, in the legal sense, for the problem and, in undertaking its work, the Panel was aware that a number of legal proceedings had been instituted and more were pending.

The Panel was not established under any legal statute and therefore did not enter into the legal arena and had no powers to compel people to appear before it. The remit of the Panel was not to find a legal solution or to undertake a detailed and comprehensive study of the pyrite issue but rather, within the timeframe available, to give an overview of the problem and provide some guidance and recommendations to assist the Minister in addressing the problem.

The Panel agreed that it should meet with a broad range of the key stakeholders who had an involvement in the pyrite issue, including representatives of the industry, local authorities, construction professional bodies, guarantee providers, insurance companies, quarry owners, builders, State agencies, banks and a representative group of homeowners directly affected by a reactive pyrite problem. The Panel also agreed that it would engage with any other individuals or groups who had a particular knowledge and/or experience of dealing with the pyrite issue and whom it considered could assist it in recommending options for dealing with affected dwellings and prevention of a recurrence of the problem.

The Panel identified four key areas that needed to be addressed:

- Establish the scale of the pyrite problem;
- Suggest technical options for the remediation of dwellings affected by pyrite;
- Pursue options with stakeholders on possible financial solutions to effect a resolution;
- Propose measures to prevent a recurrence.

The Panel invited 52 groups/organisations to meet with it and held 57 meetings with 44 groups/organisations from a broad range of backgrounds and experience. The Panel provided a forum for stakeholders from divergent backgrounds to offer views on the work being addressed by the Panel. The Panel gained valuable knowledge from this diverse range of opinion, experience and knowledge of pyrite and, through this engagement, sought to establish a range of opinions and facts. A number of submissions were received, most of which was relevant to the work of the Panel and they are available at <http://www.environment.ie/en/PyriteReport/>

Liability in individual cases is a matter for adjudication by the courts. The Panel concerned itself with identification of the developments where reported pyrite damage had occurred, the process of seeking solutions to those cases, provision of guidance for the avoidance of similar problems in future and provision of practicable assurance for all those purchasing, funding or insuring houses.

All of the groups/individuals with whom the Panel met expressed genuine concern for and empathy with the individual householders whose homes were affected by pyritic heave. It is clear to the Panel that the affected people are in particularly difficult situations and left, through no fault of their own, struggling to cope with the consequences of the pyrite problem. Many found that there are very few, if any, realistic avenues open to them on an individual basis to get redress and the costs and time involved in securing the necessary remediation carried out has proven to be hugely expensive. The damage to homes due to pyrite unfortunately coincided with the downturn in the house building industry and the economy in general. The strained economic situation resulted in many builders and developers, large and small, going out of business. This has exacerbated the situation for homeowners whose first port of call, the builder/developer, is no longer in business. Homeowners believed that the overall regime under which they purchased their homes would be such that it would protect them against eventualities such as pyritic heave and consequently they feel let down by the level of response and action to what has happened. The Panel understands and appreciates the concerns and position of the homeowners involved.

The Panel was disappointed that some stakeholders were unwilling to meet with it and in particular some of the insurance companies involved with the construction industry. In the case of the Irish Insurance Federation (IIF), its lack of any engagement with the Panel was disappointing and frustrating and the Panel considers that it was a missed opportunity for the IIF to make a meaningful contribution to the work of the Panel. In a letter to the Panel dated 8 February 2012, the IIF stated *“it is not possible for the IIF to assist the Panel with the three core issues it wishes to address”*. The Panel considered this to be a disappointing response particularly as the IIF states that one of its key functions (as outlined in its website) is *“representing its members’ interest to Government, state agencies, regulatory bodies, public representatives, other interest groups, the media and the general public.”*

The Panel was also disappointed that the Law Society also declined to meet with it, stating that *“this problem is not likely to be a conveyancing practice issue ....this matter is more appropriately dealt with by way of Building Regulations and is a matter therefore for the engineering and architectural bodies to deal with and that, it is not a conveyancing matter”*. The Panel considers that the members of the Law Society are engaged in conveyancing and, in this regard, there are issues in relation to the pyrite problem that could have been usefully discussed with the Panel.

### 1.4 Structure of the Report

The Report is not intended to be an in-depth study of pyrite or associated problems. Chapter 2 deals generally with pyrite while Chapters 3 and 4 deals with the emergence of the pyrite problem and the scale of the problem respectively. Chapter 5 gives an overview of the Building Control System and Chapter 6 deals with stakeholder activity and responsibilities. Chapter 7 looks at the technical solutions for dealing with pyrite in hardcore and Chapter 8 sets out the Panel's conclusions and recommendations.

A list of individuals, groups and companies who met with the Panel is attached at Appendix 1. A number of companies who were invited but decided not to engage with the Panel are listed at Appendix 2.

The Panel would like to express it's gratitude to everyone who gave of their time, expertise and experience to assist it in undertaking its task.



# Chapter 2: Pyrite in Ireland

## 2.0 Introduction

This chapter explains what pyrite is, the damage it can cause to structures and where it can be found in Ireland.

## 2.1 Pyrite and pyritic heave

### 2.1.1 What is Pyrite?

Pyrite (Iron Sulfide  $\text{FeS}_2$ ) is a naturally occurring mineral comprised of the elements iron and sulfur. It is the most common of the iron sulfide minerals. Others include marcasite<sup>4</sup> and pyrrhotite<sup>5</sup>. Pyrite generally occurs as an accessory or trace mineral in rocks, most commonly in sedimentary rocks<sup>6</sup>. Within the sedimentary group of rocks, it occurs particularly in argillaceous (clayey or shaley) or carbonaceous (coaly) rocks. Pyrite can occur in both igneous rocks<sup>7</sup> and metamorphic rocks<sup>8</sup> but is mainly associated with metallic mineral deposits as veins, disseminations (i.e. scattered) or massive. Pyrite samples are shown in Photograph 2.1 below.

4 Marcasite: Marcasite has the same chemical formula as pyrite –  $\text{FeS}_2$ . It occurs in similar sedimentary rocks as pyrite (shales and carbonaceous sediments) but is not as common. Marcasite does not occur in igneous rocks (except in some mineral veins).

5 Pyrrhotite: Pyrrhotite has a chemical formula  $\text{Fe}_{1-x}\text{S}$  where x is between 0 and 0.2. This means that there is usually more sulphur in the mineral than iron. Pyrrhotite occurs in mafic (iron and magnesium rich) igneous rocks. It may also occur in many different types of mineral deposits. Pyrrhotite is present only in specific geologic environments in Ireland of which there are relatively few. These are mafic (iron and magnesium rich) igneous rocks, high-grade metamorphic rocks, thermal aureoles and skarns and, in some instances, metalliferous orebodies. Pyrrhotite is known to occur in ore veins at localities in Connemara, for instance.

6 Sedimentary rock is rock formed by the deposition of material at the Earth's surface or within bodies of water. Limestone, sandstone and shale are examples of sedimentary rocks.

7 Igneous rock is formed through the cooling and solidification of magma or lava. Granite and basalt are examples of igneous rocks.

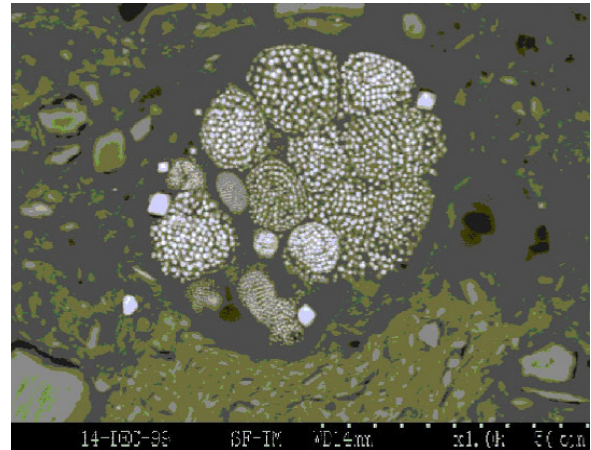
8 Metamorphic rock is the transformation of an existing rock type, (either a sedimentary rock, igneous rock or another older metamorphic rock). The rock may be subjected to heat and pressure (temperatures greater than 150 to 200 °C and pressures of 1,500bars). Marble, slate, and schist are examples of metamorphic rocks.

## Chapter 2: Explanation of the pyrite problem

Photograph 2.1 Samples of pyrite



a. Crystalline pyrite



b. Framboidal pyrite  
(Electron microscope photo image)

In general, pyrite may be described as being either reactive or non-reactive. Reactive pyrite generally has a framboidal texture – a texture that superficially resembles raspberries on a microscopic scale (Photograph 2.1b). It is not visible to the naked eye. It is reactive as it affords a large surface area which facilitates the oxidising reactions. On the other hand, non-reactive pyrite usually occurs as crystals (Photograph 2.1a). Non-reactive pyrite actually reacts very slowly at a rate that may not be noticeable over a lifetime.

### 2.1.2 Pyrite oxidation

Put simply, when exposed to moisture and oxygen, pyrite will oxidise to form sulfuric acid ( $\text{H}_2\text{SO}_4$ ) and other products. The acid may in turn react with other minerals found in the rock. If calcium carbonate is present in the rock, it will react with the sulfuric acid to form calcium sulfate ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) in the form of gypsum. (See Figure 2.1). Bacteria, acidity and temperature may also influence these reactions. For example, the rate of oxidation increases as temperature increases.

Photograph 2.2 shows two samples of a drill core. The upper drill core is solid limestone without any pyrite which was drilled several years ago and it is still intact. The lower sample contains pyrite and when drilled came out of the ground as a solid cylinder of rock as in the upper sample. However, as is evident, the sample has deteriorated and contains many cracks and loss of integrity. This sample was photographed only one month after it was drilled.

Photograph 2.2 Samples of limestone cores<sup>9</sup>

Top: Limestone core containing no pyrite (after several years of exposure)

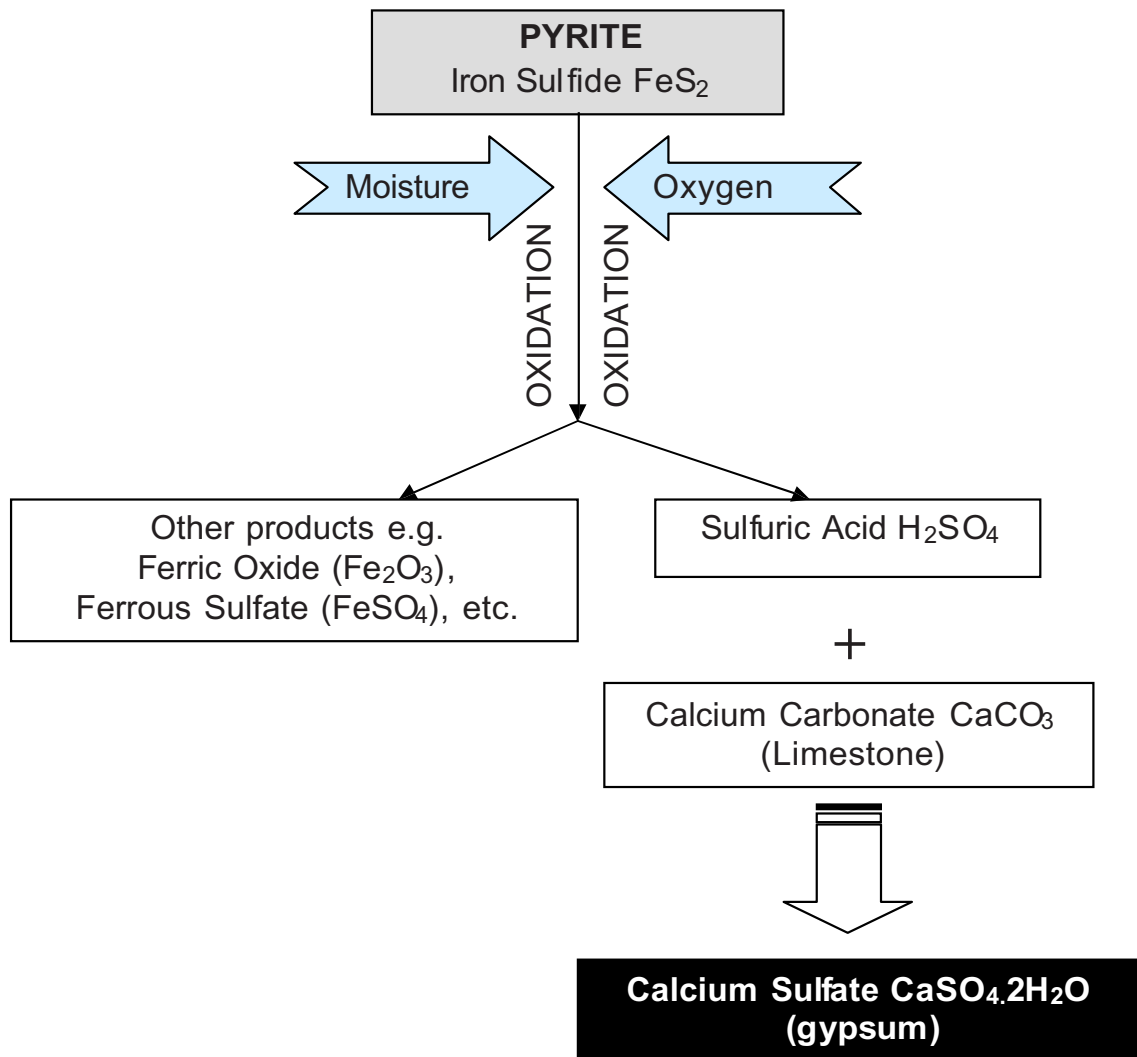
Bottom: Limestone core containing reactive pyrite (after one month of exposure)



<sup>9</sup> Photographs courtesy of Geological Survey of Ireland, 2011



Figure 2.1 Simplified illustration of Pyrite Oxidation <sup>10</sup>



10 Source: BRE 2011 Hardcore for supporting ground floors of buildings Part 2: Placing hardcore and the legacy of problem materials BRE DG 522 Part2.

### 2.1.3 Pyritic heave

Gypsum, formed in the manner described above, has a significantly greater volume, approximately twice<sup>11</sup> that of the source pyrite. The growth of its crystals, in between the laminations of rock, prises open cracks. This results in greater overall expansion than just the volume of the gypsum crystals.

New research also suggests that *“the initial expansion experienced in the Dublin properties is related to the development of the ferrous sulfate rims, prior to the expansion due to the growth of gypsum”*<sup>12</sup>.

Where the greater overall volume cannot be accommodated (e.g. in well compacted hardcore confined between rising walls and ground floor concrete slab), heaving occurs that may result in

- the cracking of floors, internal partitions and external walls,
- outward movement of external walls; or
- the heaving of ground floors and bulging of internal partition finishes.

Cracks in the concrete floor slab caused by pyritic heave are typically known as “spider” cracks and take the form of a cross or a star. Results of pyritic heave can be seen in Photographs 2.3 below.

This damage can lead to further problems such as doors not closing or opening, counter tops buckling, ingress of water, stresses on service pipes etc. In the more serious cases, there may be a concern about fire safety and safety in respect of gas pipes, if the service pipes are damaged. The Panel has contacted Bord Gáis Éireann, which has no record of any such damage to connections, to date. However, it recommends that customers who are concerned, suspect a leak or notice a smell of gas contact Bord Gáis Éireann immediately.

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11 Association of Engineering Geologist, Montreal Section, Pyritic shales and heaving problems - Technical Report (1997) “the formation of iron hydroxides and calcium sulphates leads to a volume increase over 100% with relation to the original materials (calcite and pyrite).” 2. Hawkins, A. B (2011)- Sulphate heave: a model to explain the rapid rise of ground bearing floor slabs. [Bulletin of Engineering Geology and the Environment Volume 71, Number 1](#) (2012), 113-117, “The product mineral has a volume approximately double that of the original components.”

12 Hawkins, A. B (2011)- Sulphate heave: a model to explain the rapid rise of ground bearing floor slabs. [Bulletin of Engineering Geology and the Environment Volume 71, Number 1](#) (2012), 113-117

Photographs 2.3 Cracks typical of pyritic heave<sup>13</sup>

(i) Cracking of floor slab



(ii) Cracking of footpath



13 Photographs courtesy of Ballymun Regeneration Ltd. and others

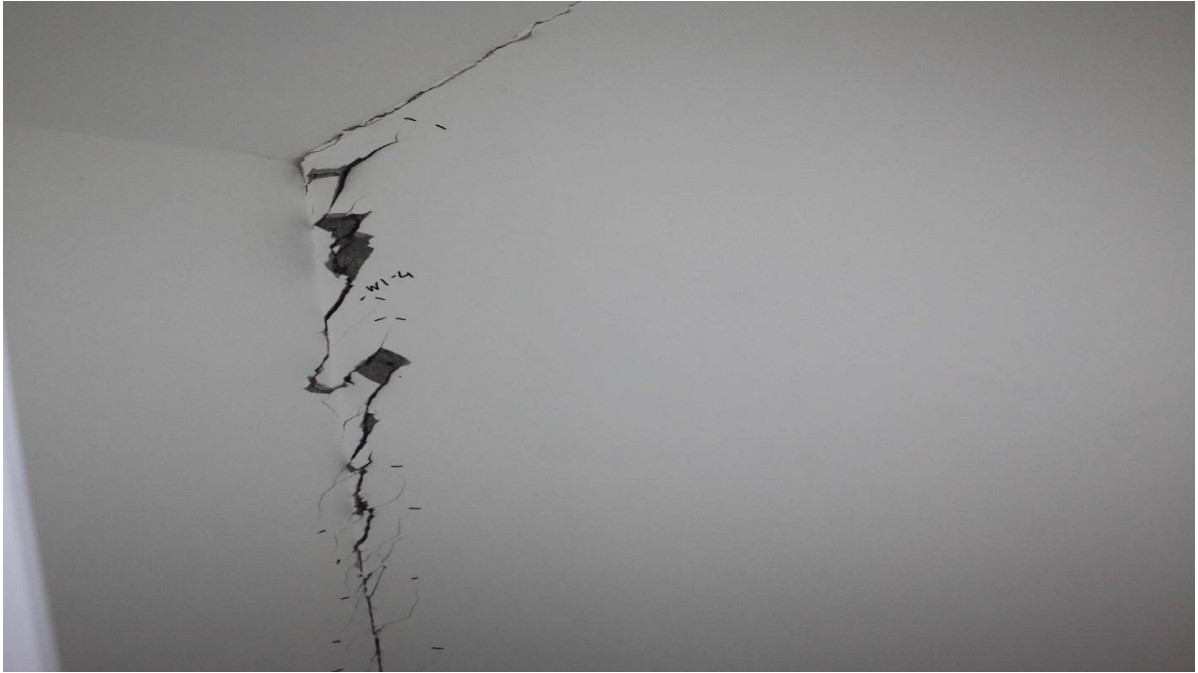
(iii) Cracking at door frames



(iv) Cracking at head of door



(v) Cracking at corners



(vi) Bulging of wall finishes



(vii) Bulging of wall finishes



(viii) Bulging of wall finishes



(ix) External wall cracking



(x) External wall cracking



### 2.1.4 Other problems associated with pyrite

There are other problems that may be associated with pyrite in hardcore, one of which is sulfate attack of some adjacent cementitious materials. This is explained below. Other problems associated with sulfides such as pyrite are described in Appendix 3.

#### 2.1.4.1 Sulfate attack

While oxidised pyrite creates a sulfate that can attack Portland cement in materials, it should be noted that there are also many other sulfates that cause this damage e.g. waste products from heavy industries, iron/steel industry, coal mining, demolition waste containing gypsum as well as other naturally-occurring sulfur species e.g. epsomite, mirabilite etc.

In general, sulfate attack happens when water-soluble sulfates (e.g. gypsum), in the presence of water (to transfer the sulfates into susceptible materials), react with the constituents of Portland cement (e.g. tricalcium aluminate,  $\text{Ca}_3\text{Al}_2\text{O}_6$ ). The reaction results in a destructively expansive material.

Some cementitious materials in contact with the pyritic hardcore are vulnerable to this form of attack. Examples include the masonry in rising walls, the mortar in bed joints of such walls, concrete ground floor slabs, etc. However, sulfate attack of concrete floor slabs would be unusual in modern construction as, normally, insulation and a radon or damp proof membrane separate the concrete floor from the hardcore below.

If subject to sulfate attack, some cement-based products will crack and stresses will build up, ultimately resulting in the concrete or mortar crumbling at the interface with the sulfate.

The Panel was informed by a number of experts, directly involved in cases of damage caused by pyritic heave, that sulfate attack had not presented, thus far, as a significant structural issue.

## 2.2 Pyrite in Irish geology

### 2.2.1 General

Pyrite is a fairly ubiquitous mineral and occurs in three broad classes of rocks:

1. Argillaceous rocks (fine grained clay mineral rich rocks)
2. Carbonaceous rocks (coal measures and carbonaceous shales)
3. Mineral deposits
  - A. As massive thick beds of pyrite in volcanogenic massive sulfide deposits, e.g., Avoca, Co. Wicklow.
  - B. As disseminations in porphyry<sup>14</sup> (copper – molybdenum deposits, e.g. Mace Head, Co. Galway. Molybdenum is an element which is used as an additive in the manufacture of some steels.
  - C. As veins which may cut almost any rock type, e.g., Lackagh, Co. Tipperary
  - D. As lens shaped occurrences in Irish limestones which are commonly associated with Irish type zinc lead deposits.

14

Porphyry is a descriptive term referring to a particular feature that may occur in igneous rocks – essentially it is the occurrence of larger minerals in a groundmass of smaller minerals.



Even if pyrite is not visible to the naked eye, it can be present as microscopic disseminations. A further complication arises in that there is always the possibility of crush zones, fault gouges, or shale bands in an otherwise 'non-pyritiferous' rock.

The Geological Survey of Ireland (GSI) maintains a database of Irish mineral occurrences, known as Minlocs (mineral localities)<sup>15</sup>. This database can be interrogated and a list of pyrite occurrences generated. Out of the 7,632 entries in the database, 327 are for pyrite – representing some 4% of the entire database. There are only 9 occurrences of pyrrhotite and no entries for marcasite.

### 2.2.2 Prevalence of pyrite in Irish rock formations

Guided by the information above, it is possible to derive a map which shows geological formations with the potential to contain pyrite. Figure 2.2 is a preliminary assessment of the occurrence of pyrite in the geological formations of Ireland. It shows three features:

- the prevalence of pyrite in the geological formations (subdivided in to 'common', 'present' and 'rare or not known').
- counties for which there has been limited work to derive the map.
- an area of detail centred on north County Dublin.

From the map it appears that pyrite is common in certain formations distributed around the country. Of particular concern to the Panel is an area centred on north County Dublin/ Fingal / County Meath. This area is illustrated in more detail in Figure 2.3, which also shows the Tobercolleen formation (calp formation consisting of calcareous mudstone).

The database used to generate this map has been used to identify those formations which are most likely to contain pyrite and those that may contain pyrite. See Appendix 4 for *Table A4.1: Geological formations with known presence of pyrite* and Appendix 5 for *Table A5.1: Geological formations with potential presence of pyrite*.

The national geological map is generated from over 24,000 polygons and each polygon has been assessed individually (except for the counties illustrated in Figure 2.2 where in these cases a generalisation has been made). It should be emphasised that this is a preliminary exercise generated by the GSI at the request of the Pyrite Panel.

The purpose of these maps is to provide a general indication of where pyrite might occur across Ireland. As a generalisation, it should not be used to draw conclusions about specific sites or locations. The suitability of any particular location or site needs to be assessed on its own merits. These maps should not be used as a basis for such assessment.

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15 [http://spatial.dcenr.gov.ie/imf/imf.jsp?site=GSI\\_Simple](http://spatial.dcenr.gov.ie/imf/imf.jsp?site=GSI_Simple)

Figure 2.2 An indication of the presence of pyrite in geological formations in Ireland.

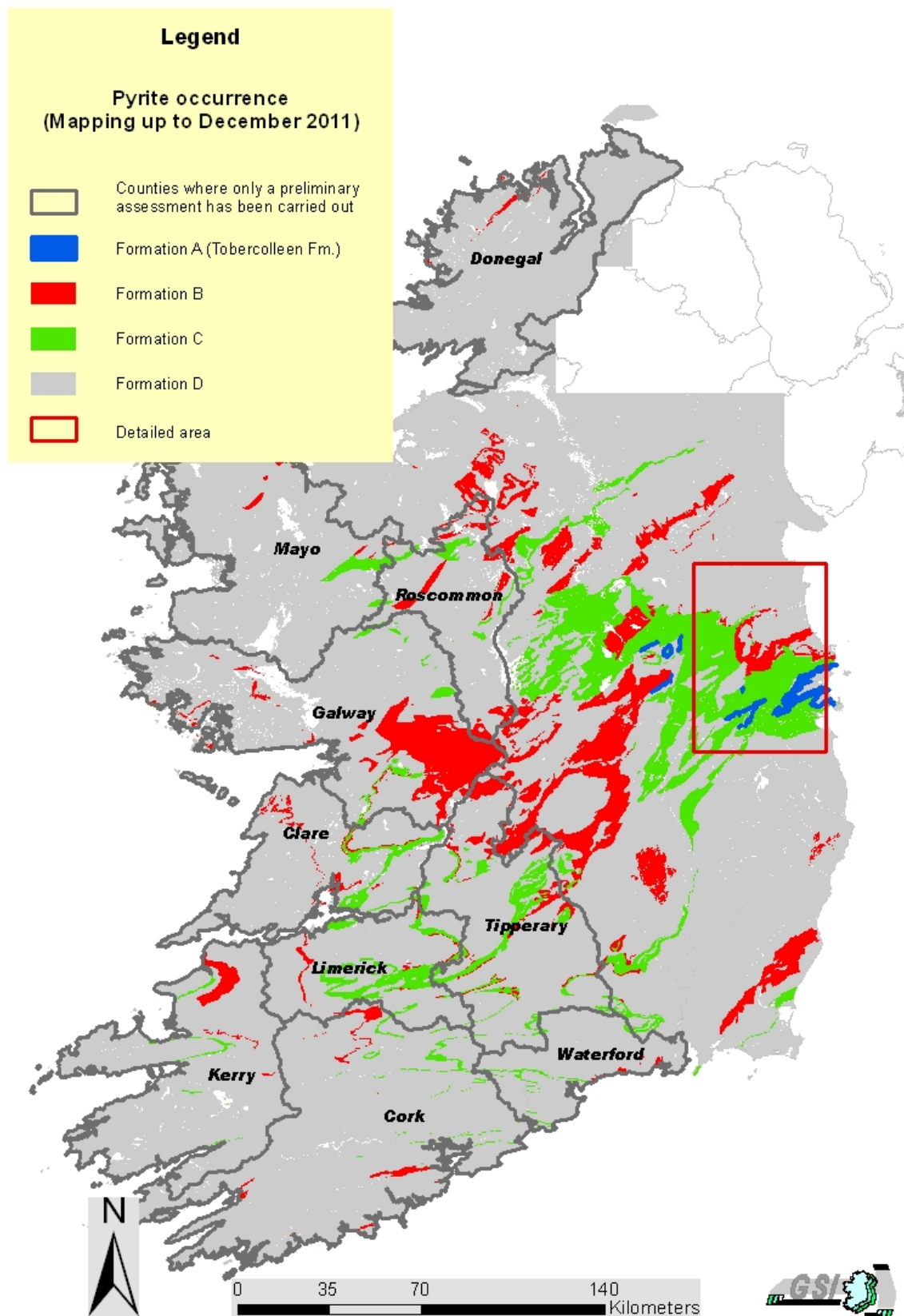
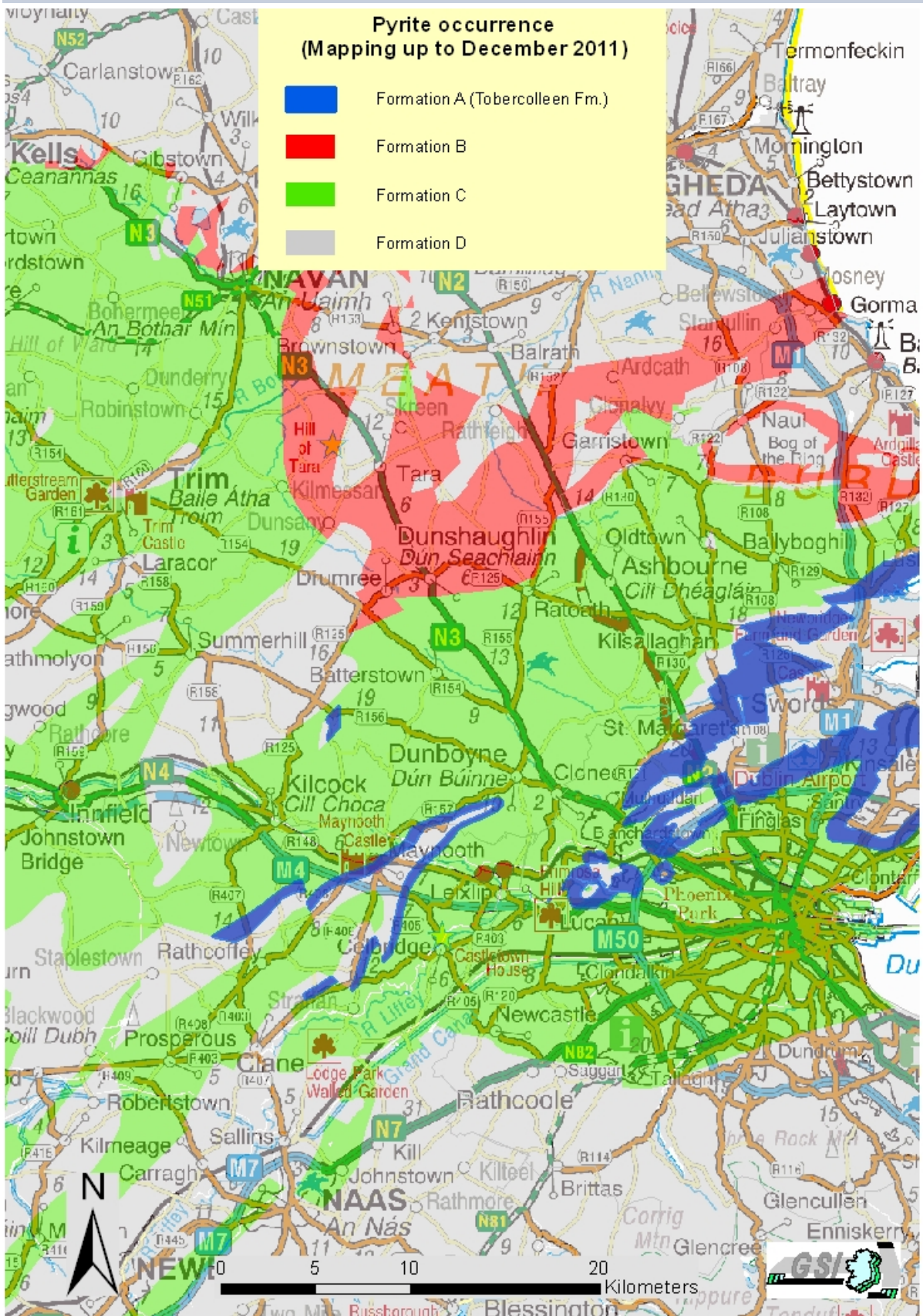


Figure 2.3 An indication of the presence of pyrite prevalence centred on north Co. Dublin



Figures 2.2 and 2.3 subdivide the many geological formations in the country into four groups labelled for simplicity as formations A (Tobercolleen Formation), B, C and D on the maps. It should be understood that this is not to imply that there are only four rock formations in the country but rather they are an attempt to provide an indication of the prevalence of pyrite across the country. The four groups are explained in the following paragraphs.

### Formation A (Tobercolleen Formation)

Formation A is known as the Tobercolleen Formation and is highlighted by the **blue** colour. The Tobercolleen Formation consists of dark grey, calcareous mudstones with thin micritic limestones and, in which, pyrite is a common constituent.

Note: There are other formations in which pyrite is a common constituent apart from the Tobercolleen Formation.

### Formation B

The **red** colour represents rock formations where pyrite is also a common constituent of the formation. The area shown on the map comprises of a number of different rock formations including the Calp Limestone in the west of the country, the Avoca volcanic Formation, some rocks from the Leinster Coalfield area and some granitic rocks in the West of Ireland.

Note: There is no difference between the areas designated A and B in terms of their likelihood to contain pyrite.

### Formation C

The **green** colour represents rock formations where pyrite may occur but it is not ubiquitous constituent of the rock. These rocks include some limestone formations from the central midlands and the Calp limestones from the Dublin and eastern part of the country.

### Formation D

The **grey** colour represents rock formations where pyrite is unknown in the rock formations or where it is uncommon. These are the rocks from the remainder of the country and include most of the granites of the country, the sandstones from the Cork – Kerry area and most of the grits, slates and other volcanic rocks of Lower Palaeozoic age (greater than 410 million years old).

### 2.2.3 Locations of quarries

Five quarries were identified to the Pyrite Panel as possible sources of hardcore used in dwellings displaying signs of pyritic heave. These quarries are all located within the map in Figure 2.3. It is important to note that at least one of these quarries is located in each of the four formations identified on the map i.e. Formations A, B, C and D. For further information on quarries see Chapter 4, section 4.3.5. Due to legal, commercial and other sensitivities that surround the pyrite issue, the names and exact locations of suspected quarries identified to the Panel are not included (except where already in the public domain through court reports or other publications).

### 2.2.4 Discussion

It was suggested to the Panel that the relevant people in the quarrying industries should have been aware that the Tobercolleen Formation, in particular, was prone to pyrite and as a consequence a more rigorous testing regime should have been in place. However, as can be seen from the above, pyrite is not unique to the Tobercolleen Formation and can be present in other rock formations.

While geologists are and have been aware of the likelihood of certain rock formations to contain pyrite, this knowledge is put to use primarily in the metal mineral exploration community and the academic community. Geologists are not commonly involved in the construction or quarrying sectors. It was suggested to the Panel that the level of geological input at quarries varies significantly and in some cases it is simply inadequate.

The Panel also acknowledges that the quality of stone in individual quarries can vary and it is not unusual to see seams of poor quality material in otherwise good rock.

### 2.2.5 Conclusion

The presence of pyrite is not confined to particular geological formations (e.g Tobercolleen Formation). It is widespread and the likelihood of the presence of pyrite across the country is illustrated in Figure 2.2. A testing and inspection regime for all quarries, by suitably qualified personnel, should be established. This should identify the presence of pyrite and reduce the risk of reactive pyrite being present in hardcore used in buildings. It should also help to ensure that hardcore meets the appropriate specification.

# Chapter 3: Emergence of the pyrite problem

## 3.0 Introduction

This chapter sets out the events that led up to the confirmation of pyritic heave in 2007. It explains the context of a rapidly-growing construction sector in Ireland at the time and, in particular, a huge growth in residential construction. It describes the response of key stakeholders and the evolution of the specification for hardcore. The information is also represented graphically on a timeline.

## 3.1 Investigations over the period 2005-2007

### 3.1.1 Background

In 2005, HomeBond, one of the companies providing structural defect warranties for new dwellings<sup>16</sup>, began investigating cracking in walls and floors of a dwelling in the Midlands, the cause of which was unknown at the time. During 2006, Menolly Homes was investigating abnormal cracking in three housing estates in the Fingal area. Ballymun Regeneration Limited (BRL) was also investigating cracks that had appeared on the Ballymun Central Youth Facility (RECO) shortly after construction. In the absence of other explanations, it was considered that the damage must have been due to settlement. Remediation works to address settlement were carried out on some of these sites. However, the cracks re-appeared. In early 2007, testing confirmed high levels of the mineral pyrite in the hardcore beneath ground floor slabs in a number of the units under consideration.

### 3.1.2 Discussion

In discussions with the various professional disciplines involved in the construction sector in Ireland, it was stressed to the Panel that the professions concerned were unaware of the potential problem of pyritic heave prior to 2007.

The early diagnosis of the problem failed to identify pyrite initially but subsequently the diagnosis concluded that the problem was due to pyritic heave.

The Panel was informed that there was only passing reference to the mineral pyrite as part of geology modules in third level construction and engineering courses, but no specific information on pyritic heave or on the damage it causes.

However, it was also suggested to the Panel that the problem of pyrite in hardcore had been well documented in UK literature prior to 2007.

The information available from the UK, mainly through publications of the Building Research Establishment (BRE), was provided in the context of general problems with hardcore.

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16 Refer to chapter 6, section 6.1 information on HomeBond

## Chapter 3: Emergence of the pyrite problem

From 1979, the BRE publications<sup>17</sup>, in general, identified three forms of failure that had been caused by or associated with hardcore.

- The first, was the common problem of settlement of concrete floor slabs mainly due to poor consolidation or compaction of the hardcore. This had occurred in Ireland also. The problem rarely arises now as there are well-established methods of compaction.
- The second, was a specific, but widespread, problem in the UK due mainly to the use of waste materials from heavy industries as hardcore such as, for example burnt colliery spoil (red shale), furnace bottom ash (black ash) and oil shale residue. Thousands of dwellings across the UK were affected by sulfate attack of concrete floors or oversite concrete, due to the high soluble sulfate content of these materials. The affected concrete expands and loses strength which, in turn, results in damage such as cracks, displacements and doming or uplift of concrete floor slabs.
- The third, “less frequent occurrence”<sup>18</sup>, was the expansion of hardcore. This was caused by several types of material, mainly by-products of steel and coal heavy industries, including blast furnace slag, steel slag and unburnt colliery spoils, but also from weak quarried rock containing pyrite. In the case of the latter, however, there were only two documented cases of such failures;
  - (i) In the 1970s, in North East England, Cleveland, south of the River Tees, quarried pyritic mudstone (from the Whitby Mudstone formation)<sup>19</sup> was used as hardcore. Several houses were affected by heave (The exact figure is unknown but it is thought to be in the tens).
  - (ii) In 1989, another case of pyritic heave in a warehouse in the Midlands occurred again due to pyritic shales used in hardcore<sup>20</sup>.

Since the 1950’s, almost all of the literature which emerged from the UK, dealing with hardcore, has focussed on limiting the damage of sulfate attack of concrete (second bullet point above). For the most part the offending materials from the heavy industry sectors were not widely available in Ireland and, therefore, did not raise much attention here.

The small number and isolated nature of the incidences of pyrite in weak rock used as hardcore, in the UK, did not attract attention within the construction sector in Ireland. Indeed, in the latest technical literature, produced by BRE in the UK<sup>21</sup> as recently as 2011,

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17 BRE Fill and Hardcore. BRE DG 222 London, HMSO, (1979)  
BRE Hardcore, BRE DG 276 Watford BRE (1983, Revised 1992)  
BRE - Building Elements: Floors and flooring, performance, diagnosis, maintenance, repair and the avoidance of defects - BR 460 - Pye PW and Harrison HW (2003) CRC London

18 BRE - Hardcore for supporting ground floors of buildings Part 2: Placing hardcore and the legacy of problem materials – BRE DG 522 Part 2. Longworth I, (2011)

19 Nixon PJ. Floor heave in buildings due to the use of pyritic shales as fill material. Chemistry and Industry, 4 March 1978, pp160-164

20 BRE - Hardcore for supporting ground floors of buildings Part 2: Placing hardcore and the legacy of problem materials – BRE DG 522 Part 2. Longworth I, (2011)

21 BRE - Hardcore for supporting ground floors of buildings Part 2: Placing hardcore and the legacy of problem materials – BRE DG 522 Part 2. Longworth I, (2011)

the Canadian and Irish experiences in relation to this issue of expansion of hardcore containing pyrite are documented.

The problems in Canada, associated with pyrite in hardcore, appear to have only come to light in Ireland as a consequence of the Irish problems manifesting themselves. See Appendix 9 for the Canadian experience.

### 3.1.3 Conclusion

The Panel accepts, at face value, the statement by the design professionals and the construction sector, at large, that they were unaware of the problems associated with pyritic heave prior to 2007. The Panel considers that Continuing Professional Development courses should be developed and made widely available by the professional bodies in the construction sector that incorporate specific programmes on pyrite and pyritic heave. The Panel also considers that a part-module on pyrite and pyritic heave should be included in all relevant third level construction, design and engineering courses.

The Panel commends the organisers of the Pyrite Symposium held at Trinity College Dublin in April 2012. The Panel welcomes the production by the Association of Consulting Engineers Ireland (ACEI) of a guidance note for its members. The Engineers Ireland one day CPD course in May 2012, dealing with pyrite is also seen as a very positive step, along with its decision to prepare a document on the issue. The attendance and quality of technical debate at these events demonstrate the expertise and knowledge that has developed among those professionals who are involved in dealing with pyrite in recent years. The Panel supports these initiatives and considers that there would be major benefits to be gained if the relevant professional institutions collaborated to develop and deliver such courses. This would assist in the improvement of the knowledge base across the country.

## 3.2 Timeline of events over the period 1993-2012

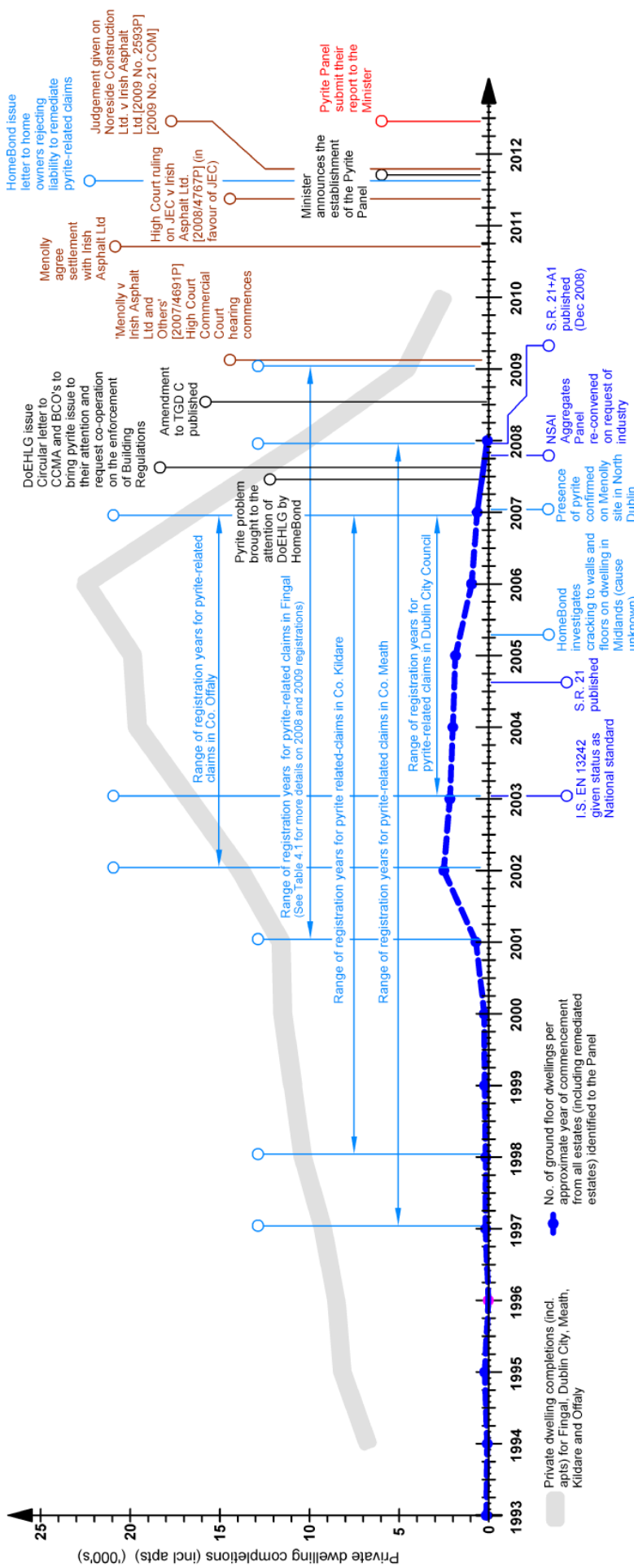
Figure 3.1 graphically illustrates the timeline of known key events recording the following:

- Number of private dwelling completions per annum in the affected local authorities
- Number of ground floor dwellings on estates per approximate year of commencement from all estates identified to the Panel;
- Range of registration<sup>22</sup> years of dwellings for which a pyrite-related claim has been made to a guarantee provider per local authority;
- Response by the construction industry and the Department of the Environment, Community and Local Government;
- Evolution of the standards for aggregates;
- High profile court cases relating to pyrite;
- Total construction output over the period, 1997 - 2011;
- Estimated industry volume of extracted stone products, 1993 - 2011;
- Breakdown of private dwellings identified to the Panel.

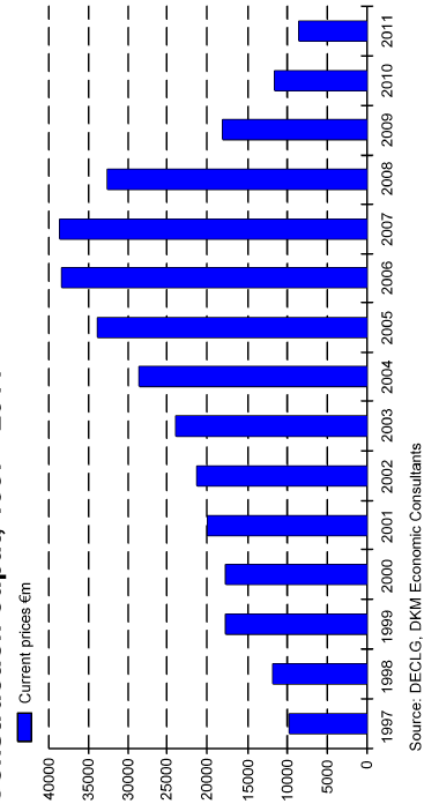
<sup>22</sup> This refers to the year in which the dwelling was registered with a Guarantee provider. In general, this occurs before work commences on site. On larger estates, builders normally register the dwellings in bundles or groups. These groups of dwellings would then be built on a phased basis over a number of years.



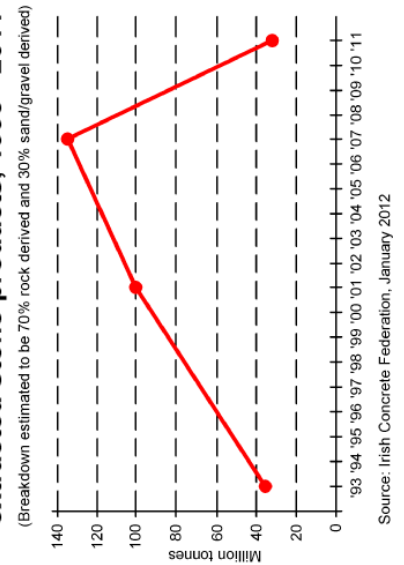
Figure 3.1 Timeline of events



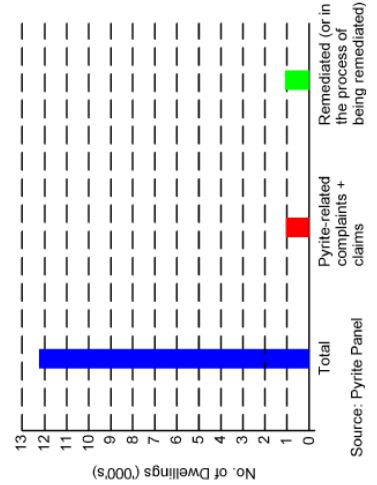
Construction output, 1997 - 2011



Estimated industry volume of extracted stone products, 1993 - 2011



Breakdown of private dwellings identified to the Panel (March 2012)

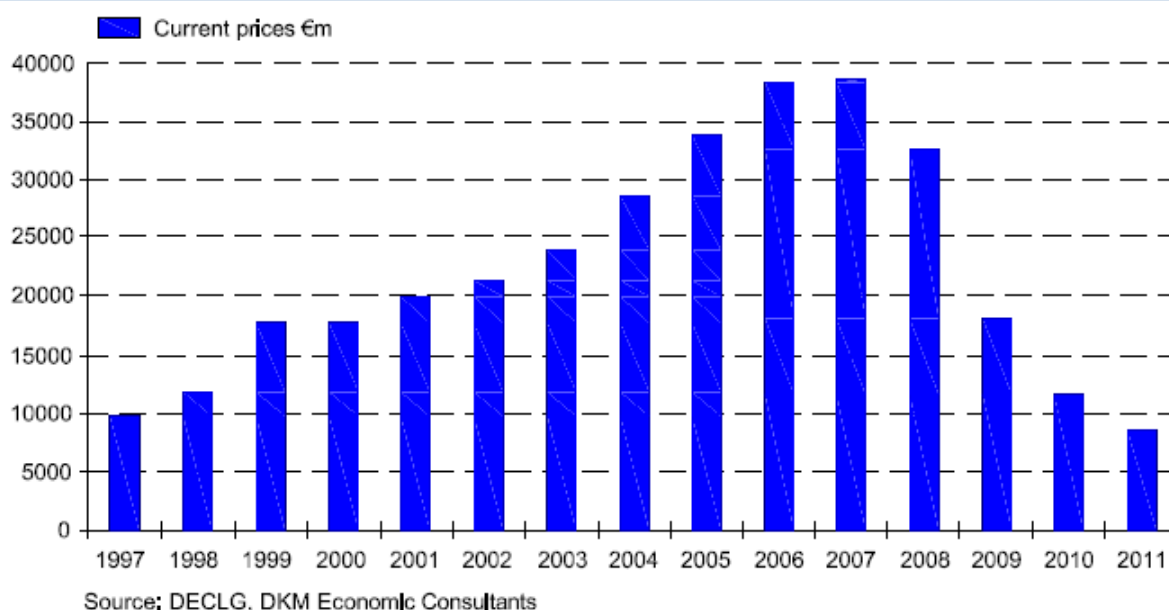


### 3.3 Construction over the period 1995-2007

#### 3.3.1 Rapid growth

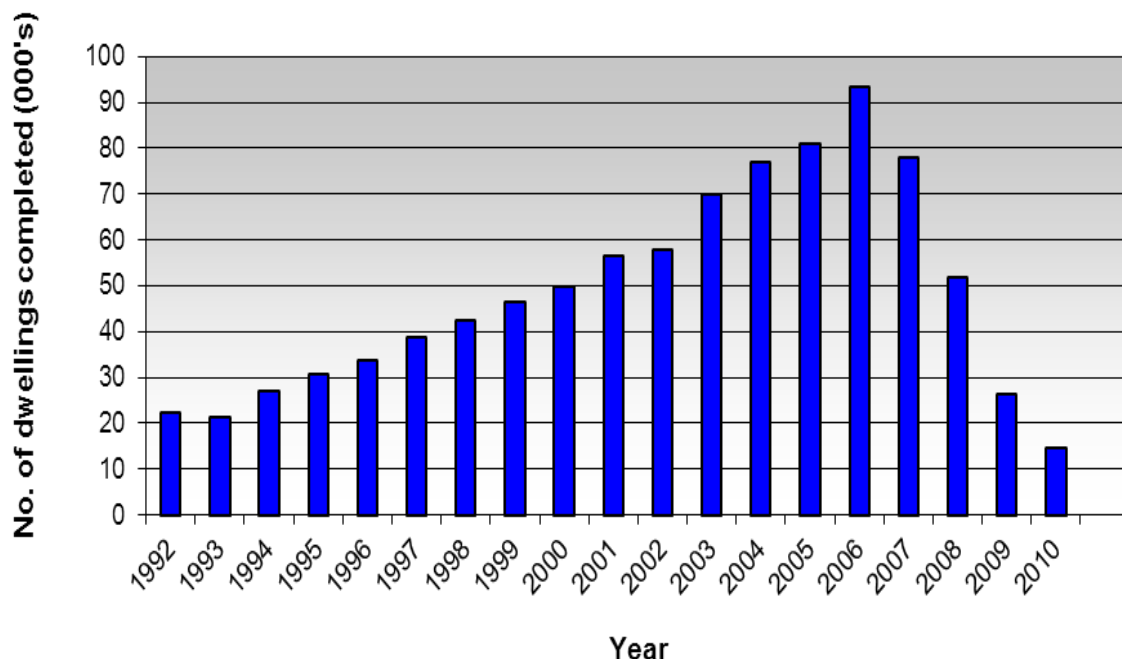
The economy of Ireland grew rapidly between 1995–2007. The Gross National Product (GNP) increased from approximately €48 billion in 1995 to €163 billion in 2007. The construction sector was a major contributor to this growth. By 2007, it supported in the region of 400,000 jobs and accounted for approximately 23% of GNP, equating to approximately €38 billion from a base of €10 billion in the mid 1990's. See Figure 3.2 below.

**Figure 3.2 Overall Construction Output 1997-2011**



The value for overall construction output (€38 billion in 2006 and 2007) is the summation of output from residential, civil engineering and general contracting. Typically, during this time, the residential sector represented approximately 65% of output. The number of dwellings completed increased by nearly 88% between 2000 and 2006, peaking at 93,000 completions in 2006. See Figure 3.3 over.

**Figure 3.3** No. of dwelling completions per annum (nationally)



**Note:**

The figures above include both private and social dwellings completions. Source: DECLG

This level of growth and expansion created an unprecedented demand for construction materials. Extracted stone products (i.e. quarried stone materials such as hardcore, road sub-base materials e.g in accordance with Clause 804<sup>23</sup>) were used extensively in construction projects of all types. The volume of quarried stone products on the market in this period follows the same upward trend of overall growth, with stone output increasing threefold between 1993 and 2007. See Figure 3.4.

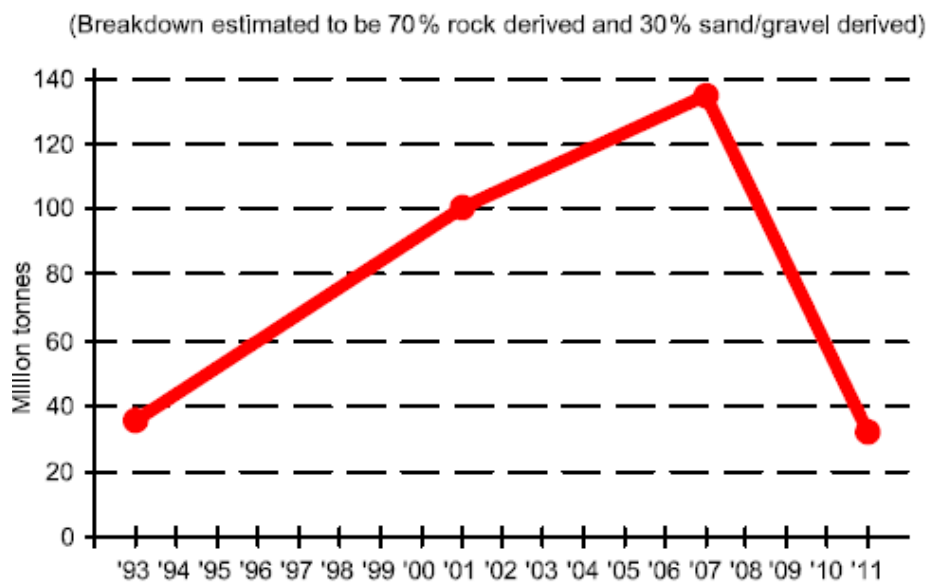
According to the Irish Concrete Federation<sup>24</sup>, which represents many quarries in Ireland, *“the levels of construction output seen throughout the first half of the last decade led to an opportunistic supply of materials often without the necessary technical knowledge at specifier, user or supplier level.”*<sup>25</sup> It was also suggested to the Panel, by ICF and others that, in times of unprecedented levels of demand, the normal quality processes may not have been adequately implemented.

23 Clause 804 is an unbound material used in road construction for sub-bases and road-bases. It is made from crushed rock and must meet a number of physical and chemical requirements as set out in the National Roads Authority specification. See chapter 5, section 5.2 for explanation of “Clause 804”

24 Irish Concrete Federation’s membership represents 80% of extracted stone output

25 Irish Concrete Federation’s submission to the Pyrite Panel December 2011

Figure 3.4 Estimated volume of extracted stone products 1993-2011



Source: Irish Concrete Federation - January 2012

### 3.3.2 Discussion

It was proposed to the Panel by a number of people that the building boom was a contributory factor in the supply of hardcore contaminated with reactive pyrite. When questions were raised as to the reason why the pyritic material came into usage mainly in the period 2002 to 2006, which was the height of the construction boom, it was suggested by many of those whom the Panel met that, in a high demand situation, fill material which previously may not have been considered fit for use in construction may have been used.

It was also mentioned that pyritic hardcore tended to be used in residential construction rather than road construction or in concrete products. This may have been due to the lack of on-site testing in residential projects, whereas such on-site testing would be commonplace on road construction projects. However, nobody provided any specific evidence to support this view.

While there is general acceptance of the necessity for a greater level of testing and certification of hardcore for use under ground floor slabs, there were differing views as to who should carry out the testing. Builders considered that the onus should be on the quarry owners to ensure that product is fit for purpose for which it is to be used while quarry owners suggested that builders should not be allowed to abdicate totally their responsibility in relation to product fitness. The joint submission from Engineers Ireland (EI) and Association of Consulting Engineers of Ireland (ACEI)<sup>26</sup> suggests, that, having regard to the nature and cost of the type and level of testing required, "...it be carried out at the larger quarry production-scale rather than on individual loads delivered to a building site". This position is supported by the judgement of Mr. Justice Charleton delivered on 25<sup>th</sup> May 2011

<sup>26</sup> EI/ACEI submission to Pyrite Panel 23rd January 2012

in *James Elliott Construction Limited and Irish Asphalt Limited* which states “...I also accept that it was not reasonable for Elliot Construction, as the purchaser of material, to carry out a suite of tests on the material”. This case is currently under appeal.

Five quarries were identified to the Panel as possible sources of hardcore used in dwellings displaying signs of pyritic heave. While the exact number of quarries is unknown, the ICF estimates that there was in excess of 1,200 quarries operating across the country in the period during the mid-2000s. The ICF noted that in overall terms the problem with pyrite has arisen in a “relatively small number of local markets” and in a “relatively small number” of quarries.

Quarry representatives suggested that builders very often did not and, still do not, specify the end use when ordering aggregates and consequently may have received aggregates unsuitable for use as under-floor fill. However, in a recent highly-publicised court case, it was stated that the builder had ordered aggregate to “Clause 804”<sup>27</sup> standard specification. A wide range of experts who spoke to the panel were of the view that ‘Clause 804’ would not have resulted in pyritic heave due to the strength and durability of the stone necessary to meet that standard specification.

While the National Roads Authority (NRA) has reported that some material containing reactive pyrite may have been incorporated in a Public Private Partnership (PPP) project, it has communicated to the Panel that it is satisfied that the material was used in a manner and in locations that would not cause a problem.

### 3.3.3 Conclusion

The period 2000-2006 was a period of very high residential construction output and consequent high demand for stone products, specifically hardcore, near where construction sites were located. In the north Dublin area, including Fingal, Meath and some other adjacent areas, non-premium aggregates were being supplied to meet demand, particularly for residential construction. It appears that some of the materials contained reactive pyrite which subsequently caused extensive problems in a significant number of houses.

From responses to questions raised by the Panel, it appears that these aggregates did not appear to have been used for concrete, concrete products or road materials. The Panel concludes that the requirements for testing and controls in place for these products and materials may have limited aggregates with reactive pyrite being used. The Panel makes some recommendations later on the standards for materials to be used in aggregates for house construction and there are also recommendations for testing of materials in quarries. While the Panel accepts the view that it would be unreasonable for builders to carry out on-site testing on all hardcore delivered to building sites, it is of the view that some sample testing of deliveries seems appropriate. This would give added reassurance and act as a potential deterrent to supplying unfit material. See chapter 5, section 5.1.2 for the role of building control authorities.

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27 See chapter 5, section 5.2 for explanation of “Clause 804”

The Panel acknowledges that, while the proportion of quarries identified to date as being involved in this problem may be considered as “small” within the quarrying industry, the scale of the problem is significant. This is clear from the number of dwellings that are potentially affected (either directly or indirectly) and the extent and cost of the remediation works needed to correct it.

In addition, it also emerged that there is a lack of consistency and uniformity in relation to the initial evaluation of potential quarries and the ongoing testing, production and supply procedures for hardcore. The Panel was not in a position to get a clear and coherent account of these processes from any of the groups or individuals with whom the Panel discussed the matter.

See chapter 5, section 5.3 for the Panel’s conclusions regarding testing and traceability of hardcore.

### 3.4 Early response to the pyrite problem

#### 3.4.1 Initial response from organisations

In June 2007, HomeBond issued a letter to its registered members concerning hardcore backfill with a request that a copy be passed on to the suppliers of such material. See Appendix 6 for the circular issued by HomeBond. At that time, HomeBond dealt with pyrite-related complaints and processed claims which, in some cases, led to remediation being carried out. See Chapter 6 for further information on HomeBond.

In July 2007, Fingal County Council, became aware that pyrite in the hardcore infill had been identified as the cause of cracking and structural movement of concrete floor slabs, walls etc. in certain residential dwellings within their jurisdiction. The main source for the material at that stage was identified as a single quarry. On 26<sup>th</sup> July 2007, Fingal County Council notified certain bodies about the problem, including the quarry, the Construction Industry Federation (CIF), HomeBond and the Department of the Environment, Community and Local Government (DECLG). In an effort to bring attention to the issue, Fingal County Council circulated a notice to developers, designers and/or private individuals who had submitted commencement notices from the 1<sup>st</sup> June 2007. Fingal County Council also provided an information service for the public on foot of these notices. See Appendix 7 for a copy of the circular. Fingal County Council contacted, visited and advised the operators of the quarry, identified as the main source, at the time, to stop supplying such material. See Chapter 5 for further information on the response of building control authorities to the issue.

Around the same time, the Department of the Environment, Community and Local Government became aware of the issue of pyrite by way of representations and media coverage. The initial response of the Department of the Environment, Community and Local Government involved making contact with key stakeholders<sup>28</sup>, firstly to try and assess the problem and then to find appropriate mechanisms to address the issues raised. Having consulted with the Building Regulations Advisory Body<sup>29</sup>, a Circular Letter was issued by

<sup>28</sup> Fingal County Council, HomeBond, Geological Survey Ireland, National Roads Authority

<sup>29</sup> Building Regulations Advisory Body Meeting 17th July 2007

the Department of the Environment, Community and Local Government to all City and County Managers and local building control officers on 16<sup>th</sup> August 2007. See Appendix 8 for Circular Letter: BC 6/2007. Copies were also sent to construction industry representative groups. It brought the pyrite issue to their attention and requested their co-operation in the enforcement of the relevant statutory requirements, notably under the Building Regulations and the Construction Products Directive<sup>30</sup>. The circular also referred to and enclosed a copy of a notice issued by Fingal County Council, arising from the problem of pyrite in hardcore in foundations in certain housing developments in that county.

### 3.4.2 Changes to the NSAI Standard Recommendation (SR21)

HomeBond and the Irish Concrete Federation sought a meeting with the Department of the Environment, Community and Local Government during the summer of 2007 to discuss how best to ensure that an appropriate standard recommendation for testing and assessing underfloor hardcore material for pyrite could be put in place. A meeting took place on 27<sup>th</sup> August 2007. The Department advised that the National Standards Authority of Ireland (NSAI) was the State agency with responsibility for the development of standards. Following the meeting, the Department immediately contacted the NSAI about the possible development of a Standard or Standard Recommendation (SR) in relation to aggregates.

In response to the industry request and the approach from the Department, NSAI reconvened its Aggregates Panel. The main industry stakeholders (HomeBond, Irish Concrete Federation, National Concrete Producers Association, Construction Industry Federation, the Department of the Environment, Community and Local Government) were represented on this Panel.

From experience in 2004, with developing *Standard Recommendation SR<sup>31</sup> 21:2004 Guidance on the use of IS EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*, the Aggregates Panel agreed that new guidance, particularly for hardcore, should be incorporated into the SR. The Panel commenced its deliberations in October 2007. By November 2007 amendments to *SR 21:2004 Guidance on the use of IS EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* were proposed. Following a public consultation and final agreement with the Aggregates Panel, an amended Standard Recommendation, *SR21:2004+A1:2007 Guidance on the use of IS EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* was published on 7<sup>th</sup> December 2007. See Chapter 5, Section 5.2.2 for details of the amendment to SR21.

### 3.4.3 Discussion

It was suggested by professionals in the industry that they were not generally aware of the problem associated with pyrite until the end of 2007 when the standard recommendation for aggregates was revised. The Panel was informed that those involved with individual cases or problematic sites were reluctant to talk openly about pyrite or share information because of existing and pending legal actions.

30 See Appendix 12 for further information on Construction Products Legislation

31 Standard Recommendation – NSAI recommendation based on the consensus of an expert panel and subject to public consultation

The Panel was also informed that many builders, design professionals and others involved in the construction sector were not notified at the time as no formal mechanisms existed for notifying people of such problems. However, despite this, the use of contaminated hardcore appears to have been contained from about mid-2007. To date, the Panel has not been informed of any dwellings commencing after 2007 that have submitted claims to guarantee companies. See Chapter 4, Table 4.1 for more details. Since then, quarries appeared to have stopped supplying pyritic hardcore to construction sites and some quarries ceased operation entirely.

The NSAI process for standards states that *“development is a collaborative process, with documents developed on an internationally recognised consensus based approach, involving expertise and stakeholder interest derived from the area under review. As such standards represent the best solution available at the time.”*<sup>32</sup> SR21 was amended based on this approach and with the then current available knowledge on the matter of reactive pyrite in aggregates. See Chapter 5, Section 5.3 for more discussion on the amendment to SR21.

### 3.4.4 Conclusion

In the summer of 2007, after it was confirmed that pyrite was the cause of the problem, initial information was disseminated to local authorities and builders. In so far as the pyritic material appears to have stopped being used as hardcore under residential ground floors, it appears reasonable to conclude that the approach taken by builders/developers, central government, local authorities, State agencies and HomeBond was effective in preventing the problem from continuing to develop.

However, the Panel came to the conclusion that for handling such cases in the future, a more organised and efficient method of formal dissemination of important and urgent information should be established by the Department of the Environment, Community and Local Government, in conjunction with the professional institutions involved in the construction sector. For example, a centralised web based alert system should be established with a suitable confirmatory loop to ensure that the information has been brought to the attention of those who should be informed and that action is taken on the ground immediately. This can then be reported back to a central point and the information made readily available publicly via the internet.

The Panel notes the view held at Departmental level that, when there is a defect with a dwelling, the main path of recourse for the homeowner is to the developer, builder and/or the relevant insurers or guarantee companies, depending on the policy in place. The Panel is of the view that the scale, extent and complexity of the problem associated with pyrite are such that a more systematic proactive approach is required and this is best led at Government level. The Panel acknowledges that the Minister of Environment, Community and Local Government, in setting up the Panel, has taken the first step in this direction. The Panel concludes that the Government should take a central leadership and co-ordinating role in influencing the engagement of the relevant parties and in facilitating an urgent and effective resolution to the pyrite problem.

32 NSAI submission to Pyrite Panel, 31st January 2012



The lessons learned in respect of pyrite should encourage Government generally and, in particular, the Department of the Environment, Community and Local Government, to look at how best similar types of problems should be addressed in the future. Any system put in place should address the importance of following up on circular letters issued by the Department so as to ensure that effective action is taken by local authorities to implement the circular letters and that confirmation of such action is available. The recommendations contained in this report provide a template of actions designed to assist in achieving this objective.

In relation to the publication of SR21:2004+A1:2007 *Guidance on the use of IS EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*, the Panel acknowledges that NSAI acted quickly to facilitate the development of the amendment within a matter of months. See Chapter 5, Section 5.3 for more information on SR21:2004+A1:2007 *Guidance on the use of IS EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*.

# Chapter 4: Scale of the pyrite problem

## 4.0 Introduction

This chapter discusses the findings of a desktop study conducted by the Panel. The Panel endeavoured to quantify the scale of the pyrite problem and estimate the potential number of private dwellings that could possibly be exposed to the problem in the future. In addition, this chapter briefly outlines the findings from consultation with State bodies and agencies on similar experiences in the broader housing, commercial and civil engineering sectors.

## 4.1 Scale of the pyrite problem in private dwellings

To date there have been various opinions expressed estimating the potential exposure to the pyrite problem in private dwellings. To this end, the Panel undertook a desktop study, in conjunction with stakeholder consultation, to establish the facts and, based on the information available to the Panel, to estimate the potential future exposure to the pyrite problem. The Panel notes that there was a reluctance by some of the key stakeholders to identify to the Panel areas and the number of dwellings involved where pyrite heave has manifested itself or where pyritic material has been used as hardcore material under ground floor slabs. Nonetheless, the Panel proceeded to make an estimate of the scale of the potential problem drawing on a variety of sources of data.

### 4.1.1 Pyrite-related claims made to guarantee providers

The total number of pyrite-related claims (verified and un-verified) made to the main guarantee providers<sup>33</sup> up to March 2012 was approximately **850**. Not all of these claims have been confirmed to have structural damage due to pyritic heave. Each claim represents a single dwelling. The pyrite-related claims mainly relate to houses and are distributed across 44 different estates<sup>34</sup>. In most cases, these claims represent only a fraction of the total number of dwellings in the respective estates. The Panel is led to believe that the number of claims made to the main guarantee providers is somewhat less than the number of pyrite-related complaints made. In general, the total number of complaints exceeds the number of claims by approximately 25%. It is unclear why some homeowners did not pursue the initial complaint and make an official claim.

The number of pyrite-related claims made to the main guarantee providers has steadily increased from 2006 to 2010. During 2011, pyrite-related claims increased exponentially (refer to Figure 4.4). It may be expected that claims will further increase in the near future due to increased public awareness through media, legal actions and the publication of this report.

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33 Of the 375,000 homes built from 2002-2008, approximately 76 per cent have been registered with one of two insurance schemes, namely, HomeBond or Premier Guarantee - National Consumer Agency - The Home Construction Industry and the Consumer in Ireland - Volume 4 - Review of insurance issues - November 2008 [http://corporate.nca.ie/eng/Research\\_Zone/sectoral-research/Home\\_Construction/introduction.html](http://corporate.nca.ie/eng/Research_Zone/sectoral-research/Home_Construction/introduction.html)

34 In addition, there are also two one-off houses with pyrite-related claims made to one of the main guarantee provider

## Chapter 4: Scale of the pyrite problem

### 4.1.2 Remediated dwellings

In addition to the pyrite-related claims discussed in section 4.1.1, it has been stated to the Panel that remedial work has already been implemented or is in the process of being implemented to approximately **1,100** dwellings on 12 different estates<sup>35</sup>. This is being funded through a guarantee scheme, through direct intervention by the builder, or as a result of legal settlement between the builder and the supplier of the material deemed to have been unsuitable.

### 4.2 Potential upper limit of the pyrite problem in private dwellings

The Panel is led to conclude that the figures presented above are reflective of the state of play up to March 2012, however this may not fully represent the potential number of private dwellings that may experience damage due to pyritic heave in the future. The methodology outlined below was adopted by the Panel to estimate the potential future exposure to the pyrite problem and, in coming to its estimate, the Panel relied heavily on the co-operation of the relevant stakeholders.

#### 4.2.1 Methodology and assumptions utilised by the Panel

Information on estates where it is suspected that pyrite is present was collated from various sources including local authorities, house guarantee providers, resident groups, private builders, public representatives and media reports. This enabled the Panel to establish a profile of the areas suspected to be affected by pyrite from a number of separate perspectives.

Once an estate was identified by one or more of the above sources, further research was conducted by the Panel. This included an analysis of planning permissions, commencement notices, ortho photography<sup>36</sup>, ordnance survey maps and contact with local authorities and others to clarify the following key information:

- Total number of ground floor dwellings in the identified estate;
- Year(s) of construction of the dwellings on the identified estate;
- Year when the pyrite problem in the estate was first suspected (if known); and
- Suspected source of the unsuitable material.

Due to legal, commercial and other sensitivities that surround the pyrite issue, detailed information such as estate names, builders' details and suspected sources of the unsuitable material has not been published in this report (except where already in the public domain through court reports or other publications). However, such information was of great value to the Panel in establishing its estimate of the scale of the pyrite problem.

35 Five (5) of these estates are included in 44 estates mentioned in section 4.1.1 as they are only partially remediated.  
36 Aerial photography geometrically corrected ("orthorectified") such that the scale is uniform: the photo has the same lack of distortion as a map.

The Panel made the following key assumptions when evaluating the information received:

- (i) The Panel accepted at face value the identification of estates from the above sources and conducted a further cross-referencing exercise to verify, as far as practicable, its validity. However, the Panel did not attempt to definitively establish, through testing or any other manner, whether or not pyrite was present in specific dwellings;
- (ii) The figures presented are heavily reliant on the identification of estates where pyrite is suspected to be a problem. It is reflective of the level of knowledge up to March 2012;
- (iii) The Panel notes that there has been a reluctance by some developers and stakeholders to identify to the Panel properties associated with the pyrite problem. Given the short timeframe for the Panel to report and the reluctance of some people or groups to share confidential information on pyrite problems, the figures presented here represent the Panel's best assessment based on the information available to it. However, this does not rule out the possibility of an increase in these numbers if more affected estates are identified in the future;
- (iv) There may be multiple cases where more than one builder was involved in the construction of an identified estate. The material used as hardcore under ground floor slabs may also have been sourced from multiple quarries. It was not possible for the Panel to investigate or confirm this exact level of detail. The Panel also concurs with the view of the Construction Industry Federation that *"The identification of pyrite in a development does not necessarily mean that all the houses in the relevant development are affected"*.<sup>37</sup> However, in order to, conservatively, estimate the potential exposure, the figures used in this report are based upon the total number of ground floor dwellings in the estate, in the case of estates identified as having one or more suspected instance of pyrite;
- (v) The Panel acknowledges that the unsuitable material may also have been incorporated in the construction of various one-off houses. However, with the exception of two cases brought to the attention of the Panel, the evidence advanced to the Panel to support this was not forthcoming. No additional allowance has been made in the final figures for one-off houses. However, the Panel notes that the assumption made in (iv) could partially compensate for this.
- (vi) The Panel has included all ground floor dwellings in estates which have at least one pyrite-related claim. Some of the guarantee providers suggest that not all of these claims have been confirmed to have damage due to pyritic heave. Nevertheless, the Panel has included the total number of ground floor dwellings in its figures. Guarantee providers further advised the Panel that such incidences will continue to be monitored.

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37 Construction Industry Federation submission to the Pyrite Panel, December 2011

### 4.3 Analysis of the Panel's findings

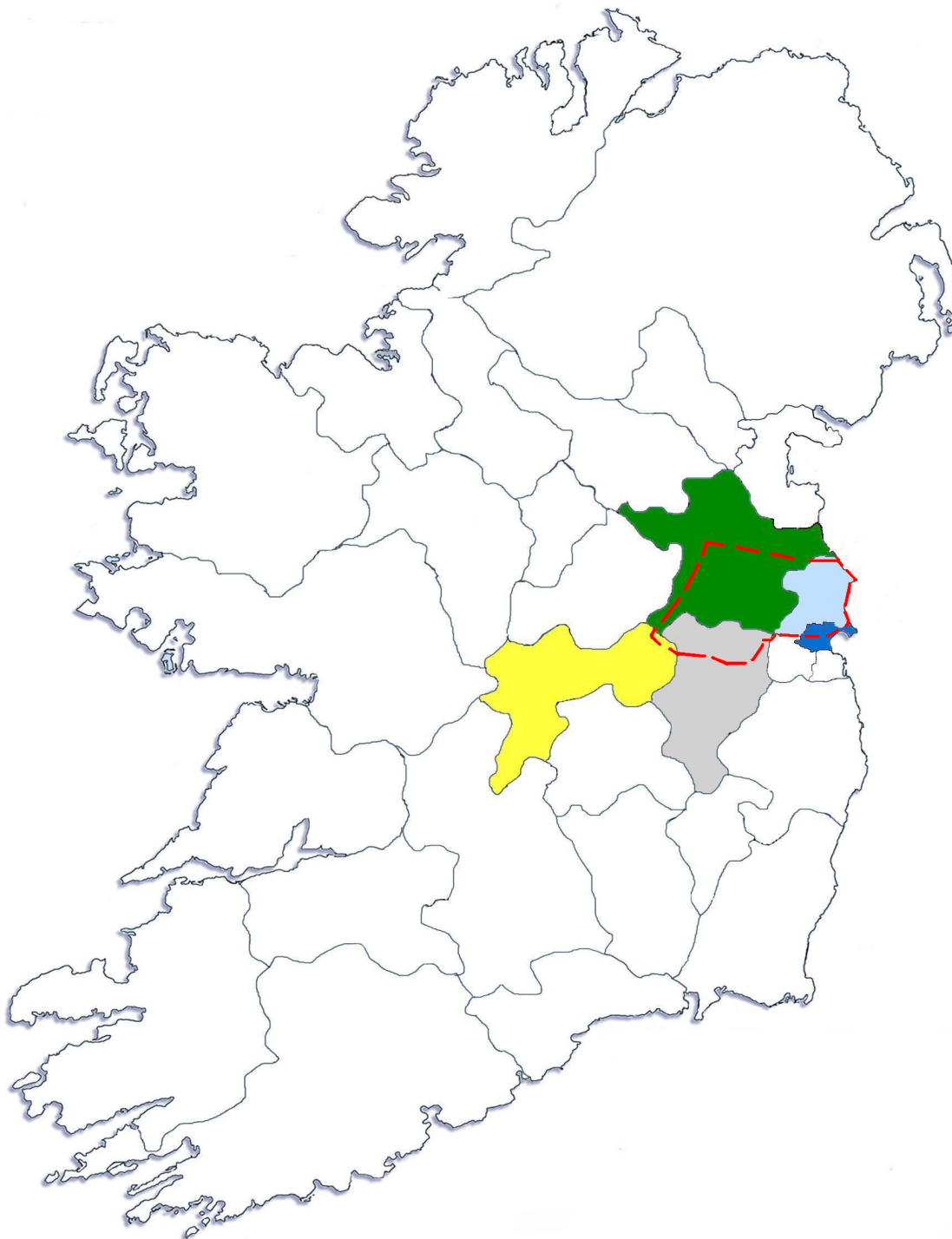
This section outlines the key findings of the Panel study.

#### 4.3.1 The location affected







The local authority areas identified to the Panel as having problems with pyrite are Fingal County Council, Dublin City Council, Meath County Council, Kildare County Council and Offaly County Council (refer to Figure 4.1).

The boundary of the area containing all of the private housing estates identified to the Panel during the course of its study is broadly defined by a broken red line in Figure 4.1. Whilst Fingal County Council and Meath County Council contain the majority of identified estates, the problem does not appear to be as extensive throughout the remaining local authorities of Dublin City, Kildare, and Offaly. Indeed, in County Offaly identified estates appear to be localised in an urban area on the Offaly/ Kildare border.

Figure 4.1 Local authorities where dwellings identified to the Panel are located



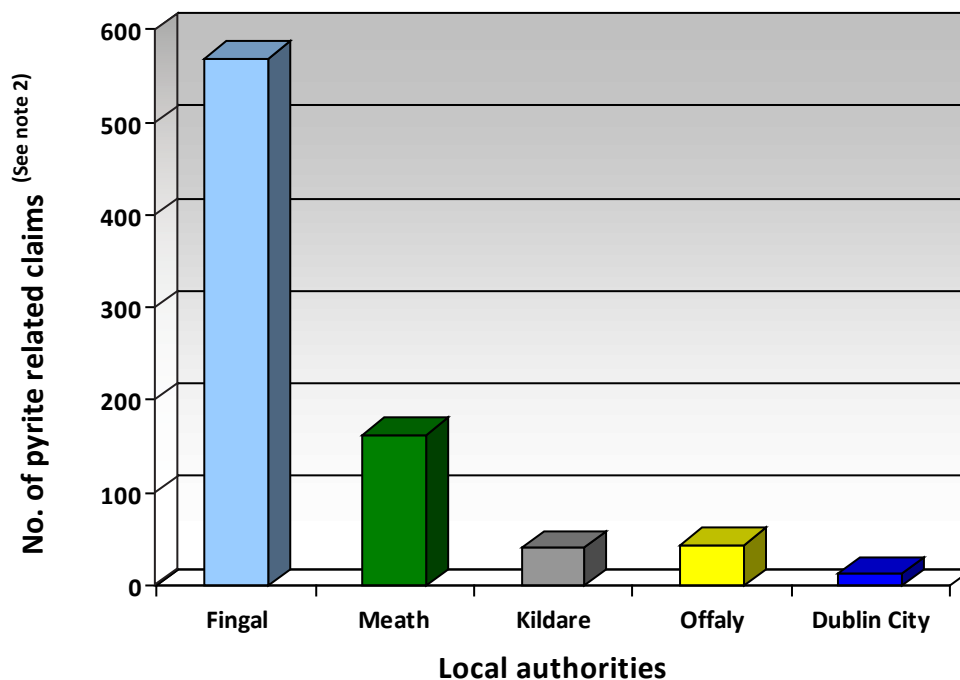
Key

- |   |   |
|---|---|
|  Dublin City Council   |  Kildare County Council  |
|  Fingal County Council |  Offaly County Council   |
|  Meath County Council  |  General area containing private estates identified to the Panel as having pyrite problems |

### 4.3.2 The distribution of pyrite-related claims made to guarantee providers per local authority

Figure 4.2 shows the distribution of pyrite-related claims made to the main guarantee providers for each local authority. It is observed that the majority of pyrite-related claims relate to dwellings located in Fingal County Council, followed by Meath County Council.

**Figure 4.2** Distribution of pyrite-related claims per local authority



Note:

1. The total number of pyrite-related claims (verified and un-verified) made to the main guarantee providers up to March 2012 was approximately 850.
2. The total number of pyrite-related claims (verified and un-verified) plus formal pyrite-related complaints made to the main guarantee provider, up to March 2012 was approximately 1050.

### 4.3.3 The period when problems occurred

Table 4.1 below shows the range of years of dwelling registration<sup>38</sup> for which pyrite-related claims have been made to the main guarantee providers. The earliest year of dwelling registration for which a pyrite-related claim was made is 1997. This claim relates to Co. Meath. The latest year of registration for which a pyrite-related claim was made was 2009<sup>39</sup>. This claim relates to Fingal.

38 In general, dwellings are required to be registered with the Guarantee provider before work commences on site. On larger estates, builders normally register the dwellings in bundles or groups. These groups of dwellings would then be built on a phased basis over a number of years.

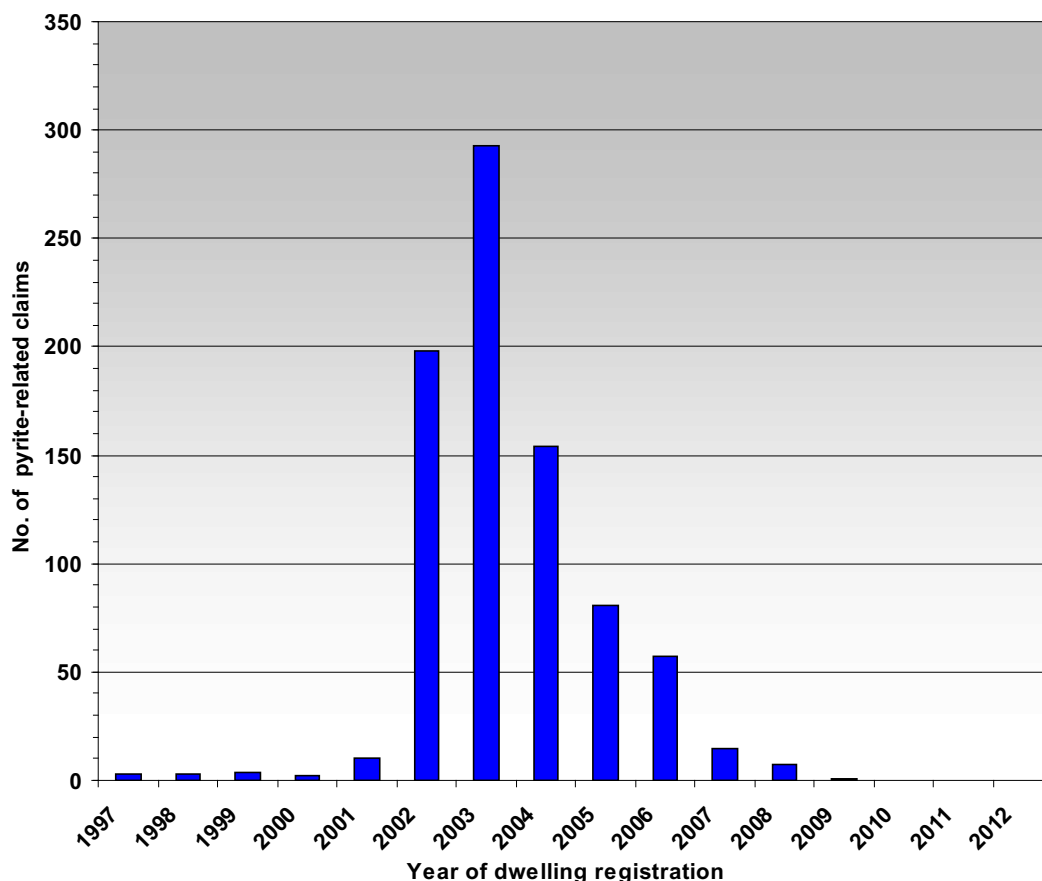
39 In some cases, the construction of dwellings on site had commenced prior to registration with the guarantee provider. There is no evidence of any dwelling commenced post 2007 that has a pyrite-related claim.

Local authority	Year of dwelling registration	
	Earliest year	Latest year
Meath County Council	1997	2007
Kildare County Council	1998	2006
Fingal County Council	2001	2009
Offaly County Council	2002	2006
Dublin City Council	2003	2006

Note:  
In Fingal, seven (7) dwellings had registrations in 2008 and a single dwelling was registered in 2009. It was confirmed to the Panel that none of these dwellings were commenced post 2007.

When the pyrite-related claims received per year are plotted against the year of dwelling registration across all identified local authorities, a pattern emerges which suggests that dwellings registered between 2002 and 2006 contain the vast majority of all suspected cases (refer Figure 4.3).

**Figure 4.3 Distribution of pyrite-related claims per year of dwelling registration**



Note:

1. In Fingal, seven (7) dwellings had registrations in 2008 and a single dwelling was registered in 2009. It was confirmed to the Panel that none of these dwellings were commenced post 2007.

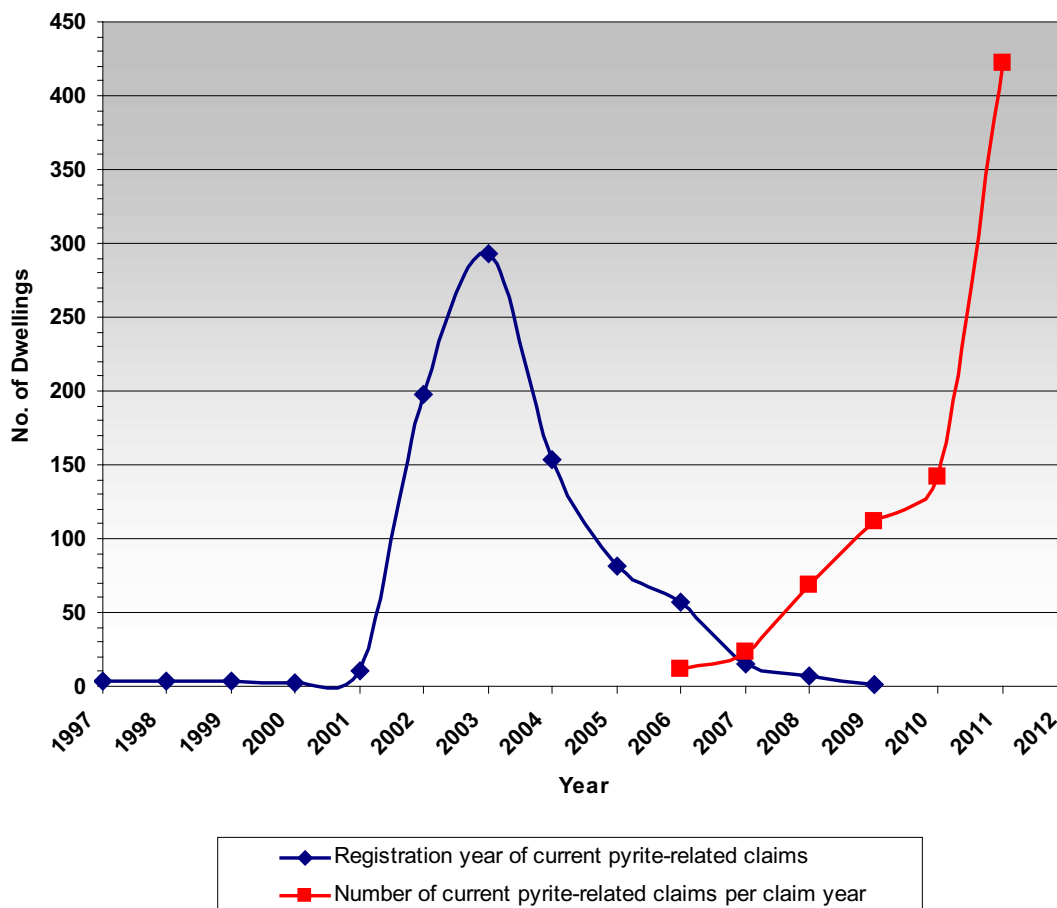


### 4.3.4 The timeframe for cracks to develop

In Ireland, the rate of presentation of damage appears to be particularly fast, ranging from 2 to 9 years after construction. As discussed in Chapter 3 and Chapter 7, this is much earlier than in Canada, where, in general, it took 8 to 20 years to manifest as a problem. While a definitive reason for this has not been established, a number of factors that may influence this were brought to the attention of the Panel. These include the nature of the particular type of pyrite in Ireland, temperature and exposure of hardcore. See section 7.4 for further information.

Figure 4.4 below illustrates the relationship between the year the dwelling was registered and the year when the problem became of such significance for the homeowner that they considered it necessary to take action and make a claim to one of the main guarantee providers.

**Figure 4.4** Distribution of registrations and pyrite-related claims



Note:

1. The main guarantee providers advised the Panel that they were not aware that problems were pyrite-related prior to January 2007
2. In Fingal, seven (7) dwellings had registrations in 2008 and a single dwelling in 2009. It was confirmed to the Panel that none of these dwellings was commenced post-2007.

The High Court case of *James Elliott Construction Limited and Irish Asphalt Limited*<sup>40</sup>, shares other experiences on the manifestation of damage to ground floor slabs in a community, youth and childcare facility developed by Ballymun Regeneration Limited. The judgement of Mr. Justice Charleton delivered on 25<sup>th</sup> May 2011, presented the following timeline for damage to occur as follows:

- 13<sup>th</sup> December 2004: “.....Digging and construction of the last foundation pad at the north western end of the building....”
- 17<sup>th</sup> December 2004: “.....The ground floor slabs are poured in concrete on the Clause 804 support.....”
- 28<sup>th</sup> August 2006: “....I find it probable that if there was pyrite heave or sinking walls, the early part of the process had now begun...”
- 1<sup>st</sup> February 2007: “Over the intervening period of five months, cracks in the internal ground floor plasterboard walls and internal stud partition walls of the building keep reappearing. There seems to have been some effort by Elliott Construction to chase the cracks and to repair them as they appeared. For the next period from the snag works in September 2006, over a period of fourteen months to November 2007, the internal ground floor plaster wall cracks not only reappear but gain in intensity, proliferating throughout the ground floor of the new portion of the building.....”
- 9<sup>th</sup> November 2007: “....Just under 3 years have passed since the pouring of the ground floor slabs on to the Clause 804 hardcore infill on 17th December 2004. The floors in several areas are apparently forced up against the plasterboard of the internal ground floor walls and the room dividing stud partitions are also bulging and cracking.”

This timeline suggests that damage appeared to manifest itself between two and three years after pouring of the ground floor slab. This case is currently under appeal to the Supreme Court. The defendants deny that the presence of pyrite in the stone infill supplied from its quarry has resulted in structural damage to any building.

### 4.3.5 The sources of the unsuitable material

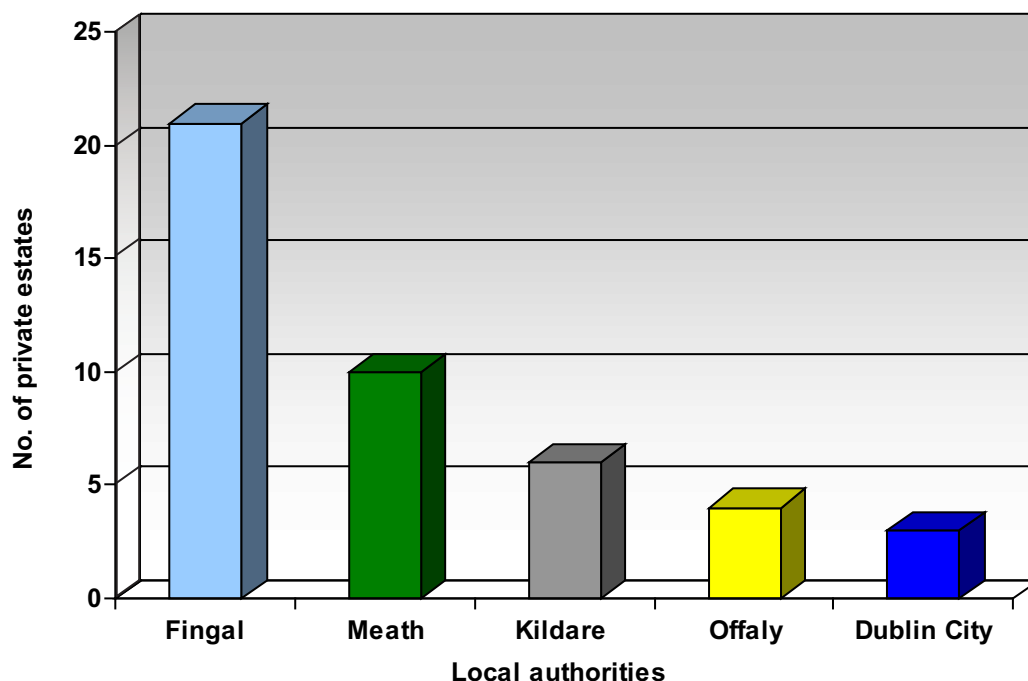
Five (5) quarries were identified to the Panel as possible source of hardcore used in dwellings displaying signs of pyritic heave. These quarries are all located inside the boundary defined by a broken red line in Figure 4.1. For further information on the geology of this area, refer to section 2.2 of Chapter 2. Due to legal, commercial and other sensitivities that surround the pyrite issue, the names and exact locations of suspected quarries identified to the Panel are not included. As a general rule of thumb, in order to make transport costs for hardcore fill commercially viable, the haulage distances from source are generally limited to a range of between 15 and 20km, with a maximum limit generally of 25km from the source.

### 4.3.6 The estimated number of private dwellings that potentially may be exposed to the problem in the future

A total of forty four (44) estates were identified to the Panel as having at least one pyrite-related claim made to either one of the main guarantee providers. This figure excludes estates where remediation has already taken place. Their distribution between each local authority is shown in Figure 4.5.

40 [ 2011] IEHC 269, judgement delivered on 25 May 2011.

**Figure 4.5** Distribution of private estates identified to the Panel where at least one pyrite-related claim has been made

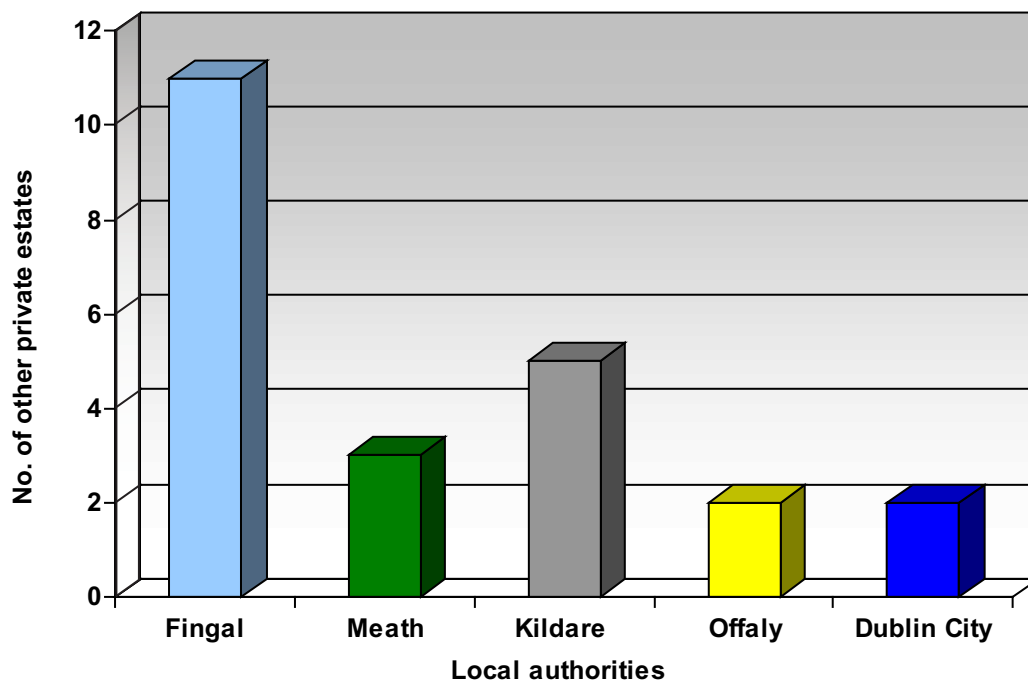


**Note:**

1. 44No. private estates were identified to the Panel that have a pyrite-related claim made to a main guarantee provider and the claim has not yet been remediated.
2. Five (5) of these 44 estates have been partially remediated.

A further twenty three (23) private estates were identified to the Panel as possibly having pyritic material present in some of the dwellings, but they do not appear to have any history of claims or remediation. These estates have been identified by some of the sources discussed in section 4.2.1. Many of them may still be covered by a guarantee provider. However, some of these estates come from older housing stock where it is likely that the guarantee has expired. The distribution of these estates is shown in Figure 4.6 over.

Figure 4.6 Distribution of other private estates identified to the Panel



**Note:**

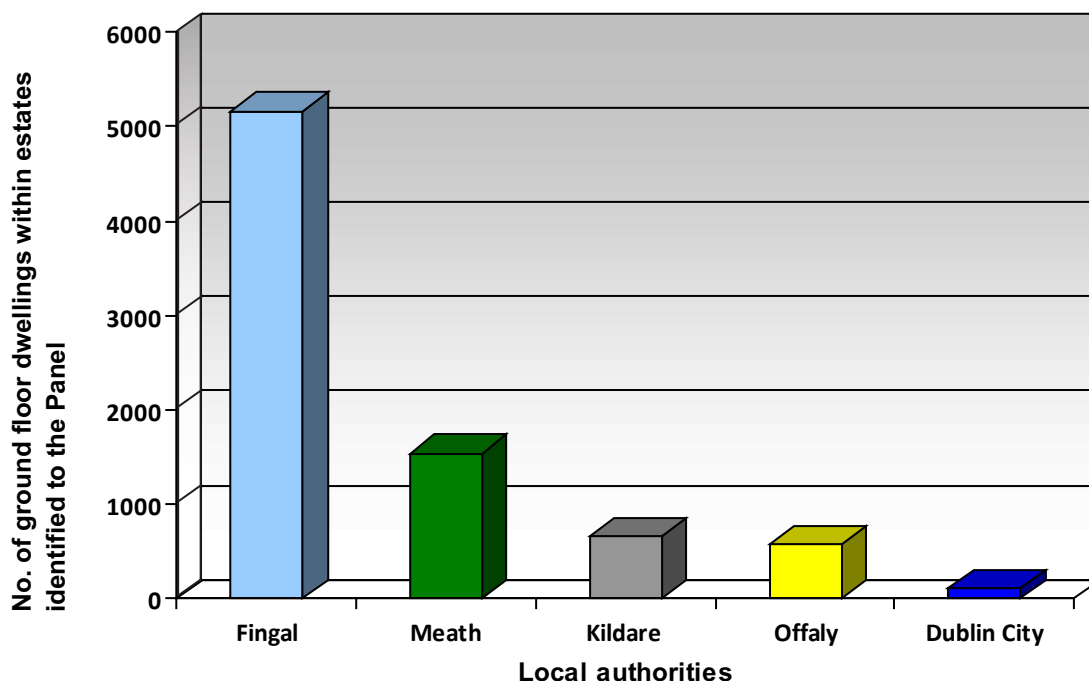
1. A further 23 No. private estates were identified to the Panel as possibly having pyritic material present in some of the dwellings. These estates are in addition to the 44 estates mentioned in Fig 4.5,
2. There is no evidence of pyrite-related claims to guarantee providers for dwellings on these estates, nor is there evidence that dwellings in these estates have been remediated.

As discussed in section 4.2.1, the Panel concurs with the view of the Construction Industry Federation that *“The identification of pyrite in a development does not necessarily mean that all the houses in the relevant development are affected”*.<sup>41</sup> However in order to estimate the potential number of private dwellings that may be exposed to the problem in the future, the Panel has assumed that the total number of ground floor dwellings in the estates identified is included, regardless of whether the presence of pyrite has been proven by testing or other means in all of the dwellings. Therefore, the results of the study, based on the information available, presents a considered estimate of future potential pyrite problems in private dwellings.

For the estates where at least one pyrite-related claim has been made and that claim has not yet been remediated, the Panel estimates (based on the assumptions discussed in section 4.2.1) that the total potential number of private dwellings (with a ground floor) that may be exposed to the pyrite problem in the future is approximately **8,000** dwellings across 44 estates. This figure is the summation of all ground floor dwellings from estates where a pyrite-related claim has been made and which have been identified to the Panel. Figure 4.7 shows the distribution of these dwellings between each local authority.

41 Construction Industry Federation submission to the Pyrite Panel, December 2011

**Figure 4.7** Distribution of private dwellings (with a ground floor) from estates identified to the Panel where a pyrite-related claim has been made

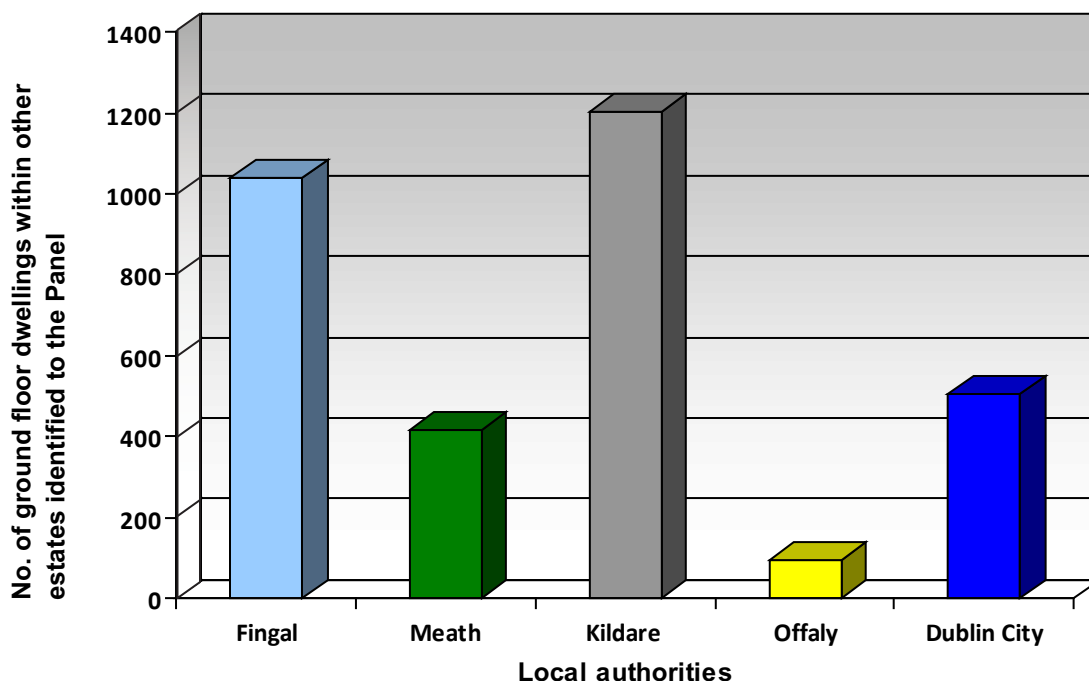


**Notes**

1. The values above are the summation of all ground floor dwellings in 44 No. private estates identified to the Panel where at least one pyrite-related claim has been made.
2. The total number of private dwellings with a ground floor in these estates is approximately 8,000.

For the other 23 estates identified, the Panel estimates (based on the assumptions discussed in section 4.2.1) that, as a reasonably informed view, the total potential number of private dwellings (with a ground floor) that may be exposed to the pyrite problem in the future is approximately **3,250** dwellings across the 23 estates. Figure 4.8 shows the distribution of these dwellings between each local authority.

**Figure 4.8** Distribution of private dwellings (with a ground floor) from other estates identified to the Panel



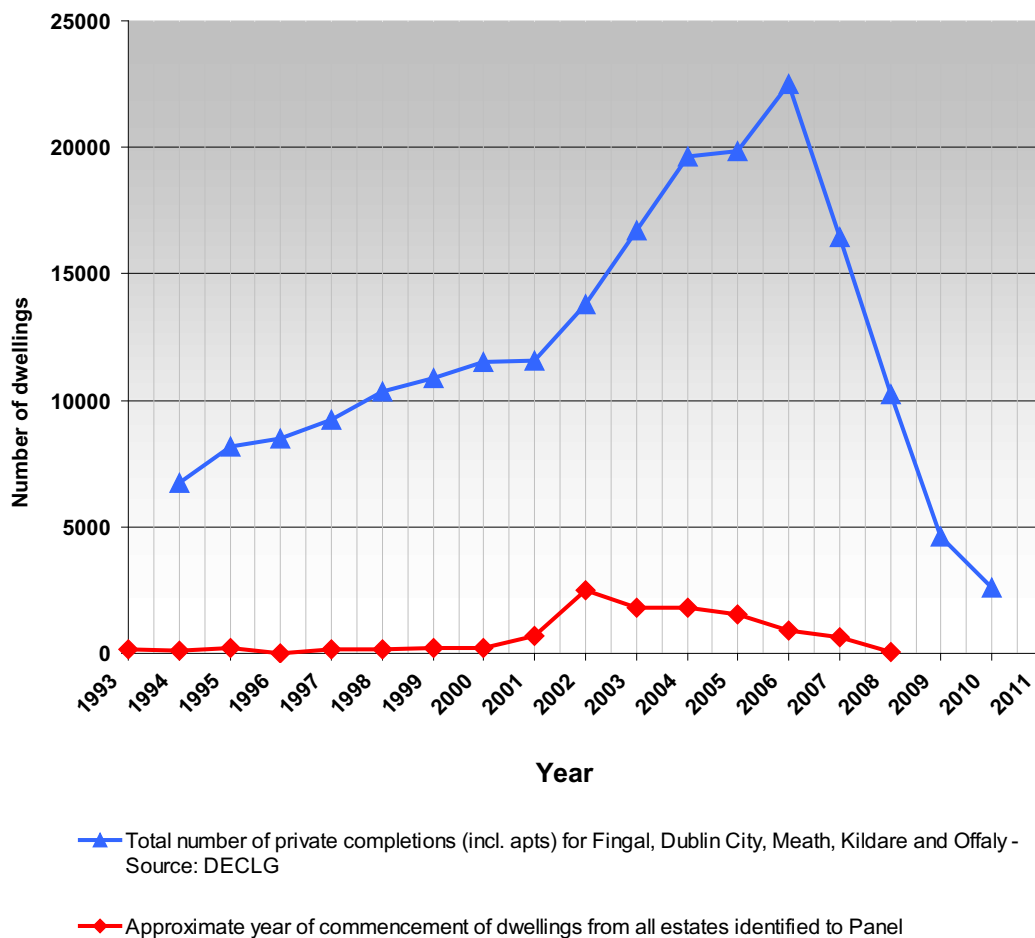
**Notes**

1. The values above are the summation of all ground floor dwellings in the 23 No. other private estates identified to the Panel as possibly having pyrite material present. There is no evidence of pyrite-related claims to guarantee providers for dwellings on these estates, nor is there evidence that dwellings in these estates have been remediated.
2. The total number of private dwellings with a ground floor in these estates is approximately 3,250.

The total number of estates identified to the Panel during the course of this study was 74. The total number of private dwellings (including apartments) completed in the combined affected local authorities of Fingal, Dublin City, Meath, Kildare and Offaly during the respective range of years in Table 4.1 was approximately 120,000<sup>42</sup> private dwellings (including apartments) of which private house completions accounted for approximately 91,000. Figure 4.9 shows the distribution of private dwelling completions versus the approximate dwelling commencements from all estates identified to the Panel.

42 Department of the Environment, Community and Local Government  
<http://www.environ.ie/en/Publications/StatisticsandRegularPublications/HousingStatistics/>

**Figure 4.9** Comparison between total output of private dwellings and those identified to the Panel as being affected by pyrite



### 4.3.7 The findings from a survey of State bodies and agencies

In order to understand the broader scale of the pyrite problem in Ireland, the Panel endeavoured to obtain information on social and affordable housing, the commercial and civil engineering sectors to establish whether these sectors had similar experiences. The following State bodies and agencies were consulted and their responses are summarised below.

#### Department of Defence

The Department of Defence reported no incidence of pyrite problems to date.

#### Department of the Environment, Community and Local Government

The Department of the Environment, Community and Local Government provides the capital funds for social and affordable housing projects.

Local authorities in the affected areas were requested by the Panel to identify social and affordable housing estates where pyrite-related problems were known or suspected within their respective areas. Only Fingal County Council, Dublin City Council and Meath

County Council reported that they have any suspected housing estates. Kildare and Offaly County Council reported no incidences of pyrite problems, to their knowledge. The total number of suspected social and affordable dwellings identified by the local authorities amounts to approximately 850 dwellings across 18 developments in 3 local authorities. The commencement of construction of all social and affordable dwellings suspected of having pyrite material in the sub-floors was between 2002 and 2007.

### Department of Education and Skills

National figures on completed construction works to primary and post primary schools between 2000 and 2010 are as follows:

- 148 No. new primary schools;
- 292 No. large scale primary school extensions/ refurbishments;
- 41 No. new post primary schools;
- 167 No. large scale post primary school extensions/ refurbishments;

The Department of Education and Skills has reported to the Panel that, following a survey in Quarter 4 2011, it noted that there are three schools in the Dublin area affected by pyritic heave. These consist of a new school and two school extensions. Construction on these schools projects was completed between 2002 and 2008.

### Department of Health

The Department of Health has reported no incidence of pyrite problems to date.

### Department of Transport, Tourism and Sport

The Department of Transport, Tourism and Sport has reported no incidence of pyrite problems to date.

### Health Service Executive

The Health Service Executive has reported no incidence of pyrite problems to date.

### National Asset Management Agency

The National Asset Management Agency (NAMA) advised the Panel that the Agency has acquired loans (land and development and associated loans) from participating financial institutions but NAMA does not own the underlying property that is security for these loan assets. In view of their broad portfolio of loans across the NAMA portfolio, it is acknowledged the potential exists that some of the properties that may be security on these loans could be affected by pyrite and as such, their value would be reduced. NAMA has stated to the Panel that their role is that of a lender holding security for its loan rather than that of an owner and they recommend that enquiries and claims arising from suspected pyritic heave should normally be referred to the original property developer. (It is, of course, a matter of decision by homeowners).



### National Roads Authority

The National Roads Authority (NRA) has reported that some material containing pyrite may have been incorporated in a Public Private Partnership (PPP) project as general fill. The NRA is satisfied that such use of the material does not contravene the NRA's 'Specification for Roadworks' and would not cause a problem with regard to the long term performance of the road. In addition, the PPP operator has responsibility for maintenance and operational matters for the period of their concession. At the end of the concession period the PPP operator must hand over the facility in a serviceable condition.

### Office of Public Works

The Office of Public Works has reported no incidence of pyrite problems to date.

## 4.4 Discussion

The Panel used a number of sources to try to establish the scale of the problem caused by pyrite and also the outer likely limit of the scale of the problem. The Panel was disappointed that some stakeholders were unwilling to share information on the number of houses potentially affected with pyritic material. The Panel is also aware that at least one confidential agreement was entered into as part of a settlement and, although some very useful information would have been available from the delivery dockets (showing the various estates to which the pyritic material was delivered), it was not possible for the Panel to gain access to that information.

## 4.5 Conclusions

- A tabular summary of the Panel's findings are given in Table 4.2 over.
- A total of 74 estates were identified to the Panel during the study.
- Approximately **1,100** private dwellings on 12 different estates to date have either been remediated or are in the process of being remediated.
- There are approximately **850** dwellings on 44 different estates for which pyrite-related claims (verified and un-verified) have been made to the main guarantee providers. Of these estates, 5 estates are included in the figures mentioned immediately above as they are partially remediated estates.
- Keeping in mind the key assumptions discussed in section 4.1.3, the Panel estimates that the potential number of private dwellings on the 44 estates mentioned immediately above is approximately **8,000** ground floor dwellings.
- A further 23 other estates were identified to the Panel as possibly having pyritic material in some of the dwellings but no pyrite-related claims have been lodged with the main guarantee providers. Again keeping in mind the key assumptions discussed in section 4.1.3, the Panel estimates that the total number of ground floor dwellings in these 23 estates is approximately **3,250** ground floor dwellings.

Number of estates identified to the Panel	Approximate number of outstanding pyrite-related claims	Approximate number of dwellings remediated (or in the process)	Remaining number of dwellings (with a ground floor) on identified estates
7	-	1,000	-
44	850	100 <sup>1</sup>	7,050 <sup>2</sup>
23	-	-	3,250
<b>74</b>	<b>850</b>	<b>1,100</b>	<b>10,300</b>

Note:

1. This figure relates to dwellings in 5 estates that are partially remediated
2. The identification of pyrite in an estate does not necessarily mean that all dwellings in the estate are affected.

The typical cost of remediation for an average house, as quoted to the Panel by those who have undertaken a significant amount of such work, is approximately €45,000, see section 7.2.4



# Chapter 5: Building control system

## 5.0 Introduction

This chapter explains the building control system in Ireland. It examines the requirements of the Building Regulations and the guidance provided, in relation to ground floors for buildings and compares these with other countries. It outlines the enforcement system in Ireland and discusses its effectiveness.

It details the specifications that were commonly used in practice on sites, for hardcore in buildings.

## 5.1 Building control system

The building control system in Ireland is based on the Building Control Acts of 1990 and 2007 (No. 3 of 1990 and No. 21 of 2007). The Acts provide for the making of Building Regulations and also the legislative basis for the system of enforcement.

### 5.1.1 Building Regulations

The Building Regulations were first introduced in 1991 and came into effect from 1 June 1992. They were subsequently consolidated in 1997 and they have been revised on an on-going basis since then, as deemed necessary.

The Building Regulations set the minimum standards with regard to the design and construction of buildings, including the use of products and materials.

The Building Regulations 1997-2011 comprise of twelve Parts, each dealing with a particular subject matter e.g. Part A Structure; Part B Fire Safety; Part C Site Preparation and Resistance to Moisture; Part D Materials and Workmanship, etc (See Appendix 10). The legal requirements of each Part are set out in broad performance terms in the Second Schedule of the Building Regulations, 1997-2011.

Technical Guidance Documents (TGDs) are published to provide guidance with respect to compliance with these requirements. Works carried out in accordance with the guidance in the TGDs is considered, *prima facie*, evidence of compliance. However, an approach other than that set out in the guidance is not precluded, provided compliance with the relevant requirements can be demonstrated.

TGDs are revised in conjunction with changes to the requirements of each Part, but they may also be amended to provide more detailed guidance on particular issues in between such revisions.

Responsibility for compliance with the requirements of the Building Regulations rests with the owner of a building and/or those carrying out the works (i.e. the builder and designers).

## Chapter 5: Building control system

### 5.1.1.1 How is hardcore dealt with in the Building Regulations?

The statutory requirements of the Building Regulations are that “*all works be carried out with proper materials*” which are “*fit for the use for which they are intended and for the conditions in which they are to be used*”<sup>43</sup> (Part D). In relation to ground floors in buildings, it is required that they be “*designed and constructed as to prevent the passage of moisture to the inside of the building or damage to the fabric of the building*”<sup>44</sup> (Part C).

In addition, TGD C<sup>45</sup> provides general guidance on hardcore under ground supported floors. Prior to 2008, TGD C stated as follows: “*The hardcore bed should be at least 150mm thick and should be broken stones, broken brick or similar suitable material well compacted and clean and free from matter liable to cause damage to the concrete.*”<sup>46</sup>

In 2007, at the behest of the construction industry representatives<sup>47</sup>, following the discovery of problems due to pyrite, a more detailed specification for hardcore was produced by the National Standards Authority of Ireland (NSAI) in an amendment to an existing Standard Recommendation (SR 21:2004 +A1: 2007) dealing with aggregates.

The text of TGD C was subsequently amended to refer to this Standard Recommendation to provide more detailed guidance on hardcore. Since 2008, TGD C states “*The hardcore bed should be at least 150mm thick. Hardcore should conform with I.S. EN 13242:2002<sup>48</sup> and meet the specification as outlined in Annex E of the accompanying guidance document to this standard, SR21:2004+A1: 2007<sup>49</sup>. The layer of hardcore should be well compacted, clean and free from matter liable to cause damage to the concrete. Specific guidance is given in 3.4.2 of SR21:2004+A1: 2007 on limiting the presence of a reactive form of pyrite which may give rise to swelling or sulfate attack on concrete. A blinding layer should be provided in accordance with the specification given in Annex E, of SR21:2004+A1:2007 for fines material. The blinding layer should be of adequate depth to fill surface voids thus creating an even surface and avoiding sharp projections, which may damage radon or damp-proof membranes.*”<sup>50</sup>

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- 43 Extract from Part D Materials and Workmanship of the Second Schedule to the Building Regulations – Requirement D1 & D3
- 44 Extract from Part C Site Preparation and Resistance to Moisture of the Second Schedule to the Building Regulations – Requirement C4
- 45 TGD C provides guidance to Part C Site Preparation and Resistance to Moisture
- 46 Extract from TGD C paragraph 3.1.4 (b) September 2004 Edition
- 47 HomeBond and the Irish Concrete Federation
- 48 I.S. EN 13242:2002 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction)
- 49 SR 21: 2004 + A1: 2007 Guidance on the use of I.S. EN 13242:2002 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
- 50 Amendment C (i) to paragraph 3.1.4 (b) of TGD C September 2004 Edition

### 5.1.1.2 United Kingdom Building Regulations

Similar legal requirements for materials, workmanship and performance of the elements of a building (e.g. the floors) apply across the United Kingdom. See Table 5.1 for the current regulations in Ireland, England & Wales, Scotland and Northern Ireland on these matters.

The first iteration of the UK Buildings Regulation, in 1966, dealt with the specification of hardcore by providing the following guidance *“No hardcore laid under such floor shall contain water-soluble sulfates or other deleterious matter in such quantities as to be liable to cause damage to any part of the floor.”* This addressed the significant problem of sulfate attack on concrete ground-bearing slabs that was prevalent in the UK at the time<sup>51</sup>. Since the 1960's several publications by the Building Research Establishment (BRE),<sup>52</sup> along with guidance notes from the UK National House Building Council, were issued on the specification of hardcore and construction details to avoid sulfate attack. These publications recommended restricting the depth of hardcore to 600mm, limiting the soluble sulfate content and incorporating a suitable membrane to separate the hardcore from the concrete floor. As a result, the current guidance (since 2000) to the Building Regulations for England and Wales has evolved to state in respect of ground supported floors *“... well compacted hardcore bed, no greater than 600mm deep, of clean, broken brick or similar inert material, free from materials including water-soluble sulfates in quantities which could damage the concrete (BRE Digest 276);...”*<sup>53</sup> See Table 5.2 for a comparison of the guidance given regarding hardcore in Irish and UK Building Regulations.

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- 51 It was due to a large extent to the use of waste materials from heavy industry (coal mining, coal combustion ashes, slags from the iron industry) and construction waste containing gypsum as hardcore for building. The use of sulfate bearing (pyritic) shaley mudstones also caused sulfate attack albeit, to a much lesser extent. See chapter 3 section 3.1 for further details.
- 52 BRE - Concrete in sulfate-bearing soils and groundwaters - BRE DG 90 (1968)  
BRE - Fill and Hardcore - BRE DG 142 (1972)  
BRE - Fill and Hardcore - BRE DG 222 (1979)  
BRE - Hardcore - BRE DG 276 (1983, revised 1992)  
BRE - Sulfate and acid resistance of concrete in the ground.- BRE DG 363 (1991)
- 53 Part C of Schedule 1: Site preparation and resistance to moisture and its associated Approved Document C (2004 Edition incorporating 2010 amendments) of the Building Regulations 2000 (England and Wales) Clause 4.7

Table 5.1 Comparison of the requirements for materials and floors across Irish and UK Building Regulations			
Ireland	England and Wales	Scotland	Northern Ireland
<p><b>Part D - Materials and Workmanship (2000)</b></p> <p>D1 All works to which these Regulations apply shall be carried out with proper materials and in a workmanlike manner.</p> <p>Definition for this Part D3 In this Part, “proper materials” means materials which are fit for the use for which they are intended and for the conditions in which they are to be used,...</p>	<p><b>Regulation 7 –Workmanship and Materials (2010 - unchanged from 2000 version)</b></p> <p>Building work shall be carried out :</p> <p>(a) with adequate and proper materials which</p> <p>(i) are appropriate for the circumstances in which they are used;</p> <p>(ii) are adequately mixed or prepared ; and</p> <p>(iii) are applied used or fixed so as adequately to perform the functions for which they are designed; and</p> <p>(b) in a workmanlike manner.</p>	<p><b>Regulation 8 – Durability, workmanship and fitness of materials (2011 - unchanged from 2004 version)</b></p> <p>1.Work to every building designed, constructed and provided with services, fittings and equipment to meet a requirement of Regulation 9 to 12, must be carried out in a technically proper and workmanlike manner, and the materials used must be durable, and fit for their intended purpose.</p>	<p><b>Regulation B2 - Fitness of materials and workmanship (2000)</b></p> <p>In any relevant work-</p> <p>(a) the materials used shall :</p> <p>(i) be of suitable nature and quality in relation to the purposes and the condition in which they are used;</p> <p>(ii) be adequately mixed and prepared;</p> <p>(iii) be applied , used or fixed so as adequately to perform the functions for which they are designed; and</p> <p>(iv) not continue to emit any harmful substances longer than is reasonable in the circumstances</p>
<p><b>Part C - Site Preparation and Resistance to Moisture (1997)</b></p> <p><u>Resistance to weather and ground moisture</u></p> <p>C4 The floors, walls and roof of a building shall be so designed and constructed as to prevent the passage of moisture to the inside of the building or damage to the fabric of the building.</p>	<p><b>Part C - Site preparation and resistance to contaminants and moisture (2010 – unchanged from 2004 version)</b></p> <p><u>Resistance to moisture.</u></p> <p>C2. The floors, walls and roof of the building shall adequately protect the building and people who use the building from harmful effects caused by:</p> <p>(a) ground moisture;</p> <p>(b) precipitation and wind-driven spray;</p> <p>(c) interstitial and surface condensation; and</p> <p>(d) spillage of water from or associated with sanitary fittings or fixed appliances.</p>	<p><b>Section 3 - Environment</b></p> <p><b>Moisture from the ground (2011 – unchanged from 2004 version)</b></p> <p><b>3.4 Every building must be designed and constructed in such a way that there will not be a threat to the building or the health of the occupants as a result of moisture penetration from the ground.</b></p>	<p><b>Part C -Preparation of site and resistance to Moisture (2000)</b></p> <p><u>C4 Resistance to ground moisture and weather</u></p> <p>Every wall, floor and roof shall be constructed so as to prevent any harmful effect on the building or the health of the occupants caused by the passage of moisture to any part of the building from—</p> <p>(a) the ground; and</p> <p>(b) the weather.</p>

**Table 5.2 Comparison of guidance on hardcore in Irish and UK Building Regulations**

Ireland	England and Wales	Scotland	Northern Ireland
<p><b>Ground supported floors (1991 and 1997)</b></p> <p><b>3.1.4(b)</b> The hardcore bed should be at least 150mm thick and should be broken stones, broken brick or similar suitable material well compacted and clean and free from matter liable to cause damage to the concrete.</p> <p><b>Ground supported floors (2008)</b></p> <p><b>3.1.4(b)</b> The hardcore bed should be at least 150 mm thick. Hardcore should conform with I.S. EN 13242:2002 and meet the specification as outlined in Annex E of the accompanying guidance document to this standard, SR21: 2004+A1: 2007. The layer of hardcore should be well compacted, clean and free from matter liable to cause damage to the concrete. Specific guidance is given in 3.4.2 of SR21: 2004+A1: 2007 on limiting the presence of a reactive form of pyrite which may give rise to swelling or sulfate attack on concrete. A blinding layer should be provided in accordance with the specification given in Annex E, of SR21: 2004+A1: 2007, for fines material. The blinding layer should be of adequate depth to fill surface voids thus creating an even surface and avoiding sharp projections, which may damage radon or damp-proof membranes.</p>	<p><b>4.7 Ground supported floors</b></p> <p>A well compacted hardcore bed, no greater than 600mm deep, of clean, broken brick or similar inert material, free from materials including water-soluble sulfates in quantities which could damage the concrete (BRE Digest 276)<sup>1</sup>;</p>	<p><b>3.4.2</b> The solum<sup>2</sup> is brought to a level surface. Hardcore bed 100 mm thick of clean broken brick or similar inert material free from fine material and water soluble sulfates in quantities which would damage the concrete; blinded with suitable fine material and constructed to form a level, crack-free surface.</p>	<p><b>1.4</b> Ground preparation for floors next to ground. Prepare the ground to an even surface. Lay a hardcore bed 100 mm thick of stone, clean broken brick or similar inert material free from fine material and water soluble sulfates in quantities which would damage the concrete; consolidated and blinded to form an even surface.</p>

54 BRE Digest 276 Hardcore, makes reference to the small number of isolated cases across the UK of pyritic heave. Its primary focus was sulfate attack. See chapter 3 section 3.1 for further details.

55 In Scottish law, the solum is the area of ground that lies inside the walls or foundations of a building



### 5.1.1.3 Canadian Building Regulations

As a further comparison, the Panel reviewed the requirements in Quebec, Canada, where heave due to pyrite in hardcore caused damage in some houses built in the 1980's and 1990's. See Appendix 9 for a summary of the Canadian experience.

It appears that, prior to 1999, hardcore ("backfill" as it is known in Canada) did not have to comply with any particular standard or specification. In practice, a low cost all-purpose material, locally called "*tout venant*" or "TV" was used in commercial and residential construction. "TV" was composed of easily crushed stone and could include clay-rich shale, one of the known types of stone likely to cause swelling.

In 1999, following the uncovering of the scale of the problem in Quebec, a voluntary control procedure (CTQ M-100<sup>56</sup>) was published. It provided a procedure for producers to certify hardcore. This involved analysis of the stone by an independent laboratory and designation "*concassé certifié DB*" (*meaning DB certified gravel with the DB standing for Dalle de Béton, French for Concrete Slab*). This provided a guarantee to customers that the hardcore was suitable for use under concrete slabs for both construction and renovation.

In 2001, official standards were developed based on the CTQ M -100 procedures. These were subsequently incorporated into the Quebec Building Regulations (*Code de Construction du Québec*).

Small buildings are however outside the scope and control of the *Quebec Building Regulations*, so in 1999, the Québec government made the "*Guarantee Plan for New Residential Buildings*" mandatory for such buildings. Member contractors are required to use "DB" hardcore to ensure the problem does not recur.

### 5.1.1.4 Discussion

The opinion was expressed to the Panel that the lack of specific guidance in the Technical Guidance Documents to the Building Regulations was seen as a contributory factor in the supply and use of unsuitable hardcore, which subsequently caused pyritic heave.

### 5.1.1.5 Conclusion

Traditionally, Building Regulations in Ireland and the UK dealt with hardcore in a general way through fitness for purpose and performance of the elements of a building.

In the UK and Canada, guidance evolved to respond to particular issues, knowledge and local events. For example, guidance in the UK developed in an effort to deal with the specific and major problem of sulfate attack, due to the use of industrial spoils and by-products. This was not seen as a major concern for Ireland as the offending materials were not widely available in Ireland.

The Irish requirements and guidance in place prior to 2008, appear to have reflected the state of knowledge and experience up to that time in Ireland. While not referring specifically

56 *Comité Technique Québécois d'étude des problèmes de gonflement associés à la pyrite, CTQM100 Protocole de caractérisation du potentiel de gonflement des matériaux granulaires – Matériaux DB – et procédures d'application. April 1999*

to pyrite, the guidance stipulated the use of hardcore that was “*clean and free from matter liable to cause damage to the concrete.*”

Following the publication of the amended NSAI *Standard Recommendation, SR 21:2004 +A1: 2007*, developed at the request of the construction industry, TGD C to Part C of the Building Regulations was amended promptly to refer directly to it. In doing so, compliance with the more detailed specification for hardcore became, *prima facie*, evidence of compliance with the Building Regulations.

While there is an overarching legal obligation imposed by Building Control Legislation, on owners, designers and builders, to specify and/or use materials that are “*fit for the use for which they are intended and for the conditions in which they are to be used*”<sup>57</sup>, there is also a legal responsibility on suppliers placing construction products on the market. Under the European Communities (Construction Products) Regulations 1994 (SI 198 of 1992 and SI 210 of 1994), suppliers of construction products “*... shall not place a product, other than a minor product, on the market unless it has such characteristics that the works in which it is to be incorporated, assembled, applied or installed can, if properly designed and built, satisfy the essential requirements when, where and to the extent that such works are subject to regulations containing such requirements*”<sup>58</sup>. Building Regulations are an example of regulations containing such requirements. See Appendix 12 for further information on this legislation.

Also, the Sale of Goods and Supply of Services Act 1980 (No.16 of 1980) establishes that there is an “*implied condition that the goods supplied under a contract are of merchantable quality*” and this is defined as “*fit for the purpose or purposes for which goods of that kind are commonly bought and as durable as it is reasonable to expect ...*” This was referred to in the judgement of Mr. Justice Charleton, delivered on 25<sup>th</sup> May 2011 in ‘*James Elliott Construction Limited and Irish Asphalt Limited.*’ This case is currently under appeal. Prior to the identification of the pyritic heave problem, the Irish Building Regulations could be compared favourably with that in the UK and in other jurisdictions. Once the pyrite problem was identified, further guidance was provided in the Building Regulations Technical Guidance Documents, as happened in the UK when analogous situations arose.

### 5.1.2 Enforcement of Building Regulations in Ireland

The Building Control Acts 1990-2007, make a number of provisions for the enforcement of the Building Regulations as discussed above. These are described in brief below.

#### 5.1.2.1 Building control authorities

There are currently thirty seven designated building control authorities made up of city and county councils. They have various powers (as set out below) to carry out inspections and enforce the Regulations. In addition they may take prosecutions for breaches of these Regulations. There are variations, across the country, as to how building control authorities are structured, as each local authority is itself responsible for staffing and organising the function.

57 Extract from Part D Materials and Workmanship of the Second Schedule to the Building Regulations –Requirement D3

58 Extract from European Communities (Construction Products) Regulations 1992 (S.I. No. 198 of 1992) and European Communities (Construction Products) Regulations 1994 (S.I. No. 210 of 1994). See Appendix 12

### 5.1.2.2 Authorised persons

Building control authorities have the power to appoint an “authorised person” under the Acts. Authorised persons have specific rights to inspect works at any stage and to require any information or samples of materials to establish compliance with the requirements of the Building Regulations. Local authorities generally confer this power on the building control officer or officers.

Building control officers conduct sample site inspections to check and promote compliance with the Building Regulations. The target inspection rate, as communicated to the Panel by the County and City Managers Association (CCMA), is 12–15% of all buildings for which a valid commencement notice is received. The building control authority is free to choose which works to inspect. This choice may be based on processes established within the Authority, on builders/developer’s track record or may be triggered by complaints from the public.

### 5.1.2.3 Enforcement notices

The building control authority may serve an Enforcement Notice, up to 5 years after completion, where a building or works are not designed, constructed or carried out in conformity with the Building Regulations. These notices may require specific steps to be taken within a certain period of time for the purposes of ensuring compliance. It is served on the owner of the building or works concerned, or any other person who carried out the works.

To strengthen the powers of the building control authorities, the Act of 2007 made provisions to allow building control authorities, where a person fails to comply with the requirements of the Enforcement Notice, to apply to the High Court or the Circuit Court for an order requiring the removal, alteration or making safe of any structure or the discontinuance of any works or restricting or prohibiting the use of the building until there has been compliance with the enforcement notice. Alternatively, the building control authority may enter into any building or works to which the enforcement notice relates and take any action or do anything required by the notice.

### 5.1.2.4 Prosecutions

In order to simplify the process for building control authorities, the Act of 2007 introduced the option for building control authorities to bring summary prosecution for all building code offences (e.g. non-compliance with the Building Regulations, non-compliance with an enforcement notice) in the District Court, rather than by way of prosecution on indictment by the Director of Public Prosecutions (DPP) in the Circuit Court (a resource intensive process).

The Act of 2007 also provides for the recoupment of costs incurred by building control authorities in taking enforcement action and to obtain the benefit of fines resulting from summary prosecutions brought by them. The Act of 2007 also increased the maximum penalties for an offence<sup>59</sup>.

59 For breaches of the national Building Regulations from £800 (punts) to €5,000 on summary conviction; with fines for ongoing offences increased from £150 (punts) to € 500 per day after summary conviction; and from £10,000 (punts) to €50,000 on conviction on indictment

### 5.1.2.5 Response of the building control authorities

The building control authority in Fingal County Council (FCC), where the highest incidence of the reported problems occurred, informed the Panel that they took certain actions in 2007, including the following:

- The development of a notice on the issue of pyrite in hardcore. See Appendix 7 for details. This notice was sent to developers, designers and private individuals who submitted commencement notices from 1<sup>st</sup> June 2007.
- All of these sites were visited by building control staff to ensure that the developers/builders were aware of the notice and the issue.
- An addition to the commencement notice form was developed, to alert prospective builders and developers of the issue. See Appendix 11 for details.
- As a result of the notices, Fingal building control authority received a number of queries about pyrite from builders, designers and especially owners of one-off housing developments to whom it gave advice.
- A quarry, that was identified as the source (at the time) of suspect hardcore, was contacted, visited and the operators advised to stop supplying the material. The Panel was informed that this quarry closed very shortly afterwards.
- Fingal building control authority also advised and shared its knowledge with many other local authorities. In 2008, a building control officer presented a paper on the pyrite problem to the Irish Building Control Institute (IBCI) annual conference.
- Even now, when inspections are carried out by building control officers, the builder/developer is reminded of the notice and requirements for hardcore.

A number of other local authorities have followed a similar approach to Fingal County Council by publishing notices.

### 5.1.2.6 Discussion

Some stakeholders complained to the Panel that the lack of control, oversight and independent inspection of residential construction was a major contributory factor to the pyrite problem.

In general, building control authorities (and other construction professionals) did not regard hardcore as a high risk material in itself. Tests on materials are not routinely carried out by, or requested by building control authorities (or by other construction stakeholders). Site testing of a “perceived low risk material,” such as hardcore, would have been uncommon. However, poor compaction practices had led to ground floors settling in the past and thus compaction procedures may have been focussed on as part of some routine inspections.

The risk-based approach to inspections is explained by the County and City Managers Association, in its submission; *“In addition to general assessments, some of the specific issues that building control authorities would have focussed on at the time, reflecting national priorities, include:*

- *Timber framed construction*
- *Compliance with Part M – Accessibility*
- *Installations of fire barriers*
- *Installations of radon barriers*
- *Compliance with Part L – (Conservation of Fuel and Energy)*
- *Non-standard materials and design elements and forms of construction which were continuously being introduced by the industry.”<sup>60</sup>*

The Panel also heard views regarding the reluctance of building control authorities to bring enforcement action on builders for failure to comply with the Building Regulations.

In the years following 2007, when pyrite in hardcore was confirmed as the cause of cracking, many industry stakeholders affected by pyrite assessed the problem on a case by case basis. Guarantee companies processed claims, which in some cases led to remediation; builders investigated cracking in developments which in some instances led to lengthy court cases and which, in turn has led to ongoing remediation in cases; other builders carried out remedial works at their own expense on a one to one basis and some chose to ignore or deny the problem. Some homeowners have and are preparing to take legal action against builders or developers.

The Panel was informed by building control officers that very few complaints were received by them on which they could have reacted. It is thought that complaints were not generally made in order to protect the reputation of developments and homeowners’ investments.

Building control authorities explained to the Panel that compliance with the Building Regulations is, generally, achieved by seeking the co-operation of builders on site. Warning letters may be used if this approach is not successful. The County and City Managers Association explained that enforcement notices and prosecutions are *“generally taken on a breach at a particular point in time, so if the breach was noted by an authorised officer, it can be taken so long as the prosecution was initiated within the statutory time limits. However, if there is a genuine commitment given to make good the defect, then the cost, time etc., of initiating court proceedings and getting a conviction, or a minimum fine due to the mitigating circumstances (i.e. the defect made good) has to be taken into account.”<sup>61</sup>*

By 2011, the pyrite problem had become a more public issue (see chapter 6 for more background) and some building control authorities have informed the Panel that they are now investigating individual projects to establish if there are breaches of Building Regulations and then deciding what actions they can take.

A view was also expressed to the Panel that the voluntary opinion of compliance/self-certification system was seen by many as totally inadequate, as it was not supported by proper inspections and a site supervision system. It was, however, acknowledged to the Panel that this did not, of itself, directly contribute to the problem of pyrite.

60 County and City Managers Association submission to the Pyrite Panel, dated 20<sup>th</sup> February 2012

61 County and City Managers Association submission to the Pyrite Panel, dated 20<sup>th</sup> February 2012

### 5.1.2.7 Conclusion

The Panel considers that there are significant limitations within the current system of building control. The Panel identified it as important that building control authorities have adequate levels of managerial, technical and financial resources to address the enforcement of Building Regulations on a risk-based approach. The Panel is not confident that building control has had a significantly high priority within many local authorities as it should have had. The Panel is of the opinion that building control authorities should adopt a more consistent and co-ordinated approach across the country with an effective system of sharing information and expertise in a timely manner.

The Panel considered whether it was reasonable to have expected that the pyrite problem in hardcore should have been identified by building control officers. On balance the Panel considered that it was unreasonable to expect that the unprecedented issue relating to pyrite in hardcore could have been identified by building control officers during normal inspections of construction sites at the time.

In relation to sample testing, the judgement of Mr. Justice Charleton delivered on 25<sup>th</sup> May 2011 in *'James Elliott Construction Limited and Irish Asphalt Limited'* states *"I also accept that it was not reasonable for Elliott Construction, as the purchaser of material, to carry out a suite of tests on the material..."*. This case is currently under appeal. The Panel considers the same could be said for building control officers. However, while it may not have appeared reasonable prior to 2007 to require testing of hardcore, which was regarded as low risk, the Panel considers there is now a strong case for building control to require evidence of testing and certification, of actual hardcore used, to demonstrate compliance with the Building Regulations.

In respect of the existing cases, where pyritic material has been used in buildings and the situation has not been remediated, the Panel is disappointed to hear that the five year limitation for action by some of the building control authorities may have passed and the building control authorities may not now be in a position to proceed against the builders concerned. Nevertheless, the Panel recommends that the relevant building control authorities should urgently address the issue in respect of its own functional areas and consider using the full provisions of the Building Control Acts to seek to get the builders concerned to remediate the problem, taking into consideration the responsibility of the builders, as outlined in the legislation. In particular, the Panel recommends that building control authorities should consider taking enforcement procedures and/or prosecutions for serious breaches of Building Regulations, following consideration of the particulars of each individual case.

The Panel also recommends that, the County and City Managers Association should review its guidance (as articulated in their submission to the Panel) in relation to building control enforcement and, in particular, the reasons why building control authorities did not seek to utilise the provisions of the legislation to seek remediation of the pyrite-affected dwellings. The lessons from this should be incorporated into any new revision of the guidance issued by the County and City Managers Association.

The Panel acknowledges the opinions expressed by many that the over-reliance on the industry to comply with the Building Regulations is not effective and requires a re-appraisal. At the time of writing the report, the Panel has been informed that the Minister for the Environment, Community and Local Government is preparing secondary legislation to strengthen the system of compliance with the Building Regulations through, among other initiatives, mandatory certification. The Panel is of the view that the development of a mandatory certification system is a necessary development and it should take cognisance of the importance of inspections, product certifications, site supervision and take proper account of the risk associated with design, materials and construction. The Panel would also suggest that there is a need to strengthen the system of independent inspections, carried out by the building control officers, to complement the proposed mandatory certification process.

The Panel also recommends that consideration should be given to introducing a mandatory register for all builders. This would require builders to demonstrate technical competence, financial capacity and to hold adequate insurance for the type and value of work for which they are registered. Such a register, with details of insurance certificates, should be available publicly over the internet.

In light of the experience of building control authorities following the advice of the CCMA with respect to prosecutions and the constraints that may result from the 5 year limit for prosecutions, the Panel would recommend that the 5 year limit be reviewed by the Minister for Environment, Community and Local Government.

### 5.2 Specification for hardcore in dwellings

In practice, on construction sites, a number of different practices prevailed in relation to specifying, ordering and using hardcore under concrete ground floor slabs. The most commonly utilised specifications were the HomeBond specification and the specification for road sub-base materials known as "Clause 804".

#### 5.2.1 HomeBond specification

Many builders, both HomeBond members and non-members, relied heavily on the "*HomeBond House Building Manual*"<sup>62</sup> and "*Right on Site*"<sup>63</sup> publications.

The *HomeBond House Building Manual* was first published in 1993. It covers all stages of house building construction, from foundations to roof, focussing on the integration of materials, details and services. The publication is revised on a periodic basis and incorporates relevant changes to the Building Regulations in a timely fashion. The first edition achieved a distribution of approximately 18,000 copies. This has steadily increased over time and reached 95,000 by 2008.

In relation to hardcore for use under concrete ground floors, ever since its first publication (1993), the *HomeBond House Building Manual* gave clear guidance on a number of aspects of hardcore, as follows:

62 HomeBond House Building Manual 6<sup>th</sup> Edition 2008,  
63 HomeBond Right on site leaflets No. 1-No. 46

- Type of material:* Clean, crushed, well graded stone. Free from shale. 100mm maximum size. No demolition waste, site rubbish, pit run gravel or excavated material to be used.
- Compaction:* Hardcore to be compacted in layers 225mm thick.
- Depth:* Hardcore to be a minimum of 150mm thick and a maximum of 900mm. Suspended floor slab to be used in excess of 900mm.

### 5.2.2 “Clause 804” - A specification for a road sub-base material

Some builders (often on the basis of advice from engineers) chose to specify a road building material known as “Clause 804”. “Clause 804” is a reference to a specification for an unbound material used for sub-bases and road-bases in the Specification for Road Works, published by the National Roads Authority<sup>64</sup>. This document was originally produced by the Department of the Environment (first published in 1979), but now, in an entirely new format, forms part of the *NRA Manual of Contract Documents for Roadworks*. Material in compliance with “Clause 804” is made from crushed rock and must meet a number of physical and chemical requirements as set out in the *Volume 1 - NRA Specification for Road Works Series 800 - Road Pavements, Unbound and Cement Bound Mixtures (2000, amended in 2004, 2010 and 2011)* and, since 2004, in conformity with *I.S. EN 13242:2002 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* and the relevant testing standards referred to therein.

Those who specified “Clause 804” took comfort from the clear and detailed specification that existed, knowledge that it was a premium aggregate and the familiarity that quarries had in producing such material for road construction.

Material complying with “Clause 804” is not tested for the presence of pyrite or for sulfur (unless it is used within 500mm of concrete, in which case the threat of sulphate attack exists and sulfur tests are carried out). The vulnerability of this aggregate to pyritic heave is minimised due to the premium quality of its physical characteristics. The Panel was informed by experts in this field that *“susceptibility to pyrite-induced heave is critically dependent on the quality of the rock in terms of its porosity, resistance to abrasion and mechanical strength.... Good quality inert crushed rock should be used as hardcore infill under floor slabs. The infill in the buildings, in Ireland, exhibiting pyrite-induced floor heave typically contain predominantly calcareous mudstones and/or siltstone, and occasionally shale. These rock lithologies typically represent lower grade materials than should be used for the production of construction aggregates”*<sup>65</sup> While limestone may contain fine grained pyrite *“in low concentrations, this does not impair their performance as construction aggregates. In dark grey mudstones and siltstones, framboidal and other fine grained forms of pyrite predominate and can be problematic, even at low concentrations”*<sup>66</sup>.

64 NRA *Manual of Contract Documents for Roadworks, Volume 1 - NRA Specification for Road Works Series 800 - Road Pavements, Unbound and Cement Bound Mixtures (2000, amended in 2004, 2010 and 2011)*

65 Golder Associates, *Technical Memorandum; Steps in establishing the presence of reactive pyrite in hardcore infill* submission to the Pyrite Panel, February 2012

66 Golder Associates *Technical Memorandum, Steps in establishing the presence of reactive pyrite in hardcore fill* submission to the Pyrite Panel, February 2012



### 5.2.3 Discussion

From some sample copy invoices for hardcore material delivered to a number of building sites and seen by the Panel, it appears that the builders concerned had specified that the hardcore was to a “Clause 804” specification. These sites included some of the estates which subsequently experienced pyritic heave. It was suggested that, in many cases, “Clause 804” was not the grade of stone that was actually supplied. The judgement of Mr. Justice Charleton delivered on 25<sup>th</sup> May 2011 in *‘James Elliott Construction Limited and Irish Asphalt Limited’* states that “...the material removed from the building in Ballymun clearly fails the Clause 804 standard.” This case is currently under appeal. There was a general opinion held by many engineers, that if the stone met the requirements of “Clause 804”, in general, the stone would not have been subject to pyritic heave or caused the associated damage.

Since the existing specifications for hardcore grew largely from the needs of the road building industry, some stakeholders considered there was a case to be made for developing a standalone specification for aggregate used under floors in building construction, arising from the experience of pyrite now gained.

### 5.2.4 Conclusion

Based on the damage which has occurred to dwellings and the comments received from a wide range of geotechnical and construction experts, it appears to the Panel that the hardcore used where pyritic heave has occurred was unlikely to have been to the required specifications, the HomeBond specification or to the NRA specification of “Clause 804”. The Panel therefore recommends that there needs to be greater testing, certification and traceability of hardcore used in buildings, to prevent recurrence of this or similar problems. These should be incorporated into a standalone specification for hardcore used in buildings which will provide a central point of guidance on hardcore.

The Panel commends the work by the Irish Concrete Federation (in conjunction with the relevant professional institutions) to promote and encourage certification systems for materials produced by its members.

From 1st July 2013, the Construction Products Regulation<sup>67</sup> will require that any construction product placed on the market that is covered by a harmonised standard will have to be accompanied by a Declaration of Performance and will need to affix a CE marking. There is a suite of harmonised standards covering a variety of aggregates. However, it should be noted that hardcore is not covered by a harmonised standard. See Appendix 12 for further information on this legislation.

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67 See Appendix 12 for further information on the Construction Products Regulation

### 5.3 Amendment to SR 21:2004 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction <sup>68</sup>

*I.S. EN 13242:2002<sup>69</sup> Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*, was published by the National Standards Authority of Ireland (NASI) in 2002 and came into effect in January 2003.

The NSAI Roads Standards' Committee and the NSAI Concrete Consultative Committee set up a specific panel, known as the "Aggregates' Panel" to work on guidance to this standard (and others). The Aggregates' Panel was made up of representatives from industry, NSAI, Department of Transport, National Roads Authority and Department of the Environment, Community and Local Government. The guidance was published, in 2004, as SR 21:2004 *Guidance on the use of I.S. EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*.

In 2007, the NSAI Aggregates' Panel, at the behest of industry, was tasked with amending SR 21:2004 *Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*, to limit the presence of a reactive form of pyrite in hardcore, used under concrete ground floors and which may give rise to swelling or sulfate attack. The amendment contained a two-pronged approach.

- Firstly, an example specification for hardcore (5.3.1), and
- Secondly, further guidance on the suitability of material for use as hardcore depending on the results of the total sulfur test (5.3.2).

#### 5.3.1 Annex E - Example specification for unbound granular fill for use under concrete floors and footpaths

The first element of the amendment was the incorporation of a new annex (Annex E). This is a detailed sample specification for builders, for "unbound granular fill for use under concrete floors and footpaths". It sets out the results expected of hardcore, when tested in accordance with *I.S. EN 13242:2002 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*.

The Annex E specification provides stand-alone verifiable performance criteria for hardcore. It sets the quality of the aggregate (attempting to rule out low quality stone), the grading (reducing the level of fines) and the results required from sulfur-related chemical tests. The overall aim is to reduce the risk of having significant quantities of a reactive form of pyrite in the material.

68 *SR 21:2004 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction.*

69 IS EN 13242 is a harmonised European Product Standard, under the Construction Products Directive. It was amended in 2007, as such the current version of the standard is *I.S. EN 13242:2002+A1:2007 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*,

The title of Annex E explicitly states the intended use of the material. This makes all parties in the supply chain fully aware of the end use thus avoiding any confusion regarding intended use. See Figure 5.1 for extract from SR21:2004+A1:2007 *Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction – Annex E.*

**Figure 5.1 Extract from SR21:2004+A1:2007 – Annex E**

<b>Annex E (informative)</b>		A1
<b>Example specification for unbound granular fill for use under concrete floors and footpaths</b>		
<p>An example format of a preferred specification for aggregates for unbound granular fill for use under concrete floors and footpaths is given in Table E.1</p>		
<p><b>Table E.1 — Example specification for unbound granular fill for use under concrete floors and footpaths</b></p>		
Properties	Category to I.S. EN 13242:2002	
Grading (Granular Coarse)	4/40 to Gc 85/15 or Gc 80/20 As per Table 3	
Grading (Fines material for blinding top surface)	0/6.3 G <sub>F</sub> 80 As per Table 4	
Resistance to fragmentation*	LA <sub>40</sub>	
Water absorption* to I.S. EN 1097-6:2000, Clause. 7	WA <sub>24</sub> 2	
For WA >2% magnesium sulfate* soundness value	MS <sub>25</sub>	
Acid-soluble sulfate content: aggregates other than air-cooled blastfurnace slag	AS <sub>0,2</sub>	
Total sulfur: aggregates other than air-cooled blastfurnace slag	S <sub>1</sub>	
<p>NOTE Specifying values for all other properties described in I.S. EN 13242:2002 is not necessary because, as specified in I.S. EN 13242:2002, clause 4.1, 5.1, 6.1 and 7.1, they are not appropriate to the particular application at end-use or origin of the aggregate.</p>		
<p>* For Granular coarse material only</p>		

### 5.3.2 Clause 3.4.2 - Total Sulfur (I.S EN 13242:2002, Clause 6.3)

The second element of the amendment was the provision of guidance to quarry owners on the suitability of aggregate for use as hardcore, in relation to the result of the total sulfur test. Clause 3.4.2 (see Figure 5.2) sets out the following advice to quarry owners in relation to the total sulfur test results;

- If the result is less than 0.1%, no further testing is required, unless there is a significant change in the quarry deposit.
- If the result is between 0.1 and 1%, there is a risk of swelling from pyrite. It is advised that a suitably experienced petrographer carry out a detailed mineralogical examination to establish
  - the material's suitability as hardcore under floors and footpaths, and
  - an appropriate testing frequency for total sulfur based on the variability of the quarry deposit.

**Figure 5.2 Extract from SR21:2004+A1:2007 – Para 3.4.2**

<p><b>3.4.2 Total sulfur (I.S. EN 13242:2002, Clause 6.3)</b></p> <p>Category S<sub>1</sub> of I.S. EN13242: 2002, clause 6.3 limits the total sulfur content to 1% by mass for aggregates other than blastfurnace slag when this category is required for a particular end-use of the aggregate.</p> <p>For current Irish aggregate sources where the measured value of total sulfur content during initial testing is 0.1% by mass or less, it should be unnecessary to undertake further testing. In this case the total sulfur content can be assumed to conform to the 1% limit unless there is a significant change in the quarry deposit.</p> <p>Pyrrhotite, an unstable form of iron sulfide, is an uncommon constituent of aggregate in Ireland. Therefore, unless specific information on its presence is known, the special precautions specified in the Note to I.S. EN 13242:2002, clause 6.3 are unlikely to be adopted.</p>		A1
NOTE	<p>Annex E (of this guidance document) outlines an example specification for properties required by unbound granular fill for use under concrete floors and footpaths.</p> <p>This requires the total sulfur content to be category S<sub>1</sub>. Producers and specifiers should be aware that the recommended category S<sub>1</sub> for total sulfur may not of itself completely exclude the risk of swelling due to the presence of a reactive form of pyrite. Where it is envisaged that material from a quarry may be used for this purpose, it is advised that a suitably experienced petrographer carry out a detailed mineralogical examination covering the proposed area of extraction in order to</p> <p>a) ascertain the material's suitability for this end use, and</p> <p>b) establish an appropriate test frequency for total sulfur from an assessment of the variability of the quarry deposit. This assessment may need to be repeated where there is a significant change in quarry characteristics.</p> <p>Consideration should also be given to the possibility of sulfate attack on concrete and guidance should be taken from I.S. EN 206-1.</p>	A1

The amendment to *SR21:2004 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*, SR21:2004+A1:2007, was published in December 2007 and guidance to the Building Regulations (TGD C) was revised to refer to it in 2008. Since then, hardcore in compliance with *SR21:2004+A1:2007 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* is *prima facie* evidence of compliance with the Building Regulations.

### 5.3.3 Discussion

It was suggested to the Panel by stakeholders in the construction industry that the total supply of “Annex E” material has been very low since the standard was published. However, in a joint submission to the Panel, Engineers Ireland and the Association of Consulting Engineers of Ireland (EI and ACEI)<sup>70</sup> explained that *“A sample survey amongst consulting engineers has shown that, since the revision to the Building Regulations TGD C in 2008, some have updated their specifications by general reference to SR21:2004+A1:2007 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction, while others go into more detail such as incorporating Table E.1 from Annex E of SR21 into the specification.”*

There was some technical criticism of the amendment to *SR21:2004+A1:2007 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* brought to the attention of the Panel. In relation to the Annex E specification, some expressed the opinion that it was too lenient in relation to limiting the presence of pyrite and in particular the Total Sulfur Test. However, it appears that the guidance in clause 3.4.2 was often overlooked in this context. Others suggested that additional tests should be required in relation to pyrite while others suggested recycled aggregates should not be used because of the unknown risk they present. The make up of the Aggregates Panel (established by NSAI) was questioned, in so far as some considered that the representation was too narrow and focussed too heavily on the construction industry without sufficient independent experts. It was also suggested that a standalone specification for hardcore in buildings would be desirable.

The Panel notes NSAI’s account of standards’ development as *“a collaborative process, with documents developed on an internationally recognised consensus based approach, involving expertise and stakeholder interest derived from the area under review. As such, standards represent the best solution available at the time.”*<sup>71</sup>

The Panel was not informed of any failures of concrete or concrete products, due to aggregates containing reactive pyrite being used as a constituent of the concrete, at the same time or in the locality where the problems with hardcore occurred. The standards for concrete and its constituents (e.g. aggregates) are well established and there is full acceptance of the testing regime in place. However, there did not appear to be the same level of awareness of the necessity for testing aggregates for use as hardcore under floors in buildings.

### 5.3.4 Conclusion

While the Panel recognises the downturn in the housing market and confinement of pyrite problems to one area of the country may explain the low output of *SR21:2004+A1:2007 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* Annex E material. Nonetheless it was concerned about recurrence of the problem if *SR21:2004+A1:2007*

70 Engineers Ireland/Association of Consulting Engineers of Ireland, submission to the Pyrite Panel dated 23<sup>rd</sup> January 2012

71 NSAI, submission to the Pyrite Panel dated 31st January 2012

*Guidance on the use of I.S. EN 13242:2002 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* was not used as the standard specification. The Panel concluded that the method of dissemination and promulgation of standards should be reviewed by NSAI and improved so as to increase its uptake by industry.

The Panel also considers that it should be possible, with the use of modern technologies, to have a single, publicly accessible point of up-to-date information on standards that is immediately and readily available to all involved in the construction industry. It should be possible to have a free-view facility on the web-site with a cost-based model for download of the relevant standards.

See chapter 3, section 3.4.4 for other recommendations regarding the dissemination of information by the Department of the Environment, Community and Local Government and by the professional institutions.

With the depth of knowledge on pyrite that has developed in Ireland, over the last five years or so, the Panel considers that it would be worthwhile reviewing *SR21:2004+A1:2007 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* to see if it requires amendment. This would be considered good practice in terms of maintaining standards nationally and internationally. The expertise developed, the scientific data gathered and research carried out over this time should be made available to NSAI in order to ensure the best outcome from the review.

The Panel concluded that the absence of a formal testing regime for hardcore, comparable to that used for concrete, may have led to poor quality material being provided to the residential construction market. Accordingly, the Panel recommends that a standalone specification for hardcore should be developed, by NSAI, that covers the performance of the material, the testing requirements at various stages within the supply chain and ensures the traceability of hardcore. While the Panel has suggested some of the essential contents of the specification for hardcore, the scope should be further developed and refined, where necessary, by the relevant NSAI committee set up to produce the specification.

As a follow on, the Panel recommends that the Department of the Environment, Community and Local Government should review the guidance provided in Technical Guidance Document C to Part C of the Building Regulations following the publication of the Specification for hardcore referred to above.



# Chapter 6: Stakeholder activity and responsibilities

## 6.0 Introduction

This chapter gives an overview of the range of actions that has taken place to date by some of the stakeholders involved in the pyrite issue. Remediation works are being undertaken by a number of stakeholders, including warranty companies, builders, insurers and a number of individual householders, some at their own expense and others as a consequence of decisions from mediation/arbitration processes.

It refers to the issue of responsibility for the pyrite problem and the barriers faced by individual householders in trying to achieve successful outcomes to pyrite problems in their own homes.

It notes that there are a number of legal proceedings at various stages of progress.

## 6.1 Warranty/Guarantee Insurance companies

### 6.1.1 Introduction

It was generally a requirement of mortgage providers that purchasers of new dwellings should be covered by a warranty/guarantee scheme. Prior to 2007, two companies dominated the market providing structural defect guarantee or insurance warranty schemes for purchasers of new dwellings in the Irish market, namely HomeBond and Premier Guarantee. A third competitor, Construction Register (Ireland) Limited entered the market in 2007. Its product is not explicitly covered in this report as the problem with pyrite has mainly been associated with new dwellings before that period.

### 6.1.2 HomeBond Warranty Scheme

The National House Builders' Guarantee Scheme (NHBGS) was established in 1978 by the Irish Home Builders Association in conjunction with the Construction Industry Federation and at the behest of the Department of the Environment. The purpose of the scheme was to provide a structural defect guarantee to house purchasers and, more generally, to raise the standard and quality in house construction. The scheme is operated by the National House Building Guarantee Company Ltd, a private company, limited by guarantee. From 1996, the scheme operated under the business name of HomeBond. The Memorandum of Association of the company sets out the purpose for which it was set up:

*“to promote good building practices in Ireland and elsewhere” and “to found and administer a scheme for guaranteeing purchasers against defects in dwellings built, completed or sold or arranged to be sold by members of the scheme by way of compensation for or making good of such defects and accordingly to issue guarantee certificates to purchasers of such dwellings”*



## Chapter 6: Stakeholder activity and responsibilities

The scheme was designed to provide some comfort to purchasers of dwellings registered by members (developers/ builders) under the HomeBond Warranty Scheme. Under the scheme, builder members were obliged to register all houses being built by them. The purchasers of such dwellings benefited from the warranty if 'major defects' (as defined within the terms of the HomeBond agreement) appeared in their dwellings within a set period after purchase (up to 10 years). In the event of a complaint, the member builder was required to make good any major defects in the structure of the house and HomeBond only became involved in completing the relevant works if the builder did not carry out the remediation. In this way, HomeBond's expenditure was kept to a minimum and this resulted in low registration costs (approximately €100 to €250 per house) for the house builders.

Further details of the HomeBond Warranty Scheme are outlined in Appendix 13

The scheme operated by HomeBond was not underwritten by an insurance company (until after 2008) and was not initially subject to regulation by the Central Bank, as would be standard for companies providing insurance cover.

The model adopted by HomeBond for the structural defect guarantee scheme has experienced some difficulties because, under the scheme, it is the builders who are members of the guarantee scheme and not the homeowner. Essentially, the builder assumed primary responsibility for repairing defects, backed up by the scheme. It was possible for registration fees and remediation costs to HomeBond to be kept to a minimum through the involvement of the builder in the remediation work. While the model appeared to have worked well for a number of years, the scheme's limitations became evident when HomeBond was hit with a large number of claims in 2007, at the same time as many builders faced deep financial difficulties as a result of the downturn in the industry. It is considered by many that it is unlikely that HomeBond has sufficient funding to deal adequately with all the claims, if the claims were successful. The Panel considers that this is an urgent issue that should be addressed by the members of HomeBond in the first instance and by the broader construction industry as well.

In 2008, the warranty scheme was changed to an insurance based scheme underwritten by Allianz Insurance and the new policies varied somewhat from the old Warranty Scheme. The homeowner now deals directly with HomeBond often with no involvement of the builder when a claim is made.

The Panel was advised by HomeBond that cover for defects due to pyrite is specifically excluded since 1st Jan 2012.

Concerns about the HomeBond scheme were expressed by the Law Society of Ireland in a practice note published in July 2000.<sup>72</sup> A “*Client Warning*” was also issued in June 2000. Because of the unwillingness of the Law Society to engage with the Panel, it has not been possible to establish what happened in respect of the concerns raised by the Law Society in 2000. From what the Panel gleaned, the concerns were raised with HomeBond, but it is not clear what happened subsequently. The level of cover provided was raised in October 2004 from €38,000 per dwelling and €508,000 per member to €200,000 and €2,000,000 respectively.

In a report, “*Review of Insurance Issues*,” published by the National Consumer Agency in 2008,<sup>73</sup> concerns were also expressed about the HomeBond Warranty Scheme, including such issues as possible under-insurance, cumulative liability, successors in title, monetary limit, temporal and financial limits in relation to structural defects, and expressly excluded areas of under-insurance. These were important concerns which do not appear to have been addressed by stakeholders. The Panel considers that all stakeholders involved, including Government, should have addressed and responded to those concerns in a timely manner.

Disquiet was expressed by one of the groups which spoke to the Panel about the relationship between the Department of the Environment, Community and Local Government and HomeBond. Department inspectors provided an inspection service, outside the Dublin area, to HomeBond, on a fee basis, from the inception of the warranty scheme in the late 1970’s until 2004. The decision to cease this arrangement with the Department and employ inspectors directly was taken by HomeBond, apparently for commercial reasons. It was suggested that the closeness of this relationship may have limited the Department’s ability to persuade HomeBond to provide a more customer-focussed warranty scheme. However, it was noted that HomeBond operates as a private company and its operations are determined and controlled by its board of Directors without reference to the Department. The Panel is of the opinion that the relationship between HomeBond and the Department of the Environment, Community and Local Government had no material impact on the type of warranty scheme offered by HomeBond.

The Panel was informed that HomeBond was and is by far the largest provider of structural defect guarantees in the Irish housing market. The unexpected withdrawal by HomeBond of cover for defects caused by pyritic heave in August 2011, following the judgement in *James Elliott Construction Limited-v- Irish Asphalt*, was a shock to all. HomeBond had already paid out to some homeowners who had experienced serious defects due to pyritic heave and had made commitments to others with regard to remediating pyrite related defects. While some brief reference had been made by commentators to the exclusion clauses in the HomeBond scheme, nobody had forecast their use in circumstances such as this. Effectively, defects arising from specified products used may, over time, be excluded, from the cover. The withdrawal of cover left many homeowners, who were covered by a HomeBond warranty, in particularly distressing situations.

72 “HomeBond Warning,” Law Society Gazette, July 2000, Law Society of Ireland.

73 “The Home Construction Industry and the Consumer in Ireland: Volume 4: Review of Insurance Issues”, National Consumer Agency, November 2008  
[http://corporate.nca.ie/eng/Research\\_Zone/sectoral-research/Home\\_Construction/introduction.html](http://corporate.nca.ie/eng/Research_Zone/sectoral-research/Home_Construction/introduction.html)

### 6.1.3 Premier Guarantee

The Premier Guarantee product is an insurance-based product underwritten by Liberty Syndicates Insurance. The insurance policy is between the purchaser and Liberty Syndicates and the builder has no liability for dealing with structural defects that occur subsequent to purchase. Premier are funding the costs of pyrite-related remediation works under the terms of their policy.

### 6.1.4 Conclusion

On the more general issue of home insurance, a report<sup>74</sup> was published by the Competition Authority in 2005 and this makes some interesting recommendations. The Panel suggests that this report should be considered by Government, along with the issues raised by the National Consumer Agency in its report *“Review of Insurance Issues”, 2008*<sup>75</sup> In light of the experience with pyrite, the Panel considers that there would be benefits in the National Consumer Agency and the Central Bank /Financial Regulator considering the issue of possibly mandating insurance companies to provide a minimum standard of cover for homeowners that would be clearly provided for all home insurance policies (similar to third party cover in respect of motor insurance) with provision for additional add-on features that would be paid for by the homeowner, depending on the cover sought.

## 6.2 Remediation work

### 6.2.1 HomeBond

As detailed in Chapter 3 of this report, the pyrite problem was first confirmed in early 2007. Between 2007 and August 2011, HomeBond processed and satisfied claims for damage arising from pyritic heave under the terms of their warranty scheme. However, in August 2011, they withdrew cover for major defects arising from pyritic heave. They took this decision, according to themselves, on the basis of legal opinion, expert technical advice and having regard to the decision of Mr Justice Charleton in the James Elliott Construction Limited and Irish Asphalt Limited case<sup>76</sup>. A significant number of claims have been made against HomeBond and, understandably, the homeowners are frustrated that HomeBond has not continued to provide cover which those homeowners had believed would be covered under the structural defects guarantee. This frustration is understandable, particularly when one considers that the homeowner had no choice in the selection of the structural guarantee provider. The impact of this action has been very upsetting for homeowners, with some loss of confidence in the cover offered by HomeBond and, indeed, in HomeBond itself.

### 6.2.2 Premier Guarantee

The Liberty Syndicates Group (underwriters of Premier Guarantee) continues to process claims for damage resulting from pyritic heave and it has in place a comprehensive testing protocol to prove that damage is consequent on the presence of reactive pyrite in the sub-floor hardcore. A drawback is that the cost of the testing has to be funded up-front by the homeowner and

74 Competition Issues in the Non-Life Insurance Market, The Competition Authority (2005)

75 “The Home Construction Industry and the Consumer in Ireland: Volume 4: Review of Insurance Issues”, National Consumer Agency, November 2008

76 Case under appeal to the Supreme Court

this is considered quite expensive. However, the Panel understands that, in estates where several houses have been tested showing consistent results, some relaxation on the type of testing may be possible on the remainder of damaged dwellings, providing it can be shown to have the same material and construction as the others.

### 6.2.3 Other remediation work

The Panel is aware that, separate to remediation work being undertaken under the Premier Guarantee Scheme or previously by HomeBond or one of its member builders, some builders have undertaken (and are continuing to undertake) remediation work on pyrite damage in dwellings. However, there is no information or data available to the Panel in relation to the number of builders who are taking this course of action. It is also clear that most builders doing so do not wish it to be known publicly. The avoidance of publicity is such that, in the case of *Menolly Homes and Others – v – Lagan Asphalt and Others*, the judge agreed to give an order banning the publication of the names of developments reported as having pyrite-affected houses.

In a number of other cases, the Panel is aware that individual homeowners have decided to remediate the house themselves and to pay for this by borrowing funds to cover the costs involved. This course of action was taken because the damage caused by the pyrite was so serious and they were having such difficulty getting any commitments from the structural defects guarantee provider or builder to remediate the house that they considered that the only effective action open to them was to borrow to get the remediation carried out. The Panel makes a recommendation in Chapter 8 (Recommendation 11) in regard to mortgage providers supporting individual householders to carry out remediation.

### 6.3 Arbitration/Mediation processes

The Panel understands that there are also a number of cases being dealt with through arbitration and that some agreements have been concluded, putting in place funding mechanisms to facilitate remediation work. Agreements concluded through arbitration are subject to confidentiality and consequently the Panel has no knowledge of the number or type of agreements that have been reached. However, it would appear that insurance companies are involved in some of these arbitration/ mediation processes and are parties to agreements on funding arrangements to undertake remediation work. These agreements would seem to cover both housing and public contract construction projects. The Panel welcomes the fact that such agreements are being achieved and it would urge the insurance companies to expedite the process and to make the information on the processes and agreements public.

*Menolly Homes and Others* took an action against Irish Asphalt Ltd and a number of companies in the Lagan Group for the alleged supply of defective hardcore material. Following a lengthy High Court case lasting 150 days, it was reported that a settlement was reached, through mediation, in which a trust fund was set up. The agreement is also subject to a confidentiality clause, so it is not known who contributed to the trust fund or in what ratio or the total actual amount in the trust fund. It was reported that the formation of the trust fund was dependent on 85% of homeowners in the three estates covered by the

agreement accepting its terms and it is understood that almost 99% accepted the terms of the agreement. The total number of units due to be remediated by the trust fund under the court settlement appears to be 703 and work is now progressing on a planned programme of remediation of these houses. The Panel understands that a number of homeowners who did not sign up to the agreement have taken separate legal actions but the Panel is not aware of the status of those proceedings.

The Panel welcomes the establishment of such a trust fund but the time delay and legal costs in establishing it appear to have been significant. The Panel would urge insurers and other stakeholders involved to seek to come to a more rapid agreement with a greater proportion of the costs going into the remediation of houses as opposed to legal fees.

### 6.4 Legal actions

In addition, the Panel is aware that there is a number of legal proceedings at various stages of action. Two cases, James Elliot Construction Limited (JEC) –v - Irish Asphalt Limited {2008 No. 4767 P} and Noreside Construction Ltd –v-Irish Asphalt Limited {2009 No.2593 P}, are the subject of High Court decisions, both of which are now on appeal to the Supreme Court. Other than the cases on appeal to the Supreme Court, the Panel has no definite information as to who or what parties are involved in other proceedings, but it understands that a number of quarry owners have been served with notifications of action.

Ballymun Regeneration Limited (BRL), a company set up to facilitate the regeneration of Ballymun, engaged James Elliot Construction (JEC) to build a central youth facility in Ballymun. This building, colloquially known as the RECO building, was completed and handed over to BRL in 2005. However, soon afterwards it displayed cracking and, while these were remediated by JEC, the cracks soon reappeared. Further attempts to repair cracking also failed and the building became unusable. Following testing, it was confirmed that the hardcore used in the sub-floors contained reactive pyrite. In 2009, JEC carried out the remedial works at a cost of €1.55m. In June 2008, JEC issued a plenary summons against Irish Asphalt Limited, which, it was alleged, had supplied the hardcore material for the RECO building. Mr Justice Charleton issued his judgement in May 2011 and found for the Plaintiff (JEC). He held that *"it has been proven as a probability that the damage to the building came about as a result of pyrite"*. Due to the presence of pyrite and the resulting effect, Mr Justice Charleton held that the *"material supplied by Irish Asphalt to Elliot Construction was not of merchantable quality"* and *"the material was not fit for the purpose."* This judgement is currently under appeal to the Supreme Court.

In 2003, Noreside Construction Limited was awarded a contract by Dublin City Council to build 52 houses and 31 units for senior citizens at Griffith Court, Dublin. In December 2008, Noreside Construction Ltd., was advised by Irish Asphalt Ltd. that pyrite was present in products purchased from its Bay Lane quarry and that any material from that quarry should not be used as under-floor infill in any building or within 500 millimetres of concrete or any steel structure. The material from the Bay Lane quarry had been used in the Griffith Avenue site. Subsequently, Noreside Construction Ltd. was notified by Dublin City Council of problems arising from the presence of reactive pyrite in the under-floor fill material in the Griffith Avenue development. In March 2009, legal proceedings were issued by Noreside Construction Ltd. against Irish

Asphalt Limited seeking a declaration of entitlement to an indemnity and breach of contract. A judgement was delivered on 4 October 2011 by Ms. Justice Finlay Geoghegan who found that there was no limitation on the liability of Irish Asphalt Ltd. for a defective product (if any) supplied, by virtue of conditions of supply.

The judgments in both cases are under appeal to the Supreme Court and the Panel understands that it is unlikely that hearings will take place before autumn 2012.

### 6.5 Responsibility for the pyrite problem

Purchasers made enormous investments in new homes during the peak period of the house building boom. It was during this period that the vast bulk of dwellings affected by pyrite heave were built. Most dwellings sold during that period are now worth significantly less than the amount paid for them and many of them have significant mortgages that are far more than the value of the dwellings. That some of those dwellings now have serious defects, which require costly repairs, is doubly unfortunate.

Furthermore, those purchasers also had the expectation that, if a serious defect arose, then either the builder or guarantee-type insurance would pay to have the remediation carried out. Many purchasers have been disappointed in that expectation by the reaction of some builders who have not been prepared to undertake the remediation works or who have gone into receivership or liquidation. They have also been disappointed by the reaction of HomeBond, which has recently withdrawn cover for defects caused by pyrite. A further issue is that in some cases defects may not become evident until periods of guarantee or insurance have expired. Furthermore, the Statute of Limitations may defeat any action under contract or tort. The six year limit means that those homeowners whose cause of action accrued prior to 2006 may already be outside the time limit.

The Panel did not consider that it was within its remit to apportion blame for the cause of the pyrite problem and the determination of civil liability is a matter for the courts. Nevertheless, irrespective of the legal responsibility, the Panel considers there is a moral responsibility on those who were involved to help solve this problem. The Panel recognises that responsibility for the pyrite problem lies with a number of stakeholders and this is a view supported in a number of submissions received by the Panel. For example, the Construction Industry Federation (CIF) stated in their submission *"...responsibility and liability for dealing with it (pyritic heave) must revolve around those directly involved, vendors, builders/subcontractors, material suppliers, Insurers"*.

The Panel agrees with the Construction Industry Federation's submission where those acknowledged as having responsibility are identified as vendors, builders/subcontractors, quarries and insurance companies. In the opinion of the Panel, it is disappointing that these stakeholders have not engaged with the homeowners well before now to provide remedies for them. Confidence in those groups involved in the construction industry has been seriously damaged and *"there is no doubt that the stigma of pyrites is causing significant blockages in the property market, as well as uncertainty by insurers and mortgage lenders"*<sup>77</sup>.

77 Society of Chartered Surveyors of Ireland submission to Pyrite Panel February 2012

The Irish Concrete Federation<sup>78</sup> in its submission states that *“The federation is acutely aware of the difficulties which are being faced by individual homeowners and fully supports the need to find a resolution for the householders who live in or have purchased any house which has been genuinely affected by pyrite. The reality is that the solution to these homeowner’s problems can only be achieved by the remediation of the affected houses, the cost of which should be borne by those directly responsible or their insurance.”* However, they qualify this statement by stating *“Responsibility for any damage linked to pyrite heave must be confined to the stakeholders involved in each individual case.”*

The Panel considers that ideally, homeowners and others affected would have had their issues resolved well before now. Even at this late stage, there is an urgent need for the various stakeholders to assume responsibility for ensuring that the damage due to reactive pyrite is remedied and for addressing the very distressing and urgent plight of the homeowners. Whatever about the legal responsibilities involved (which will ultimately be decided upon by the courts), there is clearly a very strong moral responsibility on those involved to sort out the problem for the homeowners in an urgent and comprehensive manner. Awaiting the decisions of the courts in respect of where the legal responsibility lies on a case by case basis and refusing in the interim to engage in finding solutions to the growing problems faced by the householders, is extremely unhelpful. The Panel considers that, with the publication of this report, there is an opportunity for a focussed effort by those with a shared responsibility for the problem to help resolve the problems faced by the homeowners in a timely open and coherent manner.

### 6.6. Barriers to resolution

The Panel found that there are significant barriers for individual homeowners to find a resolution to the problem of pyrite in cases where the builder refuses to undertake the remediation work or is no longer trading or where HomeBond is refusing to provide cover . The only option for householders in such cases appears to be to initiate legal action against the builder or his insurer or against the supplier of the defective hardcore material. Legal proceedings are costly and beyond the financial capacity of most householders and can be very time-demanding.

Through the Irish Banking Federation,<sup>79</sup> the mortgage providers have stated the following in a letter to Mr. Peter Lewis, Chairperson of the Pyrite Action Group: *“IBF Members are sympathetic to any customer whose home has been affected by pyrite and will discuss with them on a case by case basis their options available if they are in financial difficulties.*

*IBF Member will work with customers to arrive at a solution in accordance with established procedures laid down by the Consumer Protection Code and the Code on Mortgage Arrears for addressing mortgage customers in difficulties. The mortgage customer in difficulties should contact their lender at the earliest opportunity.*

*Where applicable, IBF members would consider the option of additional finance on a case by case basis, where the customer would be able to service the finance, given that such remedial*

<sup>78</sup> Submission by Irish Concrete Federation to the Pyrite Panel, April 2012

<sup>79</sup> Letter from Mr. Pat Farrell, Chief Executive of the Irish Banking Federation to Mr. Peter Lewis, Chairperson of the Pyrite Action Group, 8 December 2011

*work would restore significant value to the home and thus benefit the lender as well as the borrower by enhancing underlying security.”*

In a letter to the Panel from the Irish Banking Federation (IBF),<sup>80</sup> the Federation states as follows: “Lenders have, to date, received only a handful of requests with reference to this issue (pyrite) and in all cases the issue has been or is being resolved within the framework of existing support mechanisms, which I outline later in my letter.

*IBF Members have a range of solutions that can be applied in circumstances where borrowers are experiencing financial difficulties. Given the difficult economic environment, lenders have put in place extensive forbearance measures for those mortgage borrowers who are unable to repay the agreed amount on their mortgage contract. In addition to these measures, additional measures will also be soon deployed by lenders on foot of the Keane Report....”*

In relation to borrowers requiring additional finance, the IBF states as follows: “When the question of further finance arises, such requests will be considered in accordance with standard underwriting criteria and subject to relevant regulatory requirements.”

The banks were identified by a number of groups who spoke to the Panel as having a key role to play in facilitating a solution to the pyrite problem. It was noted to the Panel that they own the assets which are subject to mortgage agreements and therefore it was considered that it would be in the banks own interest to facilitate a process that would protect their assets. In fact, this was stated in a letter from Pat Farrell (IBF) to Peter Lewis,<sup>81</sup> Chairman of the Pyrite Action Group. In circumstances where a dwelling is damaged by pyrite, the bank’s asset is devalued and homeowners believe that the banks/mortgage providers should have a co-ordinated and pragmatic strategy to deal with those situations. The Panel met with the Irish Banking Federation and with the main mortgage providers. While they understood and empathised with the difficult position of homeowners whose homes are affected by pyrite damage, they indicated that they are required to deal with all mortgage issues under the terms of the Consumer Protection Code and cannot have a separate or parallel process to deal with issues arising from pyrite damage. The mortgage providers expressed the view that the range of solutions in place to deal with borrowers who are experiencing financial difficulties are sufficiently flexible to deal with pyrite-related difficulties. They indicated that up to that date (March 2012) they have had only a small number of requests relating to pyrite issues and those had been dealt with within the framework of existing support mechanisms.

The Panel would recommend that, subject to whatever legal constraints exist on the Members of the Irish Banking Federation (IBF), the IBF Members should consider a mechanism for making some funding for remediation available to homeowners whose houses are affected by pyrite. This might possibly be done through an extension of the existing mortgage, but without increasing the current monthly repayments (beyond that which would be paid based on the original mortgage). This funding could be provided to enable homeowners to have the necessary testing completed. Where their builders or developers have gone into receivership or liquidation or the insurers are unwilling to make payments, funding could also be made available to have the necessary repairs completed. Claims might then be pursued

80 Letter from Mr. Pat Farrell, Chief Executive, Irish Banking Federation to Mr. Brendan Tuohy, Chairperson of Pyrite Panel, 6 March 2012

81 Letter from Mr. Pat Farrell, Chief Executive of the Irish Banking Federation to Mr. Peter Lewis, Chairperson of the Pyrite Action Group, 8 December 2011



by the householder against the relevant party or parties. When the insurer/structural defects guarantee provider or others reimburse the householder for the necessary costs incurred, that refund could be made payable to the mortgage provider.

An additional barrier is that the homeowner's contract is with the builder or developer and, in the event that a legal action for breach of contract against the builder or developer is not possible, an action against the material supplier would have to be an action for negligence. The householder may find it difficult proving the source of supply and such actions are likely to take a considerable time and financial commitment. In addition, establishing negligence can be more complex than breach of contract.

For householders contemplating the legal route, another barrier is the time limits contained in the Statute of Limitations Act 1957. It was suggested to the Panel that legal actions may become statute barred before plaintiffs have sufficient knowledge to determine whether they have a reasonable hope of success.

### 6.7 Insurance

In addition to the new house warranty schemes, there is a broad range of construction-related insurance packages available on the market covering Contractor's All Risk, Public Liability, Employer's Liability, Product Liability and Project Insurance.

Insurance, in general, is complicated and, in the case of cover in the area of construction work, it is an extremely complex matter with each product often tailored to the specific needs of individual builders/developers and the construction project. The degree of cover provided seems to be very much based on the price paid for that cover. Homeowners appear to be left with little recourse, if they are not in a position to engage in expensive legal challenges to progress their claims. The Panel believes that, in a number of cases, builders/developers are pursuing claims under their insurance policies and are reaching settlements enabling them to undertake remediation works, but they are not publicising this. The Panel welcomes any efforts to remediate the houses and would encourage the builders/developers to keep the homeowners updated on what efforts they are making to pursue insurance claims that could result in affected houses being remediated.

The level of stress and uncertainty for both homeowners and builders was clearly evident to the Panel during discussions. Apart from Liberty Syndicates (underwriters of Premier Guarantee), HomeBond, QBE and Liberty Insurance, the insurance industry at large was not willing to engage with the Panel despite requests to the Irish Insurance Federation and to a number of individual companies. While the Irish Insurance Federation had an initial meeting with the Panel, it refused to engage further or to make a submission stating as follows: *"It is not possible for IIF to assist the Panel ...While sub judice, all matters are confidential"*

Meanwhile, it has been brought to the attention of the Panel that liability for damage due to pyrite is now being specifically excluded from policies and individual householders are having difficulties getting household insurance even when the pyrite damage has been rectified. The Panel considers it unreasonable for insurance companies to decline to provide insurance cover for houses which have had pyrite problems and the Panel recommends that

insurers remove such a restriction. Likewise, any general or area specific exclusion for pyrite damage should not be applied to policies. As noted earlier, quarries that were reported as having supplied defective material are now closed. Steps have already been taken to avoid the problem recurring. Further measures are recommended in this report. It is reasonable to conclude that all such steps, if taken, will very significantly reduce any risk of a problem from pyrite heave in the future.

The Financial Services Ombudsman deals with complaints from consumers in relation to their individual dealings with all financial services providers, including insurance companies. This system may be a route for consumers to take in the event of difficulties with the availability of insurance cover or restrictions on such cover.

### 6.8 Resources for remediation

The Panel recognises that any solution to the pyrite problem will involve funding being provided for remediation. Developing a funding model must recognise that those who have responsibility should pay for it, and, as stated in the submission by the Construction Industry Federation, “...and to ensure that the available resources of those with ultimate responsibility for the remediation of pyritic heave, including insurers, are ring-fenced for this purpose rather than to pay for lengthy legal cases”<sup>82</sup>. The Panel considers that this proposal makes good sense and could form the basis for a resolution.

However, the Irish Concrete Federation (ICF) considers liability for the pyrite problem should only rest with those directly responsible in each individual case “...any objective analysis of the problem will show that it is impossible for an entire industry, made up of individual entities ...to be held responsible or liable for problem ... involving a relatively small number of stakeholder”<sup>83</sup>. The Panel considers that, while appreciating that the ICF is trying to ensure that those directly liable for causing the problem pay for it, the course of action suggested by the ICF would lead to a continuation of the current situation with regard to legal actions and all the attendant problems associated with such a course of action including cost, threshold of proof and time limits under the statute of limitations. Furthermore, it is evident that such processes will not lead to resolution of all effected houses now or in the future. The remit of the Panel is to try and find a resolution for householders through agreement by stakeholders and to do so in a reasonably short timescale. The ICF proposal would not ensure that remediation of houses is effected immediately. Rather, it would result in long drawn-out legal cases with no certainty as to when, or if, the affected houses would be remediated.

The Panel has found, through its meetings, consultations and the submissions received, that the problem is complex and multi-dimensional, involving many stakeholders and issues. The Panel has also noted that, while all parties who made submissions or with whom the Panel engaged, were anxious that those responsible should pay for the damage caused, there were not many suggestions as to how the work could be funded immediately in the case of those houses exhibiting pyritic heave. It appears from what was said to the Panel that the general legal advice to most builders, developers, quarry owners, guarantee

82 Construction Industry Federation submission to the Pyrite Panel, December 2011

83 Irish Concrete Federation submission to the Pyrite Panel, December 2011

companies<sup>84</sup> and insurers was not to accept any responsibility or liability. While this might be understandable from the perspective of defending one's possible exposure, this does not show sufficient regard for the need to find a comprehensive solution for homeowners and others suffering because of the damage due to the pyrite. This is also a justifiable criticism of the current method of dealing with such issues.

The Panel would recommend that, when the pyrite issue is dealt with adequately, Government should consider more generally how situations such as this can best be avoided and dealt with in the future. This should be specifically considered in relation to the construction industry but there is a wider public policy issue involved as well that could be usefully addressed. More generally, from a public policy perspective, systems should be put in place that would provide protection for the public, in the case of urgent and serious problems (such as occurred in relation to pyrite in dwellings), without having to resort to prohibitively expensive, time-consuming and uncertain legal actions having to be taken by individuals.

In its approach to the resolution of the pyrite issue, the Panel considers that resolution should be based on a categorisation of the risk of damage. See Chapter 7.

Any solution developed will require a mechanism that deals with current and future problems. In a submission from the Society of Chartered Surveyors of Ireland (SCSI), they state that there *"should be a classification system to grade the seriousness of pyrite problems in individual houses"*<sup>85</sup>. The Panel supports this view and it is incorporated into the later recommendations.

### 6.9 Conclusion

There is a range of actions being taken by various stakeholders involved in the pyrite issue but, given the confidential nature of the processes involved (arbitration/mediation), it is difficult to have an overarching view of what is taking place. It is clear that remediation work is being undertaken by a number of different stakeholders and there is also a number of legal actions at various stages. The Panel is mindful that any actions it would suggest should not hinder or impinge on any of those actions. The Panel considers that the construction (including quarrying) industry, insurance and banking sectors should participate actively in a process to immediately remediate existing damaged houses; contribute to a fund to deal with future problems; develop systems and processes to avoid this and other system failures in the future; and ensure adequate insurance, to provide confidence to purchasers and lenders for the future. The Panel also considers that, from a public policy perspective, Government needs to address the broader issue of how to establish a system that would provide protection for the public, in the case of urgent and serious problems to a large number of people (such as happened in the case of pyrite), without having to resort to prohibitively expensive, time-consuming and uncertain legal actions being undertaken by each individual.

84 It should be noted that under the terms of the Premier Guarantee Scheme, they are undertaking pyrite related remediation work

85 Submission to the Pyrite Panel from the Chartered Surveyors of Ireland, February 2012

# Chapter 7: Technical solutions

## 7.0 Introduction

This chapter describes a number of assessment methods for establishing whether or not a building has been damaged by pyritic heave or is likely to be in the future. It identifies a need for an agreed Irish testing protocol which would categorise properties directly or indirectly affected by pyrite into 'green', 'red' and 'amber'. Appropriate and particular follow-up action, if necessary, is suggested for each category and an associated certificate is proposed. These certificates should be satisfactory for all stakeholders in the property, financial and insurance markets.

The chapter also explains the process of remediation and the estimated range of costs for such work.

It also discusses the characteristics of pyritic heave in Ireland and examines some of the reasons or conditions that may have influenced its manifestation.

## 7.1 Methods of assessment and categorisation

A number of assessment methods have been developed by private companies (guarantee insurance companies and consultants) and national bodies, to establish whether or not a building has been, or is likely to be, damaged by pyritic heave due to the presence of pyrite in the hardcore under a ground floor slab. This section provides a brief summary of some of these assessment methods:

- (i) Canadian Protocol (CTQ-M200<sup>86</sup>)
- (ii) HomeBond Protocol<sup>87</sup>
- (iii) Premier Guarantee Protocol<sup>88</sup>
- (iv) Golder Associates Ireland Ltd. Protocol<sup>89</sup>

### 7.1.1 Canadian Protocol

Following the incidences of pyrite heave in Quebec, primarily in basements and garages, an appraisal procedure was set up in Canada (CTQ-M200) for establishing whether or not a building had been or was likely to be damaged by the presence of pyrite in the hardcore. It sets out the steps to be taken, both on-site and in the laboratory, to ensure that appraisals are carried out in a structured manner, in accordance with an agreed protocol and that they fulfill their purpose. The appraisal procedure for existing residential buildings comprises three steps:

86 Comité Technique Québécois d'étude des Problèmes de Gonflement Associés à la Pyrite: Appraisal procedure for existing residential buildings, Procedure CTQ-M200, Version 2.0, June 2001

87 HomeBond submission to Pyrite Panel dated 14 December 2011

88 Premier Guarantee submission to Pyrite Panel dated 23 March 2012

89 Golder Associates Ireland Limited submission to Pyrite Panel dated 23 February 2012

## Chapter 7: Technical solutions

- Visual inspection
- Sampling, and
- Laboratory tests.

The following is a brief summary of the procedures, for full details refer to *CTQ-M200 Appraisal procedure for existing residential buildings, Version 2.0, June 2001*<sup>90</sup>

### 7.1.1.1 Visual Inspection

The purpose of the visual inspection is to determine the presence or absence of apparent damage that may have been caused by pyritic heave (and/or sulfate attack of the concrete) and to quantify the extent of any damage detected. In Canada, this type of damage was often not visible for a period of years (on average ten) post-construction.

### 7.1.1.2 Sampling

The purpose of the sampling process is to obtain samples of the materials (concrete, granular backfill and natural soil) that are as representative as possible and to ensure that those samples are not contaminated when they are transported to the laboratory. Samples should be taken from the basement (150mm core, 150mm deep and a sample of bed rock) and in any garage (150mm core, 450mm deep into backfill).

### 7.1.1.3 Laboratory Tests

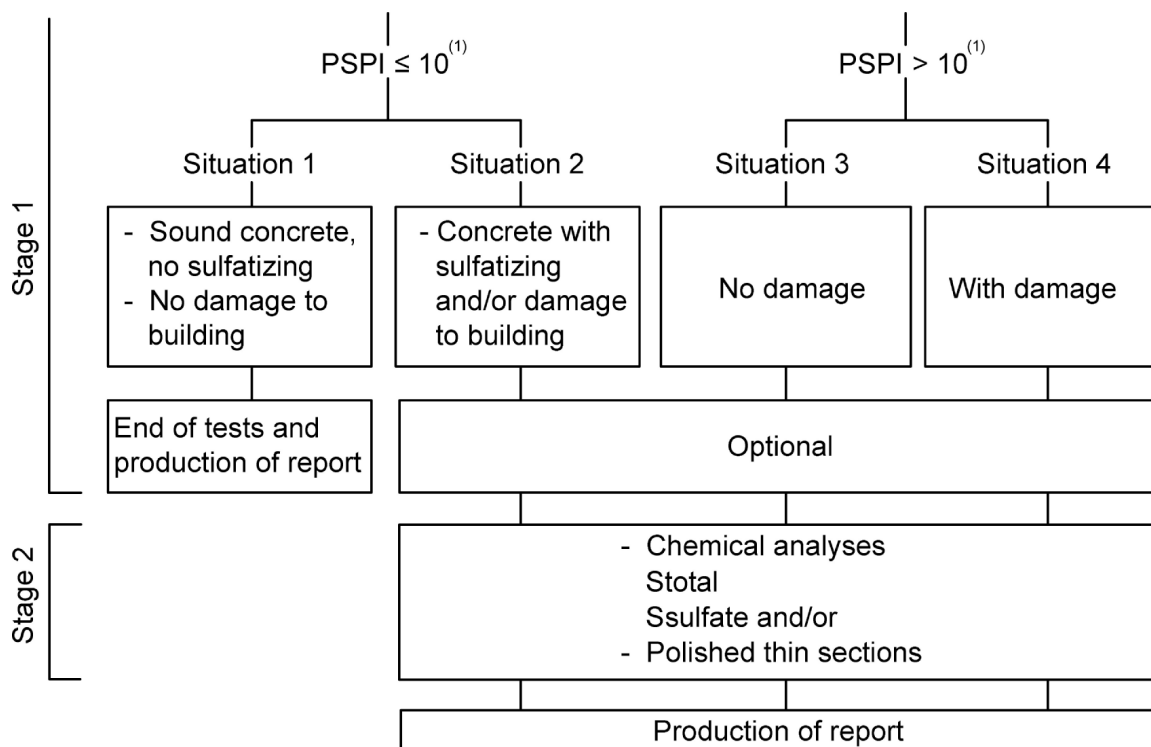
The purpose of the laboratory tests is to identify the type of granular material used and to estimate its potential for swelling and/or sulfate attack. They also serve to establish the characteristics of the concrete and natural soil.

- The concrete is visually examined for quality, depth, discolouration, surface covering etc.
- A particle size analysis is carried out on the granular backfill followed by a petrographic analysis. Based on the analysis, a Petrographic Swelling Potential Indicator (PSPI) can be established for the material. These values range from 0-100, with 0 representing the minimum swelling potential and 100 the maximum.
- The natural soil or rock is also examined to identify the constituent elements.

Depending on the PSPI value and the presence of damage to the concrete or the building, further tests may be required to be carried out. See Figure 7.1, below - *Flowchart for determining testing*. In general, if there is damage to the concrete or the building, or the PSPI value is greater than 10, then a suite of chemical tests and/or polished thin sections examinations should be carried out. Technical staff may exercise discretion on a case by case basis as to what testing should be carried out.

90 Comité Technique Québécois d'étude des Problèmes de Gonflement Associés à la Pyrite: Appraisal procedure for existing residential buildings, Procedure CTQ-M200, Version 2.0, June 2001

Figure 7.1 Flowchart for determining testing



**Note:** Extract from *Comité Technique Québécois d'étude des Problèmes de Gonflement Associés à la Pyrite: Appraisal procedure for existing residential buildings, Procedure CTQ-M200, Version 2.0, June 2001*

The chemical tests include total sulfur and water soluble sulfates. Based on these results, equivalent pyrite content and equivalent gypsum content can be calculated. While a general correlation between the pyrite equivalent percentage and the chemical swelling potential has been established in Canada, all the information collected and analysed should be used to come to a conclusion.

### 7.1.1.4 Report

The protocol requires that the report contains the following information:

- Damage identified during the visual inspection.
- Depth and condition of the concrete
- PSPI value.
- Depth, calibre and apparent density of the aggregate.
- Potential residual swelling (chemical analyses and/or thin sections).
- Age of building.

The Protocol also requires that the conclusions made in the report must answer the following questions:

- Has the structure suffered damage that can clearly be linked to slab heaving due to backfill swelling and/or sulfate attack on concrete?
- Does the concrete exhibit signs of sulfate attack, or might it do so in the future? If so, to what extent?
- Does the aggregate present a potential for swelling, if so, to what extent?

- Are there any visible signs of a reaction?
- Might the reaction continue (potential residual swelling)?
- Is damage likely to occur in the future?
- Is urgent action required?

Finally, the Protocol leads to one of three possible solutions<sup>91</sup>. These are summarised in Table 7.1 below.

Table 7.1 Canadian Protocol - Recommendations per scenario				
Scenario	Aggregate	Concrete	Damage	Recommendation
1	No significant swelling potential	No symptoms of sulfate attack	No damage has been observed	No intervention.
2	A low to moderate swelling potential.		There is a risk of observable damage, such as heaving and cracking of the floor slab, but the damage in question will normally be well tolerated by the building and will not impact upon its integrity.	Non-imperative intervention.
3	Significant swelling potential		Extensive damage has occurred or is likely to occur.	Major intervention.

### 7.1.1.5 Professional suitability

The protocol sets out the requirements for firms or individuals offering to carry out this appraisal. The firm or individual must hold recognised professional indemnity insurance specifically for this type of mandate and

- be independent of firms able to carry out repair work or having a direct or indirect interest in the conclusion
- be suitably qualified, for example;
  - Visual inspection: Professional attached to the Canadian Association of Testing Laboratories (ACLE), an ACLE test laboratory, engineer, architect, building technologist (with concrete technology training) or equivalent etc.
  - Sampling: Test laboratory registered with the ACLE for pyrite appraisals under the supervision of a professional
  - Laboratory test: Test laboratory registered with the ACLE for pyrite appraisals.

<sup>91</sup> In spring 2000, the Quebec government announced its intention to offer, over a period of ten years, financial assistance to homeowners where houses were damaged by the oxidation of pyrite. For more information see Appendix 15

### 7.1.2 HomeBond Protocol

The following is a brief summary of the procedures that HomeBond follow to establish whether or not a dwelling covered by its scheme has been, or is likely to be, damaged by pyritic heave due to the presence of pyrite in the hardcore under a ground floor slab.<sup>92</sup>

#### 7.1.2.1 General

On receipt of the initial letter of complaint from the house owner (“Purchaser”), HomeBond assesses the complaint in order to establish if it falls within the scope of the HomeBond Agreement. If it does, the builder is notified and a Defect Notification form is sent to the Purchaser for completion. If it does not, the claim is rejected as ‘out of scope’. In circumstances where the initial complaint letter lacks description or is not clear, clarification is sought from the Purchaser in order to establish whether the complaint falls within the scope. Once the Defect Notification form is returned to HomeBond, arrangements are made for an inspection of the dwelling and the Builder is also notified and invited to attend.

#### 7.1.2.2 Visual Inspection

In general, the first inspection of the dwelling is ‘visual’ only, and involves an inspection of the interior and exterior of the dwelling in relation to the items of complaint notified on the Defect Notification form. An investigation summary sheet is filled out which typically includes sketches, where relevant, descriptions and locations of cracks in walls, floors and ceilings, humps in floors, sticking doors etc. A 1.8m spirit level is used to measure humps in floors and bulges in walls, and a ‘crack width gauge’ is used to measure crack widths. When required, photographs are taken at crack locations and of other relevant damage and are referenced to the description and location on the summary sheet. ‘Opening up’ investigations are generally not undertaken at this stage in the investigation. Both the Purchaser and Builder are notified of the results of the inspection and advised whether the items of complaint are within or outside the scope of the HomeBond Agreement or if further investigations are warranted in order to make a determination.

#### 7.1.2.3 Sampling

When a stone sample is to be taken from under the concrete ground floor of a dwelling, a location is selected to cause the least disruption to the Purchaser. The sample can be taken anywhere within an affected area in the dwelling but usually in a w.c., utility room or under kitchen units. A 200mm diameter core is drilled through the concrete floor and into the stone fill beneath. The stone fill is then removed by hand, bagged and tagged for testing; if more than one layer of stone is evident, a sample will also be obtained for that layer and where possible the depth of stone fill is determined. On occasion and when deemed necessary, a core may be opened at a second location in the dwelling. Approximately 5-10kg of material is removed from the core hole but a greater amount can be retrieved, if required, by increasing the core size or creating a larger opening in the floor by multiple cores. The resultant void is then filled with imported hardcore. The damp proof membrane is repaired and the concrete core hole is made good.

92 HomeBond submission to Pyrite Panel dated 14 December 2011



### 7.1.2.4 Testing

In cases where 'pyrite' damage manifests in a 'new' housing development, usually three principal tests are carried out simultaneously on the stone samples. These are as follows:

- X-ray diffraction analysis – graphical output and table of 'counts' for relevant minerals.
- Chemical analysis - total sulfur, acid-soluble sulfate, water-soluble sulfate, calcium carbonate, mineralogical composition (whole rock suite).
- Petrographic analysis – thin section analysis by a geologist giving a brief description of the findings.

In cases where visual analysis of the stone sample reveals similar type material previously retrieved from other dwellings in the same housing development, only an x-ray diffraction analysis and a chemical analysis (without mineralogical composition) are carried out. Scanning Electron Microscopy (SEM) and Energy Dispersive Analysis by X-ray (EDAX) are carried out infrequently.

### 7.1.3 Premier Guarantee Protocol

The Premier Guarantee Protocol, for assessing and establishing whether damage is as a result of pyritic heave, sets out four main activities.

- Initial visual inspection
- Floor level survey
- Underfloor hardcore infill sample collection
- Hardcore infill testing

The following is a brief summary of the procedures that Premier Guarantee follow to establish whether or not a dwelling covered by its scheme has been, or is likely to be, damaged by pyritic heave due to the presence of pyrite in the hardcore under a ground floor slab.<sup>93</sup>

#### 7.1.3.1 Initial visual inspection

The protocol requires that details of the personnel carrying out the visual inspection and details of the property are noted in the report. A visual inspection of the exterior and interior of the property should be carried out and the details of any cracking and lifting that could potentially be attributed to pyritic heave or any signs of sulfate attack should be recorded in the report. A detailed floor level survey of the affected floors should also be carried out and included in the report.

#### 7.1.3.2 Floor level survey

A detailed floor level survey of the affected floors should also be carried out and included in the report.

#### 7.1.3.3 Underfloor hardcore infill sample collection

A trial hole should be dug at a location where there is significant evidence of alleged heave within the dwelling. The hole should be 450x450mm. A sample of the sand blinding (500grams), hardcore (500grams) from the top 50mm of hardcore and two (2No) 20 kilogram samples of hardcore between 50mm and 400mm deep should be taken. If the hardcore extends below 400mm deep, a further sample of hardcore should be taken and, if possible, a sample of the material below the hardcore should be taken also. The depth of fill should be recorded. Detailed descriptions (including photographs) of the trial hole should be recorded. From a visual inspection of the samples taken, the following should also be recorded; colour, grading, size distribution, particle shapes, main rock types present, moisture condition and presence of gypsum, pyrite or calcite. The protocol also sets out strict procedures for bagging and storing. A 2kg sample should be sent for laboratory testing. Other non-technical procedures, such as signing-off by interested parties are set out, but have not been included here. Two samples of any water observed in the trial hole should be collected; ph and temperature of samples should be recorded.

93 Premier Guarantee submission to Pyrite Panel dated 23 March 2012

### 7.1.3.4 Hardcore infill testing

The protocol for the laboratory testing sets out strict procedures for storage, drying and crushing of samples. All methodologies used by laboratories must be documented. The following tests should be carried out and details of procedures and standards to be used are referenced:

- Petrographic description and particle size distribution procedures
- Scanning electron microscopy and energy dispersive X-ray microanalysis
- X-ray diffraction analysis
- Chemical analysis for total sulfur, water soluble sulfate, acid soluble sulfate and sulfide.

The protocol contains a table summarising the features of the sample that are regarded as significant in assessing the potential to give rise to heave as a result of pyrite degradation. The features in this table include pyrite content >1%, evidence of oxidation of pyrite, sulfate crystal formation etc. From all this information, a set of conclusions should be drawn dealing with the composition of the sample and its potential to cause heave.

### 7.1.4 Golder Associates Ireland Ltd. Protocol

Golder Associates Ireland Ltd is actively involved in assessing the potential for pyritic heave in a variety of buildings in east Leinster. These assessments are conducted at the request of developers, homeowners and insurance companies, among others. The following is a brief summary of the approach that is taken by Golder Associates Ireland Ltd., when assessing the potential for underfloor infill to develop pyrite-related floor heave or to confirm that pyrite-induced heave is already taking place. For further details refer to *Golder Associates Ireland Ltd., Technical Memorandum: Steps in establishing the presence of reactive pyrite in hardcore infill.*<sup>94</sup>

In summary, there are five stages to the approach. These include:

- Property history;
- Site investigation;
- Laboratory testing;
- Analysis of findings; and
- Scenarios.

#### 7.1.4.1 Property history

A property history is gathered which documents the location, type, age of the building, name of the builder, insurances and a description and history of the damage.

#### 7.1.4.2 Site investigation

The site investigation involves a visual inspection and survey of the damage and the retrieval of samples of fill. A 200mm diameter core is drilled in a discrete location. Approximately 20kg of infill material is removed for testing.

#### 7.1.4.3 Laboratory testing

As a minimum, a visual geological inspection (by an experienced geologist) and a suite of chemical tests (total sulphur, acid soluble sulphate and water soluble sulphate) are carried out on the sample (by an accredited laboratory). The rock type and the presence of pyrite and the amount that has oxidised can be established. The presence of any visible gypsum is also documented.

In some instances, depending on the client, a petrographic analysis and physical tests are carried out. The petrographic analysis will evaluate the mineralogical characteristic of the infill, confirm the presence of pyrite and establish the form and distribution of pyrite. The physical tests will establish the quality of the stone to support the geological description.

#### 7.1.4.4 Analysis of findings

Golder Associates Ireland Ltd. reviews investigation findings on an individual basis and provides recommendations based on the findings. The following discussion provides some general guidelines that Golder Associates Ireland Ltd. uses to assist in the interpretation of investigation results.

Golder Associates Ireland Ltd. states that it is not possible to define a pyrite or total sulphur threshold due to the number of variables involved, in particular the rock quality. In the case of low grade dark grey or black calcareous mudstones/siltstones with pyrite contents above about 0.5%, there is a high risk of pyritic heave where such material is used as underfloor hardcore.

For similar materials with pyrite levels below 0.5%, an assessment is needed based on a detailed geological assessment and petrographic examination. Notwithstanding the pyrite concentrations, where gypsum is identified within laminations in aggregate particles, such material is deemed unacceptable for use in construction.

Analysis of the fill's potential to cause sulfate attack is also carried out. Sulphate attack on concrete elements develops on a longer timescale than pyritic heave. An elapsed time of 8 to 10 years to onset of sulphate damage is not unusual. Further, sulphate attack only occurs in circumstances where there is mobile groundwater to transfer the sulphates into the concrete or other cementitious products, such as masonry. Risk of sulphate attack needs to be evaluated on an individual basis. However, in cases where fill in contact with concrete has measured water soluble sulphate concentrations greater than 500 mg/l of  $SO_4$ , there is some risk of future sulphate attack damage.

Golder Associates Ireland Ltd identifies four possible scenarios based on the findings above and suggests typical recommendations that might arise, for illustrative purposes. These are summarised in Table 7.2.

Scenario	Damage	Lithologies	Presence of Pyrite	Recommendations
a	Serious damage	Potential problematic lithologies identified	Pyrite confirmed and gypsum identified	Infill unfit for purpose. Remedial action to be carried out as soon as possible.
b	Little or no damage	Potential problematic lithologies identified	Pyrite confirmed	Infill unfit for purpose. Remedial works recommended but could be postponed. Re-inspection carried out in 6-12 months to identify any on-set of damage.
c	Little or no damage	A mixture of stable and potential problematic lithologies identified	Pyrite confirmed. (Measured pyrite content may be misleading due to mixture of lithologies)	Infill unfit for purpose. Recommendation as for b above (as the extent of poor quality hardcore is undetermined).
d	Little or no damage	No potential problematic lithologies identified	Pyrite content <0.5%	Infill fit for purpose. It is highly unlikely that the fill will give rise to pyritic heave

### 7.1.5 Conclusions

From the sample of protocols provided above, some similarities emerge in terms of the procedures to be carried out. However, significant differences seem to occur when it comes to the suite of laboratory tests that should be carried out and the conclusions that can be drawn from these. This is understandable given the various individual considerations that each protocol was developed to address.

The Panel concluded, however, that an Irish testing protocol should be developed as a matter of urgency for establishing whether there is reactive pyrite in the sub-floor hardcore material and if it has caused pyritic heave in an existing dwelling. This should be done under the auspices of the National Standards Authority of Ireland (NSAI).

Such a protocol would allow pyrite-affected properties (either directly affected, or by association) to be categorised into three broad categories, as follows; red, amber and green. They could then be prioritised accordingly. See Table 7.3 below.

In proposing this, the Panel was also aware of the system developed to address the Mundic Problem that affected properties in Devon and Cornwall built between 1900 and 1950. See Appendix 16: *The approach to the Mundic problem*.

Category	Green	Amber	Red
Damage	No	No significant damage	Significant
Tests for Pyrite	Pass*	Fail	Fail
Risk of pyritic heave in the future**	No risk	Risk of damage	Not applicable (damage has already occurred)
Conclusion	No future risk	There is some risk of damage in the future.	The damage that has occurred is predominantly due to pyritic heave.
Recommendation	No action required	Dwelling should be monitored	Remediation should be carried out

\* Test results are within the limits set out in the protocol

\*\* A number of factors need to be taken into account in assessing this risk such as rock quality etc. these should be set out in the protocol

This testing protocol should be sufficiently comprehensive to allow for categorisation of dwellings into red, amber and green. It should also be cost effective, simple and relatively quick to carry out while not compromising its reliability. Critically, the testing protocol must be accepted by all key stakeholders, including financial institutions, insurance companies and all in the property market including the legal profession, as part of the basis for the overall solution to the pyrite problem.

The protocol should set out standard recommendations regarding appropriate action for each category in line with the following;

- For the **red category**, where there is significant damage due to pyritic heave, remediation should be carried out as a priority.

- The presence of pyrite in hardcore, but no associated significant damage, is considered as the **amber category**. The Panel deemed it appropriate for the amber category to monitor the situation rather than proceed to carry out costly and disruptive remediation. The Panel noted the judgement of Mr. Justice Charleton delivered on 25<sup>th</sup> May 2011 on *'James Elliott Construction Limited and Irish Asphalt Limited'* stated *"... it is not yet reasonable to remove the infill ... solely because the high sulphur content of the infill. That only established a possible danger into the future. Removing the infill because of actual heave is on the other hand entirely reasonable"*. This case is currently under appeal.
- The protocol will also help some properties that, by association, are affected by pyrite, e.g. dwellings located in the same estate as dwellings with pyritic hardcore. For the **green category** there is no risk of pyritic heave as the levels of reactive pyrite in the hardcore are insignificant or the pyritic material has been removed. For these homeowners, the protocol provides definitive proof that pyrite is not an issue for the property. It should be accepted by insurers and lenders that this house is now no different to any other house without pyrite.

Only independent competent professionals and accredited laboratories should be employed to carry out assessments and testing in accordance with the proposed Irish testing protocol. Guidance on establishing such competence should be included in the protocol.

The Panel also recognises the need for a standardised certification process to facilitate ease of communication with all stakeholders, but particularly with those in the professional, legal, insurance, banking and mortgage sectors. The protocol should include for certificates as explained in section 7.3 below.

While the Panel has provided an outline scope for the Irish testing protocol, this should be refined, where necessary, by the relevant NSAI committee set up to develop the protocol.

## 7.2 Methods of remediation and costs

### 7.2.1 Replacement of ground floor slab and hardcore

The most recognised remediation method for pyritic heave, at present, is the complete replacement of the ground floor slab and the hardcore beneath. Such work, in a completed dwelling, is a major intervention and requires the dwelling to be evacuated and the ground floor cleared for between 6 to 16 weeks, depending on a number of factors. The scope and sequence of the works is generally as follows:

- A pre-condition survey of the entire property is carried out.
- Detailed survey and recording of damage due to pyritic heave both within the house and externally. This may include the removal of floor and wall finishes to assess structural cracking, i.e. timber floor finishes, tiling and dry-lining.
- Temporary protection to the house, i.e. windows, external doors and dust protection to seal off upper floors.
- All services isolated, i.e. gas, electrical, water and drainage.
- Removal and storage of the fixtures and fittings, i.e. kitchen fittings, sanitary ware, fireplace, doors/frames and stairs.

- Cutting and removing the concrete floor slab (steel mesh) in sections as specified and the removal of the insulation, radon barrier/damp proof membrane. Internal non-load bearing walls built on the floor slab may also have to be removed and care must be taken not to interfere with the foundations to the walls when removing material.
- Removal of all services, including heating pipes, closing off the flow and returns.
- Careful removal of the hardcore infill down to the original sub-grade level.
- The temporary removal of the radon sump and piping will form part of this process.
- It is critical that all particles of the original fill are removed and stored carefully for environmentally sound management. The management of waste consisting of pyritic hardcore should be carried out in compliance with environmental legislation, particularly in accordance with the requirements of Sections 34 and 39 of the Waste Management Act <sup>95, 96</sup>
- Rising walls are brushed clean and examined for evidence of sulfate attack. Where sulfate damage has occurred, remedial works specified and supervised by a competent building professional, may be required, i.e. scabbling the rising walls and rendering with protective coating.
- New tested and certified hardcore is placed and compacted in layers.
- The radon sump and under floor services are reinstated as the fill progresses. Care must be taken to ensure all pipe work is clear and properly connected.
- The radon barrier/damp proof membrane is installed on the new blinded hardcore ensuring an adequate overlap and seal at the edges. Insulation is laid to specification.
- The new concrete slab is poured and finished. Dowelling to remnants of existing slab at walls and external doors may be required. Cube testing of the concrete may be required as specified.
- All services are re-instated as works proceed.
- Repairing all cracks and associated damage in blockwork walls, partitions and ceilings. These repairs range from simple filling of hairline cracks to filling cracks with epoxy resin, insertion of steel bars, straps or steel mesh.
- An adequate period of time is allowed to facilitate sufficient drying-out of concrete and plasterwork before any finishings are replaced, e.g. timber floors etc.
- Replacing partitions, dry-lining and stairs.
  - Refitting of kitchens, fireplace, doors, architraves and skirting.
  - Refitting of radiators, water pipes etc, and reconnecting services.
  - Re-tiling of floors and walls and painting and decorating walls and woodwork.
- Final condition survey is carried out and the finished works certified.

### 7.2.2 Technical appraisal, sign-off and certification of remediation

At present there is no established guidance on the technical appraisal, sign-off procedures and certification of pyrite remediation works. In most cases, it is specifically designed for each project. The appraisal, sign-off and certification process set out below is an example which represents good practice. It is from a larger remediation project where replacement of slab and hardcore was carried out.

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95 Waste Management Act 1996 (No. 10 of 1996) and Waste Management (Amendment) Act 2001 (No. 36 of 2001)  
96 Alternatively, the pyritic hardcore may be managed, where appropriate under certain specified circumstances, in compliance with Article 27 of the European Communities (Waste Directive) Regulations 2011



### 7.2.2.1 Appraisal

- Independent consultants carry out a visual condition survey and recording of damage.
- The consultants produce a detailed dwelling-specific report based on the test sample results and their structural survey with specific recommendations in relation to the remedial works required.
- A detailed method statement is produced by the consultants for the required works with all sign-off and certification stages clearly set out. Work stage sign-off sheets are produced by the consultants.
- The consultants provide the specification for the new hardcore including testing and certification that is required.
- The new hardcore is purchased from a tested and certified source with full traceability.

### 7.2.2.2 Sign-off

- The consultants sign off that all the contaminated hardcore is removed and inspect the rising walls for sulfate damage. Remedial work to the rising walls, if required, is specified by the consultants.
- Hardcore placement, service reinstatement, radon sump and radon barrier/damp proof membrane and insulation are signed off before the new concrete floor slab is poured.
- Remedial works are carried out, as specified, to all damaged walls, ceilings etc, and signed off by the consultants.
- Supervised re-instatement of partitions, dry-lining, stairs, kitchens, sanitary ware, doors, architraves etc. ready for finishes.
- The owner is invited to prepare a snag list and these are then attended to by the builder.

### 7.2.2.3 Certification

- The consultants issue the final certificate indicating that the remedial works have been completed to their satisfaction and are in compliance with the Building Regulations.

## 7.2.3 Alternative remediation methods

There is a number of alternative remediation methods under development to address the problem of pyrite in hardcore. These could provide alternatives to full removal of the hardcore infill beneath the floor slab. These include injection methods, which is a technique that is currently used for ground stabilisation (to reduce ground permeability and provide cohesive strength and stiffness to granular materials). In relation to pyrite remediation, the concept is based on the principle that, if all voids are filled, there will be no oxygen/moisture available to instigate oxidation. For some systems, bacteria are introduced to the infill material before grouting to eliminate residual-free oxygen and render the fill anoxic. Their success is dependent on a number of factors, including:

- The grout and grouting process is physically capable of penetrating all gaps and voids within the infill,

- The ability to re-seal radon barriers and damp proof membranes at injection piercings,
- Avoiding the potential for sulfate attack, and
- Avoiding filling the radon sumps.

### 7.2.4 Cost of remediation

As previously stated, the only recognised form of remediation at present for pyrite-damaged houses is the complete removal and replacement of the contaminated sub-floor hardcore.

A broad range of remediation costs have been quoted, to the Panel, in relation to the works. The estimated costs have ranged from €25,000 to €80,000. The final costs will depend on a number of issues: the size of the dwelling, scale of the damage (internally and externally) and the remediation required. Other factors such as access, layout, construction and the depth of infill will also influence the overall costs. General factors affecting contracts may also include:

- Preliminaries, site supervision and insurance.
- Consequential costs, e.g temporary re-housing, consultant's fees.
- Economies of scale in estates where a number of units are involved and the work can be coordinated.
- Competitive tendering and
- Delays associated with litigation.

In addition to these costs, there is the issue of disposing of the pyrite-contaminated material (referred to in section 7.2.1).

### 7.2.5 Conclusions

At present, it appears that the only proven successful method of dealing with the problem of reactive pyrite is by its removal and replacement of the slab and infill. This is a very intrusive and costly intervention. The Panel considers that a remediation method statement based on good practice should be developed by the National Standards Authority of Ireland to ensure that confidence in this remediation method is provided and to eliminate as far as possible any resultant latent defects caused by the remediation works.

The technical appraisal, the works themselves, sign-off of certain activities and the overall certification of the remedial works should be carried out by competent building professionals with proven experience in this field. Depending on the circumstances, the remediation works may have to be carried out in association with the insurance/warranty companies and the mortgage provider. Any requirements from these companies should be identified and factored in at the beginning of the contract. The Panel acknowledges the wide range of costs for remedial works and accepts there are several influencing factors on cost. However, the Panel would stress the importance of proper planning and appraisal to reduce costs to a minimum. It also considers that adequate supervision and certification is critical. Guidance on these matters should be provided in the method statement published by the NSAI.

While it is theoretically feasible that oxidation might be neutralised without the full removal of all the sub-floor hardcore and an injection solution may also be attractive from a financial, disturbance and time perspective, as far as the Panel is aware, to date none of the injection preventative measures have been tried, tested or proven on full scale remediation works and there is no independent certification that they will successfully resolve the issue. The Panel was made aware of research and testing that is being conducted on processes which may halt the expansion in aggregate where little or no heave damage has occurred. Given the potential for cost and programme savings using this technology, further research and development of these alternative remediation methodologies should be encouraged. The Panel considers that any injection or other alternative method of remediation would have to be independently tested to a suitable standard and certified by an approved body such as the National Standards Authority of Ireland (NSAI), or its equivalent, before it could be accepted as an industry standard. This guidance on the use of alternative methods of remediation should be incorporated into the remediation method statement to be published by the NSAI.

While the Panel has provided an outline scope for the remediation method statement above, this should be refined, where necessary, by the relevant NSAI committee set up to develop the method statement.

### 7.3 Certification scheme

#### 7.3.1 Certification

Certification by accredited testing laboratories, competent contractors and competent building professionals is an essential part of dealing with the problem caused by pyritic heave. This is necessary to ensure the credibility and integrity of the process and to give assurance that the problem of pyrite has been removed in respect of any particular dwelling.

A number of certificates are recommended as follows:

- 1. Certificate 1:** A certificate to confirm that the dwelling is not at risk of pyritic heave now or in the future.
- 2. Certificate 2:** A certificate to confirm that the dwelling has been remediated in accordance with the NSAI remediation method statement and is not at risk of pyritic heave now or in the future.
- 3. Certificate 3:** A certificate to confirm that the dwelling has reactive pyrite in the hardcore, but there is no associated significant damage at present.

All of these certificates should be based on test results, carried out by accredited testing laboratories in accordance with the NSAI Irish testing protocol (referred to in section 7.1). Certificate 2 above will require evidence that the remediation was carried out in accordance with the NSAI remediation method statement (referred to in section 7.2)

### 7.3.2 Conclusion

For the overall solution to the pyrite problem to be effective, all certificates should be in a standardised format, recognised and accepted by all the key stakeholders, including those in the professional, legal, insurance, banking and mortgage sectors. In this regard, the Panel would expect this to avoid, in the future, any specific insurance or conveyancing constraints being imposed on houses in respect of pyrite. The templates for these certificates should be prepared in conjunction with and incorporated into the Irish testing protocol recommended in section 7.1.

### 7.4 Characteristics of pyritic heave in Ireland

The problem encountered in Ireland as a result of pyrite in hardcore has, for the most part, been pyritic heave. In general, sulfate attack has not been a significant issue, nor has damage due to ground heave. See Appendix 3 for short case studies on these and similar problems.

Pyritic heave in Ireland has a number of unique characteristics and the following sections discuss some of these:

- Rate of presentation (section 7.4.1);
- Extent of damage (section 7.4.2);
- Unpredictable nature (section 7.4.3); and
- Construction details (section 7.4.4).

#### 7.4.1 Rate of presentation

To date, in Ireland, the rate of presentation of damage has been particularly fast, ranging from 2-9 years after construction. This is much earlier than in Canada, where, in general, it took 8-20 years to manifest as a problem. While a definitive reason for this has not been established, a number of factors that may influence this were brought to the attention of the Panel. These include the nature of the particular type of pyrite in Ireland, temperature and exposure of hardcore.

The Panel was made aware of new research that suggested that *“the initial expansion experienced in the Dublin properties is related to the development of the ferrous sulfate rims, prior to the expansion due to the growth of gypsum”*<sup>97</sup>.

Others explained to the Panel that temperature influences pyrite oxidation, in so far as an increase in temperature accelerates the process. This has been and is the subject of research and may help to explain the early on-set of damage in mild Irish conditions. The climate in Ireland is milder than Quebec and Ireland does not suffer from the extremes of temperature experienced there. Such mild conditions here may facilitate all-year round continuous oxidation, which may explain the fact that damage, in general, seems to appear relatively quickly in Ireland. Experiences reported in the literature in Canada have shown that *“when a part of the basement was kept artificially colder than the remaining space, this area showed much less distress from bulging and heaving.”*<sup>98</sup>

97 Hawkins, A. B (2011)- Sulfate heave: a model to explain the rapid rise of ground bearing floor slabs. Bulletin of Engineering Geology and the Environment Volume 71, Number 1 (2012), 113-117

98 Canadian Building Digest - Expansion of Pyritic Shales CBD 152. E. Penner, W.J. Eden, P.E. Grattan-Bellew (1972)

Another possible reason put forward to explain speed of presentation of damage in Ireland is the exposure of hardcore to periods of inclement weather before its use. This may have triggered oxidation, which continued while the material was incorporated into the sub-floor of the building. Oxidation of pyrite will continue until all the sulfide is converted to sulfate, or the conditions (moisture and oxygen) become unfavourable.

### 7.4.2 Extent of damage

The extent of damage in dwellings has varied considerably. While a definitive reason for this has not been established, a number of factors that may influence this were brought to the attention of the Panel. These include depth of fill and degree of compaction.

It was suggested to the Panel that, in certain circumstances, the depth of fill can influence the extent of the problem. The more pyritic material present the more dramatic the damage appears to be. Nevertheless, pyritic heave has also occurred in shallow depths of hardcore. This may be due to other factors such as a greater concentration of reactive pyrite present in the material. At present, there is no restriction in the Building Regulations (or Technical Guidance Documents) on the depth of fill. Homebond provides guidance on limiting the depth of granular fill to 900mm under a ground-bearing floor, to avoid settlement due to poor compaction of greater depths. In the UK, the depth of hardcore is limited to 600mm.

It was suggested that the degree of compaction, which the industry strove to achieve in order to avoid settlement, may have, in some situations, amplified the damage caused by pyritic heave by providing no leeway for expansion.

### 7.4.3 Unpredictable nature

Another significant characteristic of the problem with pyrite in hardcore in Ireland, has been its unpredictability within, for example, an estate of dwellings. Adjacent dwellings have been shown to react differently; one displaying heave and damage and the other displaying no signs of damage. Whether this is due to conditions at the time of construction (e.g weather) or within the subfloor (e.g lack of moisture to stimulate oxidation) or other factors, is unclear. However, estates are generally built over a period of time and, in some cases, over a number of years. During construction, hardcore from different source quarries may have been utilised and this may have led to some houses in an estate having hardcore with reactive pyrite while others not having such material. Hardcore may have been delivered to building sites either directly by the quarry company or by a haulier, or in other cases the ground works (including the sub-floors) were subcontracted to one or more subcontractors, making it more likely that there were multiple sources of hardcore used in the estate. It was suggested to the Panel that unacceptable practices had built up during the construction boom in relation to documentation of materials. For example, while hauliers may have sourced material from different quarries (some of good quality and some of poorer quality), the delivery dockets did not always accurately reflect this.

### 7.4.4 Construction details

It was suggested to the Panel that not all cracking that occurred in the affected areas should be attributed to pyritic heave and, in some cases, normal thermal movement and settlement cracks are being confused with pyritic heave. Some people commented that poor workmanship was a feature of the construction boom and it cannot be discounted as being, at least, a contributory factor for some of the cracking that has occurred. However, similar construction practices were used in other areas of the country, which did not present with cracking. It is unlikely that poor workmanship was confined to the areas where heaving of floors has occurred.

While a number of theories other than pyrite were proposed, there was near unanimity, in the wide range of experts and building professionals with whom the Panel met, that at least some damage was due to pyritic heave. On the other hand, representatives of the guarantee and insurance companies who spoke to the Panel stated that, in a significant number of cases where claims were received, pyritic heave has not proven to be the problem. Therefore, one of the problems in resolving the overall pyrite issue is proving that pyritic heave has occurred and identifying if it may occur in the future. Examples of continuing research were instanced to the Panel that are likely to improve the understanding of the process and identify more readily when damage will occur.

### 7.4.5 Conclusions

The Panel acknowledges that, to date, the rate of presentation of pyritic heave in Ireland ranges from 2-9 years, faster than most other documented occurrences of pyritic heave. This may be due to a number of factors including the type of pyrite present in Ireland<sup>99</sup>, the mild climate or the exposure of hardcore to inclement weather prior to use.

The Panel notes that the depth of hardcore and degree of compaction appears to influence the extent of the damage due to pyritic heave. The Panel recommends that this should be reviewed in light of good practice and consideration given to providing further guidance in the Technical Guidance Documents to the Building Regulations, to reduce the risk of damage.

The Panel concluded that, insofar as there are practices in relation to the supply of hardcore to building sites without proper documentation, these should be addressed immediately. An adequate system of certification and traceability of all hardcore should be established by the National Standards Authority of Ireland and this should be implemented by all in the supply chain.

While not all damage is attributable to heave from reactive pyrite in hardcore, it is the view of the Panel that pyritic heave is likely to be a very significant cause in many cases of severe damage. While insurance guarantee companies have protocols for establishing their own possible liability, the Panel concludes that an Irish testing protocol should be developed by the National Standards Authority of Ireland for establishing whether the hardcore in an existing dwelling has, or is likely, to cause pyritic heave. See section 7.1 for details.

99

Hawkins, A. B (2011)- Sulfate heave: a model to explain the rapid rise of ground bearing floor slabs. Bulletin of Engineering Geology and the Environment Volume 71, Number 1 (2012), 113-117



# Chapter 8: Conclusions and Recommendations

## 8.0 Introduction

This chapter outlines the overall conclusions of the Panel and includes details of the scale and categorisation of the pyrite problem in Ireland. It also includes recommendations for dealing with the current pyrite problems and goes on to make some recommendations to prevent similar problems arising in the future.

At the outset, the Panel recognises the very difficult situation in which many householders have found themselves, having purchased houses (or apartments) in good faith with an expectation that the house would be suitable to live in for many years, without any serious problems. The serious problems (arising from pyritic heave) that the householders concerned continue to face have proven extremely difficult to resolve. This has, in many cases, led to other social difficulties as they try to cope with the situation in which they have found themselves, through no fault of their own.

With the clarification in 2007 that the problem could be linked to reactive pyrite that was present in the hardcore in a number of housing estates (and individual houses), the householders had an expectation that the problem would be addressed expeditiously by those from whom they had purchased their homes – the builders/developers or the providers of the structural defects guarantee, insurers for the builders/developers and/or the suppliers of the defective infill materials.

The homeowners were hugely disappointed to find that many of those from whom they had expected an effective solution, have refused to engage and this has forced the homeowners towards legal routes, public representatives and the media. The construction sector, the insurance sector, the banking sector and the Law Society have been reluctant to engage with the issue on a collective basis and have considered that these were issues for the individual builders/developers or insurers or banks to sort out. The view appears to be that these groups as a whole do not have any role in proposing a solution. Since 2007, each of these groups has continued to react to the problem in what appears to be an individual, uncoordinated way, with much of the process conducted through legal proceedings.

When the homeowners initially raised the issue with local politicians and Government Ministers, it was stated that the matter was a civil issue for which the Government had no responsibility. However, following the withdrawal of cover for pyrite-damaged houses by HomeBond in August 2011, the Minister for the Environment, Community and Local Government, Mr. Phil Hogan T.D, announced the establishment of the Pyrite Panel in September 2011. The Panel was asked to consider the issue and to make some suggestions as to how it could be resolved. Also, drawing on the experience gained since 2007, the Panel was asked to comment on the robustness of the existing building control system and to make suggestions to prevent a similar problem occurring again.



## Chapter 8: Conclusions and Recommendations

Generally, the homeowners felt let down by the builders/developers from whom they had purchased their homes and also by the representative bodies for the construction industry, by the providers of structural defects guarantees and insurers, by the banks and, more broadly, by Government, which was seen to have overall responsibility for the operation of the Building Control Acts and regulation of the construction sector.

The Panel has great empathy with the homeowners and understands their concerns and sense of being let down by the various stakeholders involved. In its dealings with the various stakeholders in the construction, insurance and banking industries, the Panel was amazed to learn that little or no discussions about the pyrite issue and its resolution had taken place within the representative bodies (or, indeed, the professional institutions), prior to the Panel seeking the views of the relevant bodies.

The Panel was disappointed to hear of this lack of engagement and it appeared as if many stakeholders just hoped that this problem might be resolved by others if they simply did not engage. This is not considered to be a particularly constructive approach in which to deal with such issues and the bodies concerned are exhorted to reconsider their general approach so that a more effective coordinated approach can be adopted in the future giving due consideration to the interest of the homeowner. The relevant stakeholders and their representative bodies should each take a share of responsibility for the serious problems which have occurred on a significant scale to a large number of the public who relied on their products and services. The homeowners are victims of the pyrite problem and their concerns deserved to have been addressed in a systematic and effective manner long before now.

In undertaking its task, the Panel identified four core issues that it needed to address;

- Identify the scale of the pyrite problem in private housing ;
- Identify technical solutions for the remediation of pyrite damaged homes;
- Identify possible funding options for the remediation work;
- Review the robustness of the existing system to protect homeowners in the future.

The Panel's recommendations fall into four broad categories:

1. Categorisation and remediation approaches;
2. Proposals for a resolution of the pyrite problem;
3. Reducing the burden on affected homeowners;
4. Review and propose measures to strengthen the provisions to protect consumers.

### 8.1 Scale of the pyrite problem

Based on the information made available to the Panel, it is generally satisfied that the figures below represent the potential extent of the pyritic heave problem as at March 2012. Chapter 4 of this Report describes the methodology and assumptions used by the Panel in coming to this conclusion.

The Panel notes that:

- A total of 74 estates were identified to the Panel during the study.
- Approximately **1,100** private dwellings on 12 different estates have either been remediated or are in the process of being remediated.
- There are **850** dwellings on 44 different estates for which pyrite-related claims (verified and un-verified) have been made to the main guarantee providers. Of these estates, 5 estates are also included in the figures mentioned immediately above as they are partially remediated estates.
- The Panel estimates that the potential number of private dwellings on the 44 estates mentioned immediately above is approximately **8,000** ground floor dwellings.
- A further 23 other estates were identified to the Panel as possibly having pyritic material (in the hardcore) in some of the dwellings but no pyrite-related claims have been lodged with the main guarantee providers. The Panel estimates that the total number of ground floor dwellings in these 23 estates is approximately **3,250**.

A tabular summary of the Panel's findings are given in Table 8.1 below.

<b>Number of estates identified to the Panel</b>	<b>Approximate number of outstanding pyrite-related claims</b>	<b>Approximate number of dwellings remediated (or in the process)</b>	<b>Remaining number of dwellings (with a ground floor) on identified estates</b>
7	-	1,000	-
44	850	100 <sup>1</sup>	7,050 <sup>2</sup>
23	-	-	3,250
<b>74</b>	<b>850</b>	<b>1,100</b>	<b>10,300</b>

**Note:**  
 This figure relates to dwellings in 5 estates that are partially remediated  
 The identification of pyrite in an estate does not necessarily mean that all dwellings in the estate are affected.  
 The typical cost of remediation for an average house, as quoted to the Panel by those who have undertaken a significant amount of such work, is approximately €45,000 - see section 7.2.4

### 8.2 Categorisation of the pyrite problem

Where pyritic material has been used in hardcore, there are many reasons why not all dwellings in an estate will manifest with pyritic heave. The unpredictability of pyritic heave in estates where pyrite is present is dealt with in Chapter 7, Section 7.4.3. The Construction Industry Federation highlights this point, in the following statement: *"The identification of pyrite in a development does not necessarily mean that all the houses in the relevant development are affected"*<sup>100</sup>. In considering this, the Panel deemed it necessary to develop

a mechanism to categorise dwellings that are directly or indirectly affected by pyrite as a result of reactive pyrite being present in the hardcore in one or more dwellings in a development. In reviewing a number of methodologies, the Panel determined that it would use a traffic light system where:

- “red” is for dwellings that have exhibited significant damage due to pyritic heave;
- “amber” is for dwellings that have reactive pyrite in the hardcore but no associated significant damage at present, however there may be some risk of pyritic heave in the future; and
- “green” is for dwellings that have no risk of pyritic heave now or in the future (this may be due to the hardcore being suitable or where hardcore containing an excessive amount of pyrite has been removed).

A number of companies/consultancies have developed testing protocols to establish whether a building has been or, is likely to be, affected by pyritic heave. Those protocols have been developed to meet the particular needs of the individual companies/consultancies and their clients. However, the Panel believes that an Irish testing protocol should be developed under the auspices of the National Standards Authority of Ireland (NSAI) and this protocol should be accepted by all stakeholders. Based on the results provided by the testing protocol, it will be possible to categorise existing buildings into ‘red’, ‘amber’ and ‘green’, as discussed above. The protocol should be sufficiently comprehensive to allow for the categorisation of dwellings, but should also be cost effective to reduce the burden on homeowners. In developing such a protocol, the Panel recommends that the NSAI should draw upon the existing protocols outlined in Chapter 7 and upon the expertise developed in dealing with remediation since 2007. Testing should be carried out by competent persons using only accredited laboratories.

### **Recommendation 1: Development of a testing protocol**

The Panel recommends that:

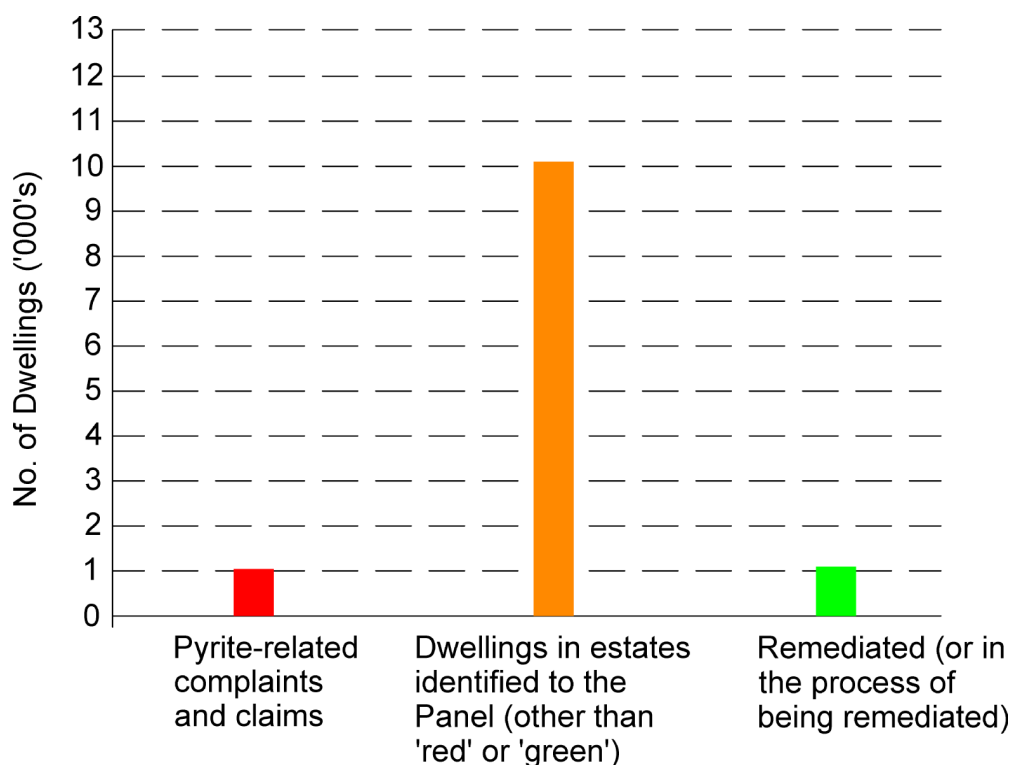
an expert industry group should be established immediately by the National Standards Authority of Ireland (NSAI) to develop an Irish testing protocol (within a three month timeframe) capable of determining whether:

- (a) there is reactive pyrite in sub-floor hardcore material, and
- (b) if it has caused pyritic heave.

### **8.3 Panel’s estimate of the distribution of red, amber and green categories based on available data**

As a result of having no common protocol to date, there are no definite figures of the number of dwellings that may fall into each categorisation in developments which have confirmed or suspected pyrite problems. However, in the interest of giving indicative figures, the Panel used the data they collected (see Chapter 4 for full details of data collected) to estimate the possible distribution across red, amber and green categories. Figure 8.1 below represents the Panel’s estimate of the possible distribution across the red, amber and green categories, given the information available to the Panel as of March 2012.

**Figure 8.1** Estimate of possible distribution across ‘red, amber and green’ categories (March 2012)



**Note:**

1. ‘Red’ includes all claims and complaints recorded by HomeBond or Premier but it should be noted that not all of the claims/complaints have been confirmed as having pyritic heave.
2. Not all homeowners that have experienced pyritic heave in their dwelling may have made complaints or claims – but this is unquantifiable
3. ‘Amber’ represents the remaining dwellings on estates identified to the Panel. Note that the identification of pyrite in an estate does not necessarily mean that all dwellings in the estate are affected.

### 8.4 Remediation approaches for dealing with categorised dwellings

Once a dwelling has been categorised in accordance with the testing protocol in Recommendation 1, general recommendations can be made to homeowners regarding appropriate action.

- For the **red category**, where there is significant damage due to pyritic heave, remediation should be carried out as a priority.
- For the **amber category**, where there is reactive pyrite in the hardcore, but no associated significant damage, the dwelling should be monitored on an on-going basis. The Panel considered it would be appropriate, for the amber category, to monitor the situation rather than proceed to carry out costly remediation initially.

The Panel notes and agrees with the point made in the judgement of Mr. Justice Charleton delivered on 25<sup>th</sup> May 2011 on ‘James Elliott Construction Limited –v- Irish Asphalt Limited’ which states “; it is not yet reasonable to remove the infill .... solely because the high sulfur content of the infill. That only established a possible danger into the future.” This case is currently under appeal. From a homeowner’s perspective, it is understandable that they

would wish to see the problem dealt with completely as soon as possible by the removal of the pyritic material. However, the cost of remediation for individual houses is expensive and it is also a very disruptive process for homeowners. The Panel considers that specific provision should be made to provide for remediation, if and when a dwelling exhibits damage and the dwelling then moves into the “red” category. The Panel is aware that a number of alternative preventative solutions are being researched and developed at present and these may provide solutions for the amber category in the future. See Chapter 7, Section 7.2.3 for more detail.

- For the **green category** there is no risk of pyritic heave as the levels of reactive pyrite in the hardcore are insignificant or the pyritic material has been removed. For these homeowners, the protocol provides definitive proof that pyrite is not an issue for the property and it should be accepted by insurers and lenders that this house is now no different to any other house without pyrite.

See Chapter 7 for further information on the approach to dealing with categorised dwellings.

The protocol referred to in Recommendation 1 will also help some properties that, by association, are affected by pyrite, e.g. located in the same estate as dwellings with problematic hardcore.

### **Recommendation 2: Guidance on approaches to remediation**

The Panel recommends that:

- (a) dwellings in the “red” category should be remediated immediately,
- (b) dwellings in the “amber” category should be monitored and remediated if and when they exhibit pyrite-related damage,
- (c) alternative preventative solutions (certified by an approved body), which prevent pyritic heave occurring, should be considered as less costly and less disruptive remediation method for the “amber” category.

## **8.5 Technical solutions for remediation**

The only recognised remediation method at present is the complete removal of the contaminated hardcore from under the concrete floor slab. This is a very intrusive and costly intervention which requires careful consideration. The Panel considers that a method statement based on good practice should be developed by the National Standards Authority of Ireland to ensure that confidence in this remediation method is provided and to eliminate, as far as practicable, any resultant latent defects caused by the works. Compliance with this method statement should be made a prerequisite for the issue of any certification as outlined in section 8.6. The expertise and knowledge gained by the professions and industry working in this area since 2007 should be made available to the NSAI in undertaking this work.

As detailed in Chapter 7, a number of companies/individuals are currently undertaking research to develop alternative solutions to the full removal of hardcore infill from under floor slabs for the remediation of houses affected by pyrite. It is hoped, by those involved in this research and development work that an alternative preventative method can be developed which could provide a more cost effective and less disruptive method of remediation of buildings affected by pyrite. The Panel supports and encourages the continuation of this work and considers that, if a successful outcome can be achieved and adequate certification can be provided which would be acceptable to building control authorities, insurance companies and mortgage providers, it may provide a more cost-effective and less disruptive solution for the dwellings that are categorised as “amber”.

### **Recommendation 3: Development of a method statement for remediation works**

The Panel recommends that:

an expert industry group should be established immediately by NSAI to develop a method statement for remediation works. Compliance with the method statement should be a prerequisite for the issue of any certification.

## **8.6 Certification**

An essential part of dealing with the problem of pyritic heave is the need to ensure the credibility and integrity of the remediation process and the Panel considers that a certification system will provide the required assurance. This requires that certification is only carried out by accredited testing laboratories and that work is only undertaken by competent contractors and certified by competent building professionals. Certificates in relation to each category should be provided to the homeowner. This will facilitate those who wish to sell their property or, for those who require verification for insurance purposes, by providing the owner (and the purchaser) or organisation with an accepted, clear and reliable method of communicating the status of the dwelling in relation to pyrite in the hardcore.

Such certification should only be required for dwellings in developments where damage due to pyritic heave has occurred. It should not be a general requirement for all dwellings. A number of certificates in standardised format should be developed by the National Standards Authority of Ireland, as follows:

**Certificate 1:** A certificate to confirm that the dwelling is not at risk of pyritic heave now or in the future;

**Certificate 2:** A certificate to confirm that the dwelling has been remediated in accordance with the NSAI Method Statement and is no longer at risk of pyritic heave now or in the future;

**Certificate 3:** A certificate to confirm that the dwelling has reactive pyrite in the hardcore, but there is no associated significant damage at present.

While the Panel acknowledges that Certificate 3 above implies some uncertainty, it should not limit a homeowner’s ability to transact in the housing market nor should it penalise homeowners or prospective buyers dealing with banking or insurance institutions. In this regard, the Panel would expect this to avoid any specific insurance or conveyancing constraints related to pyrite in the future. See Recommendation 5.

All certificates should be in a standardised format, issued by competent persons to ensure their credibility and recognition and they should be acceptable to all the key stakeholders e.g. professional, legal, insurance and banking and mortgage sector. The template for these certificates should be prepared in conjunction with and incorporated into the testing protocol, referred to in Recommendation 1 above.

The cooperation of the insurance industry, mortgage providers, certification providers (including design professionals) and the legal profession is critical if this process is to work effectively.

### **Recommendation 4: Certification of dwellings**

The Panel recommends that:

- (a) a series of certificates should be developed for dwellings affected by pyrite,
- (b) the certificates should be in a standardised format and acceptable to the key stakeholders,
- (c) certification would only be necessary in dwellings in estates where pyrite damage has been proven and where dwellings were constructed during a similarly defined period.

### **Recommendation 5: Insurers and mortgage providers**

The Panel recommends that:

- (a) the insurance industry should not penalise homeowners in estates where pyrite damage has been proven and should continue to provide standard insurance cover for all dwellings (including those in the red category),
- (b) mortgage providers should not penalise in any way homeowners simply because of the presence of pyritic material in the sub-floor construction (i.e. those dwellings in the 'amber' category),
- (c) dwellings in the 'green' category should be treated no differently to any other dwelling that has no pyrite present.

## **8.7 Possible solutions for paying for the remediation**

As previously stated in Chapter 6, the Panel considers that a basic principle needs to be adhered to that, those parties with direct or indirect responsibility for the pyrite problem (vendors, builders/sub-contractors, material suppliers and insurers), should work together to find and implement effective solutions. The Panel welcomes the statements by the Construction Industry Federation and the Irish Concrete Federation that those responsible should pay for the damage caused but the Panel was disappointed that there was no willingness from the industry as a whole to offer to commit to contribute funds to such a solution or even to elaborate on how the principle (of those who were responsible should pay) could be achieved.

While all stakeholders agree that homeowners need a solution and agree that funding for such a solution should come from those responsible, none of the organisations or bodies concerned was willing to commit to providing funding for such a process or to explain in detail how the aspiration they articulated could be met, other than through the courts. This was a source of disappointment to the Panel and such stakeholders should be encouraged to make concrete proposals as to how funding for remediation might be provided.

### **Recommendation 6: Responsibilities of stakeholders in the construction industry (including the quarrying sector)**

The Panel recommends that:

the stakeholders in the construction industry (including the quarrying sector) should re-assess their positions and follow up on their positive statements in relation to the responsibilities of the relevant stakeholders and outline how they envisage funding the costs of the remediation.

From the homeowner's perspective, their relationship is either with the builder/developer or with the structural guarantee scheme provider (e.g. Premier Guarantee). The homeowner has no direct relationship with the provider of materials or any subcontractors utilised by the builder/developer. The Panel considers this is another basic principle that should be considered in recommending any solution.

### **Recommendation 7: Immediate engagement by builders/ developers/ insurers to facilitate the remediation**

The Panel recommends that:

in the first instance, the builder/developer (and/or their structural defects guarantee provider or insurer) should immediately engage with the homeowner to remediate the damage due to pyritic heave. The builder/developer/structural guarantee provider/insurer, in turn, may seek to pursue other parties that may have a liability for the damage,

As noted elsewhere in this Report, the Panel was disappointed by the lack of engagement by the various stakeholders in addressing the pyrite problem. The Panel considers that a solution-focussed approach is needed that is capable of quickly achieving positive outcomes for homeowners. In the Panel's opinion, Government support will be required to ensure that the processes put in place are carried through. While the Minister for Environment, Community and Local Government will have a lead role in some aspects, the whole of Government support will be required to deliver an effective solution.

### **Recommendation 8: Engagement by construction industry representatives**

The Panel recommends that:

the Government should ensure that strong leadership is provided to influence the engagement of the construction industry representative bodies and other relevant parties in resolving the pyrite problem. While the Minister for Environment, Community and Local Government has an important role in this process, the whole of Government support is essential to deliver an effective overall solution.

In the Panel's opinion, the removal of cover by HomeBond in August 2011 has exacerbated an already difficult position for many homeowners. Homeowners who believed that they were protected against serious damage to their dwellings have found this not to be the case. It may be the case that the National Housebuilding Guarantee Scheme Ltd, which operates the HomeBond Warranty Scheme, has insufficient funds to satisfy all of the potential claims. Nevertheless, the members of HomeBond and the broader construction industry (which were involved in the establishment of HomeBond) are exhorted to revisit this decision



and/or engage with other stakeholders in a timely manner so as to find a comprehensive solution to the problems affecting homeowners.

The Panel considers that this is an urgent issue that should be addressed by the members of HomeBond in the first instance and by the broader construction industry as well. The Minister for the Environment, Community and Local Government, who has responsibility for policy in relation to the provision of quality housing, may be required to facilitate this process, but he should have the full support of Government to deliver an effective solution. The Panel acknowledges that Premier Guarantee, which is underwritten by Liberty Syndicate Insurance, is continuing to fully remediate pyrite-damaged dwellings which fall within the terms of its warranty scheme. The Panel notes that, once pyritic heave is proven, remediation is undertaken on a systematic basis. It should be noted that the guarantee is limited to a 10 year period from the date of activation of the insurance policy in respect of a dwelling.

In the opinion of the Panel, the early engagement by HomeBond would be advantageous to the process as HomeBond has extensive expertise and knowledge concerning claim management and remediating structural damage and, specifically, pyrite-related damage. The Panel also considers that this action by HomeBond is necessary in order to restore confidence in the construction industry sector and in the structural guarantee scheme in particular.

### **Recommendation 9: Re-engagement by HomeBond in facilitating remediation**

The Panel recommends that:

HomeBond should review its position on cover as articulated in its letter of 31 August 2011 and, as a matter of urgency, HomeBond should re-engage with homeowners in facilitating the remediation of pyrite-damaged dwellings. This should be addressed, in the first instance, by the members of HomeBond and, in turn, they should be supported in this process by the overall construction industry, which was involved in the establishment of the HomeBond structural guarantee scheme.

This would not preclude HomeBond seeking to recover costs from other parties whom they consider may have a liability.

The Panel was disappointed that it did not receive full engagement from one of the key stakeholders, the representative body for the insurance industry (i.e. Irish Insurance Federation). The Panel notes the statement on the website of the Irish Insurance Federation, *“the IIF represents its members’ interest to Government, state agencies, regulatory bodies, public representatives, other interest groups, the media and the general public.”*

The insurers are continuing to deal with issues on an individual case-by-case basis. The Panel is of the view that a more open, inclusive and structured approach by the insurance industry would be beneficial to homeowners and, indeed, to the insurance industry itself in addressing the problems of the dwellings in both the “red” and “amber” categories.

### **Recommendation 10: Engagement by the insurance industry**

The Panel recommends that:

the Insurance Industry Federation (IIF), as the representative body of the insurance industry, together with its relevant members, should immediately engage with solving the problems caused by pyrite and for which some insurers have provided insurance cover. The Panel exhorts the IIF to encourage its relevant members to respond with greater sensitivity and urgency to the homeowners and to explore the options for a collective solution to the pyrite problem, as opposed to just awaiting the outcomes of lengthy legal processes.

The banks were identified by many groups who met with the Panel as having a vested interest in trying to facilitate a resolution to the pyrite problem and thereby restoring the integrity of any loan security involving a dwelling affected by pyrite. In discussions with the Irish Banking Federation (IBF) and with the main mortgage providers, the Panel sought to explore possible options for a co-ordinated response from the group for dealing with the problem. However, the IBF members considered that they were constrained in what they could do. They would only give a commitment to deal with homeowners affected by pyrite damage on an individual basis and under existing processes which they considered were adequate to deal with the problem.

The Panel considers that, while respecting the constraints that may be on the mortgage providers, the response from the mortgage providers could be significantly improved as it appears to be lacking in its understanding of the particular circumstances of homeowners dealing with pyrite. The Panel considers that the mortgage providers should explore the provision of a more pragmatic response for homeowners dealing with pyrite problems by seeing how they can support such homeowners. Recognising that many homeowners may not have the capacity to take on an additional financial burden at this stage, the Panel suggests that the mortgage providers might consider such options as providing funding for the remediation by extending the existing mortgage but without increasing the current monthly repayments (beyond that which would be paid based on the original mortgage) or other solutions.

### **Recommendation 11: Funding by mortgage providers**

The Panel recommends that:

subject to whatever legal constraints exist on the members of the Irish Banking Federation (IBF), mortgage providers should consider providing funding for pyrite-related remediation work, including testing, to homeowners.

## **8.8 Responsibility of the State**

A number of stakeholders considered that the State should step in and take responsibility for the cost of remediation. Reflecting on this suggestion, the Panel considered that one of its own basic principles is that those responsible for the damage should bear the cost of its repair, in as much as they are capable of doing so. From the information supplied to the Panel, the pyrite problem was not foreseen by expert design professionals or others in the

construction industry and, as soon as the problem was confirmed in 2007, timely actions were taken to arrest the problem. These are detailed in Chapter 3 and 5. Also, as can be seen from Chapter 5, the relevant Building Regulations in Ireland compare favourably with those in the adjoining jurisdictions. The Panel considers that the regulations and guidance in place prior to this sudden occurrence of pyritic heave in concrete floors, were generally reasonable and reflective of the knowledge and experience widely available at that time. This form of construction had been used in hundreds of thousands of dwellings previously.

The Panel was informed that highly-experienced site personnel could not visually identify the defective material nor could normal diligent inspections by building control officers or other professionals do so.

The Panel is conscious of the potential for those responsible to readily pass this responsibility to the State, if the State is seen to step in and take responsibility. The future danger of moral hazard if the State takes over the responsibility of others is also a consideration. The Panel is supported by other submissions in its view that those responsible should bear the cost. For example, the County and City Managers' Association states as follows: *"it would appear appropriate that the suppliers, companies providing structural guarantees/ insurance and companies providing building insurance should bear the brunt of the costs of repairs. The structural guarantees provide for major defects, a category into which pyrite falls. The role of the financial institutions that provided mortgages and a contribution from them also needs to be considered"*<sup>101</sup>

The Construction Industry Federation in its submission stated that *"...Responsibility for dealing with the problem rests with those directly involved and revolves around vendors; builders/ sub-contractors; material suppliers; and insurers"* and *"...ensure that the available resources of those with ultimate responsibility for the remediation of pyrite contamination, including insurers, are ringfenced for this purpose."*<sup>102</sup>

In the light of the foregoing, the Panel considers it difficult to see what steps the State could reasonably and foreseeably have taken to avoid this problem.

Nevertheless, in view of the knowledge and expertise now available, the Panel considers it would be prudent to consider what further steps could be taken to avoid this and other such problems in future and these are dealt with in a number of comments and recommendations in the report.

The Panel does not consider that the State is responsible for the damage resulting from the use of defective material and, therefore, the State should not be asked to bear the costs of remediation. This view was supported by a majority of the individuals/groups who spoke with the Panel. Nevertheless, the Panel believes that the State has an important role in ensuring that the responsible parties engage constructively in a process to deliver effective solutions for homeowners.

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101 Extract from submission from County and City Managers Association, February 2012

102 Submission from the Construction Industry Federation to the Pyrite Panel 6 December 2011

### Recommendation 12: Role of Government

The Panel recommends that:

the Government should take the necessary steps to ensure that:

- (a) those who have responsibility for the pyrite problem should bear the costs of remediation,
- (b) remediation is carried out in a timely manner,
- (c) that comprehensive measures are put in place to minimise the risk of this or similar problems occurring in future.

The Panel considers that the State, in recognition of the difficult position being experienced by homeowners who have been dealing with the effects of pyrite, should consider giving a similar relief from the proposed property tax to that which was given to homeowners in certain categories of unfinished housing estates from the household charge.

### Recommendation 13: Exemption from proposed property tax

The Minister for the Environment, Community and Local Government should consider providing an exemption from the proposed property tax for a set period, for dwellings where damage from pyritic heave has been proven by testing, in accordance with the protocol mentioned in Recommendation 1.

## 8.9 Resolution Board

A number of contributors to the Panel suggested that a Resolution Board should be established, e.g. *“CIF believes that a fast track resolution process is needed to help homeowners ...such a process ... ..on a case by case basis ...capable of assessing individual applications, determining liability and setting out, where appropriate, the appropriate remedial actions ..”*, The Panel supports the view that a Resolution Board, (funded by those with whom responsibility and liability lie), provides a practical solution for helping to deal with the pyrite problem. However, it recognises that there are also inherent drawbacks with the proposal in that it has the potential to undermine current progress that is being made as parties await the work of the Resolution Board rather than progressing remediation immediately. The Panel considers that the Resolution Board should work in conjunction with the other remediation actions currently underway and should not cause these processes to be delayed in any way. The Panel would not envisage the Resolution Board dealing with claims where there are existing systems in place to deal with claims, such as those being dealt with currently by builders, insurers or others. The Resolution Board should only be a place of last resort when all other avenues have been exhausted and the homeowner has nowhere else to go to have the cost of remediation works funded. For example, in the case of an affected property where the builder is in liquidation/receivership and there are problems with the builder’s insurance, or where the warranty insurance/guarantee has expired, it might be appropriate for the Resolution Board to handle such a situation. A crucial question will be who will pay for the Resolution Board and, in this regard, the Panel considered systems in operation in other sectors for dealing with problems caused by a small number of stakeholders in the sector. For example, in the case of the travel trade, there is a fund that can be drawn down from by the Commission for Aviation Regulation in the event of a travel agent or tour operator running into financial problems. The focus

is on getting the situation resolved immediately for the individuals who may be stranded abroad. The tour operators and travel agents provide bonds in the form of cash or a bank or insurance company guarantee to maintain the fund. Likewise, with the Motor Insurance Bureau, by which claims against uninsured drivers are covered by the Motor Insurance Bureau, which itself is funded by the insurance industry. Again, the focus is on solving what is a real problem for an individual claimant as a result of an accident involving an uninsured driver.

It is the view of the Panel that funding for the Resolution Board should not come from the Exchequer. It could come from, for example, the imposition of a levy on the construction/quarrying sectors and on the related insurance cover for those sectors or other similar sources. (There may be other sources of funding as well and the construction/quarrying industry might have suggestions). The appropriate amount of the levy to be imposed and its division across the sectors should be determined by the Minister for Environment, Community and Local Government, after consultation with the industry sectors and consumer interests. For example, the output from the quarrying industry in 2011 was 30 million tonnes (valued at about €240 million) so a simple levy of €1/tonne would yield approximately €30 million per annum. Alternatively, an *ad valorem* levy could be applied (based on the value of the quarried material) and this might be seen to be fairer.

It should be noted that the Irish Concrete Federation has expressed to the Panel its opposition to any levy on quarrying and the Construction Industry Federation has similarly expressed opposition to a levy on construction.

### **Recommendation 14: Establishment of a Resolution Board**

The Panel recommends that:

the Government should establish a Resolution Board which would not be funded by the Exchequer but could be funded by, for example an appropriate levy on the quarrying and construction sectors and the related insurance cover for those sectors. This Resolution Board should be established under the aegis of the Minister for the Environment, Community and Local Government.

The Panel would caution that this Resolution Board should not delay any on-going remediation that is currently underway and the Board should only be the last resort for dealing with pyrite problems and related issues, where no other solution is possible.

### **8.10 Measures to prevent a pyrite-related problem (or similar) in the future**

Many of the groups/individuals who engaged with the Panel considered that there was a need for greater oversight of the testing regime in quarries for aggregates. This view was shared by the Irish Concrete Federation (ICF) which stated in its submission that “*ICF has always publicly called for greater supervision of quarries*”. They added that “*despite these repeated calls for more enforcement action against unauthorised quarries, which are often opened to supply short-term increases in local demand for aggregates with scant regard for planning, environmental, health and safety and quality standards, little has been done to address the issue*”<sup>103</sup>.

103 Submission from the Irish Concrete Federation December 2011

In a joint submission from the Association of Consulting Engineers of Ireland (ACEI) and Engineers Ireland (EI), it was suggested that quarry operators had a legal duty under the Sale of Goods Act, 1980 to ensure that the material they supply is fit for purpose and will not cause damage. Section 10 14 (4) of the Act states “ *where a seller sells goods in the course of a business and buyer, expressly or by implication, makes known to the seller any particular purpose for which the good are being bought, there is an implied condition that the goods supplied under the contract are reasonably fit for purpose*”. There is also an onus on specifiers and builders to state the standard to which they require products. See Chapter 5.

In 2007, the NSAI Aggregates Panel, at the behest of industry, was tasked with amending SR 21:2004 *Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*, to limit the presence of a reactive form of pyrite in hardcore, used under concrete ground floors and which may give rise to swelling or sulfate attack. The amendment to SR21:2004 SR21:2004+A1:2007, was published in December 2007 and guidance to the Building Regulations (TGD C) was revised to refer to reflect the amendment in 2008. Since then, hardcore in compliance with SR21:2004+A1:2007 *Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* is *prima facie* evidence of compliance with the Building Regulations.

With the depth of knowledge on pyrite that has developed in Ireland, over the last five years or so, the Panel considers that it would be worthwhile reviewing SR21:2004+A1:2007 *Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction* to see if it requires amendment. It is accepted by the Panel that there is a case for a more detailed and specific testing, certification and traceability regime to be put in place for hardcore material to be used in dwellings and buildings. This position is supported by most of the professions involved in the construction industry who engaged with the Panel. In this regard, the Panel recommends that a standalone specification for hardcore should be developed that covers the performance of the material, the testing requirements at various stages within the supply chain and ensures the traceability of hardcore.

### Recommendation 15: Specification for hardcore

The Panel recommends that:

- (a) in light of the knowledge and experience gained since 2007, the National Standards Authority of Ireland should initiate a review of Standard Recommendation S.R. 21.:2004+A1:2007 Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction,
- (b) The National Standards Authority of Ireland should develop a standalone specification for hardcore for use under concrete floors, which should become the source of guidance on hardcore. The specification should include the following key elements:
  - (i) performance requirements for the characteristics of hardcore (by reference to existing standards or standard recommendations),
  - (ii) a factory production control system and ongoing testing regimes for all quarries to verify compliance with the requirements in (i),
  - (iii) the competence required of those carrying out the tests in (ii),
  - (iv) a sampling/inspection regime at various stages in the supply chain,
  - (v) a methodology for quarries to establish traceability of hardcore,
  - (vi) a system of certification for hardcore,
  - (vii) guidance on purchasing procedures, in particular that the end-use of the material is clear to supplier and purchaser,
- (c) The expertise developed, the scientific data gathered and research carried out over the last 5 years should be made available to NSAI in order to ensure the best outcome from the review and development of a specification for hardcore,
- (d) Following the publication of a Specification for hardcore referred to in (b) above, the Department of the Environment, Community and Local Government should review the guidance provided in Technical Guidance Document to Part C of the Building Regulations and, if required, it should issue amendments to the Technical Guidance Documents.

The Panel supports the view expressed by the Irish Concrete Federation “*that compliance with the testing and other requirements of aggregates (and other construction materials) is underpinned by mandatory certification to relevant standards*”.<sup>104</sup> The Panel considers that there is need for a greater level of testing and traceability to ensure the quality and reliability of quarried products.

104 Submission to the Pyrite Panel from the Irish Concrete Federation February 2012

### Recommendation 16: Requirements for quarries supplying hardcore

- (a) Quarries should be required to demonstrate, by regular testing and appropriate certification that the hardcore material they are supplying is in compliance with the recommended specification for hardcore (Recommendation 15),
- (b) Quarries should be required to furnish to purchasers and, when requested, to building control officers, the certification, together with the results, in accordance with the specification for hardcore (Recommendation 15),
- (c) Quarries should ensure that all hardcore supplied to others is traceable to the quarry of origin which has certified it, in accordance with the specification for hardcore. This information should be readily available to the building control authorities and others who may require it,
- (d) Quarries should have adequate insurance for the scale and type of work being undertaken,
- (e) The data in relation to products used in residential construction (including copies of delivery docket) should be readily available to the building control authority in digital format and it should be readily accessible by homeowners as appropriate.

### 8.11 Building control system

The building control system operating in Ireland is outlined in detail in Chapter 5. While the Panel acknowledges that there was over-reliance on industry's self-certification to comply with the Building Regulations, with only a limited oversight by building control authorities, it considers that, having regard to the unprecedented nature of the problem posed by pyrite in hardcore, it is unlikely that it would have been possible for building control officers or others to have detected the problem during inspections of construction sites.

The Panel considers that the building control authorities have generally adequate enforcement and prosecution powers available to them under the Building Control Acts 1990 and 2007 but it notes the difficulties being experienced by building control authorities in pursuing those who have not built in accordance with the Building Regulations. The Panel notes the points made by the County and City Managers' Association, that taking prosecution for non-compliance can be expensive and time consuming and that the County and City Managers' Association favours adopting a more pragmatic approach, whereby it may be possible to have the breach remedied and achieve compliance with the Building Regulations through discussion. " *...if there is a genuine commitment given to make good the defect, then the cost, time etc., of initiating court proceedings and getting a conviction, or a minimum fine due to the mitigating circumstances (i.e. the defect made good) has to be taken into account*".<sup>105</sup>

Concerns have been expressed about the limitations of this approach, particularly where the statutory time limit has now passed. The Panel considers that the approach favoured by the County and City Managers' Association is more effective where construction is still in progress on site and where the remediation is readily effected. However, taking of prosecutions should be pursued in serious cases and this intent should be widely communicated to the construction industry. The Panel also recommends that, the County and City Managers' Association should review its guidance (as articulated in its submission

<sup>105</sup> County and City Managers Association submission to the Pyrite Panel, February 2012



to the Panel) in relation to building control enforcement and, in particular, the reasons why building control authorities did not seek to utilise the provisions of the legislation to seek remediation of the pyrite-affected dwellings. The lessons from this should be incorporated into any new revision of the guidance issued by the County and City Managers Association.

Building control authorities have a responsibility under the Building Control Acts 1990-2007 to enforce Building Regulations. The Panel considers the building control authorities should exercise their enforcement powers to require the builders to undertake remediation work on serious defects arising from pyritic heave or other causes, taking into account the builders' responsibility under the legislation and the statutory time limits.

In relation to local authority houses affected by pyrite, the Panel recognises that local authorities are remediating their own properties and seeking to recoup the costs from those who are deemed to be responsible for the damage.

Due to the time limit of 5 years in which prosecutions can be taken by building control authorities, the Panel recommends that the Minister for Environment, Community and Local Government should reconsider this time limit with a view to extending it.

In addition, the Panel also considers there is now a strong case for building control to require evidence of testing and certification, of actual hardcore used, so as to demonstrate compliance with the Building Regulations.

### **Recommendation 17: Enforcement of Building Control Legislation**

The Panel recommends that:

- (a) Building control authorities should adopt a risk-based approach to the enforcement of Building Regulations and take appropriate enforcement action for serious breaches of Building Regulations following consideration of the particulars of each individual case,
- (b) in local authority areas where pyrite has been shown to be a problem, the building control authorities should consider using the enforcement provisions of the Building Control Acts 1990 – 2007 to require builders to remediate defects in pyrite damaged dwellings,
- (c) the Minister for the Environment, Community and Local Government should reconsider the 5 year time limit for prosecutions under the Building Control Act, with a view to extending it,
- (d) Building control authorities should require evidence of periodic testing and certification, of hardcore used on sites, to demonstrate compliance with the Building Regulations,
- (e) the County and City Managers' Association should review its guidance (as articulated in its submission to the Panel) in relation to building control enforcement.

The Panel has been informed that the control, supervision and certification of construction are currently being reviewed by the Department of the Environment, Community and Local Government. The Panel welcomes and supports the publication of proposals to strengthen the building control system which have been subject to a public consultation process. The draft regulations involve, inter alia, the submission to building control authorities of mandatory certificates of compliance together with the lodgement of plans and specifications with the building control authority.

### **Recommendation 18: Mandatory certification system**

The Panel recommends the:

development of a mandatory certification system which should recognise the importance of inspections, product certifications and site supervision and takes proper account of the risk associated with design, materials and construction.

In addition, the Panel recommends that the system of independent inspections, carried out by the building control officers, should be strengthened to complement the mandatory certification process for buildings. The guidance on the level and objectives of inspections undertaken by building control authorities should also be reviewed by the County and City Managers' Association.

### **8.12 Registration of Builders**

A number of groups which met with the Panel identified a lack of regulation of builders as a risk to the achievement of best practice in construction and it was noted that, during the economic boom, many individuals who set up as builders had little or no experience of building. While electricians and gas installers are regulated, there is no general system of registration or licensing of builders in Ireland. The Panel considers that a system of registration/licensing of builders and a mandatory requirement for adequate insurance together with appropriate procedures for de-registration could provide necessary and appropriate protection for consumers.

### **Recommendation 19: Registration of builders**

The Panel recommends that:

a mandatory registration system should be established for builders with specific requirements for appropriate insurance cover (supported by regulation). Registration of builders should require demonstration of technical competence, financial capacity and adequate insurance cover. Evidence of registration and of insurance of builders should be publicly available on appropriate websites so that the public can easily access the information. More generally, the use of information and communication technologies and the internet for providing readily accessible public information on the construction sector (including registered builders) should be addressed by the Minister for the Environment, Community and Local Government.

### **8.13 Statute of Limitations**

There is a concern amongst homeowners that the Statute of Limitations could prevent them claiming from their builder or insurer if there is a fault in the house due to pyrite and the fault has not been identified before the time specified in the Statute of Limitations Act 1957 runs out. Similarly, there is a concern that pyrite problems may not manifest themselves within the period of cover under the structural warranty /insurance scheme, which is normally 10 years. From experience internationally, some pyrite problems do not manifest themselves for up to 20 years, so homeowners could find themselves in a situation that they have neither insurance cover nor legal recourse when defects occur or are proven to be due to pyritic heave.

### **Recommendation 20: Statute of Limitations**

The Panel recommends that:

the current legislation governing Statute of Limitations should be reviewed with a view to ensuring that latent defects in buildings, such as those experienced from reactive pyrite, remain covered for a reasonable period during which the defects might be expected to manifest themselves. The Panel notes that work has been done by the Law Reform Commission (LRC) and it would ask that the LRC address this issue.

### **8.14 Insurance cover**

While the question of liability has been and is currently the subject of legal proceedings, the outcome for parties affected, especially house purchasers, is quite uncertain. The sums required for remediation and the number of likely cases is such that they would be a major burden on individuals. Vendors/builders/subcontractors, especially those with significant cases, may not have sufficient funds to cover the costs of remediation. Consequently, the availability of insurance cover is seen as a critical element in the provision of funds for remediation. However, where insurance is available, the time limits and the restrictive monetary limits imposed on the policies may combine to defeat householders.

There is considerable uncertainty with regard to the outcome of legal proceedings. The Statute of Limitations may rule out certain actions while the cost and risk for individuals would be a strong deterrent for individual homeowners to initiate legal proceedings.

The Panel notes that there are apparently serious gaps or deficiencies in some existing insurance products as they relate to structural faults in houses. Many homeowners, who considered that they had adequate cover for structural faults, have now been advised that they may not, in fact, have had such cover. The Panel considers that there is general confusion amongst many householders about what cover is provided by their insurance policy/structural guarantee cover. In cases where exclusion clauses are ruling out cover for materials and products, homeowners may be left with very limited insurance cover and, consequently, potential exposure to serious loss.

The Panel considers that there is a need for the insurance industry, the Central Bank, Financial Regulator and the National Consumer Agency, in consultation with the relevant Government Departments, to jointly address the issue of ensuring that those providing insurance policies should provide a minimum adequate cover for homeowners in relation to structural faults and other serious defects in house building. The current arrangements have left purchasers and indeed builders exposed to potentially grave risks.

In the absence of comprehensive adequate insurance that provides effective cover to protect house purchasers from serious widespread defects, especially those arising from defective materials or products, the Government should consider some options such as an imposition of a levy on the insurance providers for the construction sector, so as to provide a fund for the resolution of major incidents in which the consumer is exposed, such as happened with pyrite.

### **Recommendation 21: General Insurance issues**

The Panel recommends that:

- (a) the standard limits in the Contractor's All-Risk Policy and Public Liability Policy should be reviewed on a regular basis by the construction industry and the Central Bank so as to ensure that the policies offer sufficient protection to the builders and consumers. The level of cover should be specified as part of the registration process,
- (b) consideration should be given to specifying a requirement for project-related insurance whereby the cover for each specific project is available and adequate and is related to the project only,
- (c) consideration should be given to options to provide a fund for the resolution of major unforeseen incidents in which the consumer is exposed, without adequate recourse, such as happened with pyrite.

The Panel has been made aware that there are homeowners who are facing huge difficulties in relation to insurance cover for houses affected by pyrite and, in some cases, are being refused cover even in cases where remediation work has been undertaken and all pyritic material has been removed. This is not considered acceptable and should be adequately dealt with constructively by the relevant parties.

### **Recommendation 22: Home insurance issues**

The Panel Recommends that:

- (a) the Central Bank, Financial Regulator and the National Consumer Agency, in consultation with relevant Government Departments, should undertake a review of structural guarantee policies examining in particular the level of cover provided and the exclusions contained in those policies,
- (b) The Government should examine and introduce measures to ensure that adequate structural guarantee policies, in line with the outcome of the review at (a) above, are required as part of the conveyancing of new dwellings,
- (c) the Central Bank, Financial Regulator and the National Consumer Agency, in consultation with relevant Government Departments, should address the issue of having a minimum cover with any household insurance policy advertised and, if companies wish to add more to that, they would be entitled to do so but the policy could not offer less than that,
- (d) the insurance industry should remove any additional restrictions on dwellings that have been certified in accordance with the certification process set out at section 8.6 as not having pyrite or having been cleared of pyrite. In relation to overseeing of this condition, the Central Bank, Financial Regulator and the National Consumer Agency should engage with the insurance industry with a view to preventing any exclusion for pyritic heave in a household insurance policy for remediated dwellings,
- (e) the insurance industry should not withhold standard household insurance cover to dwellings specifically affected by pyrite.

### **8.15 Continuing Professional Development and Education**

During discussions with the various professionals working in the construction sector, it was highlighted to the Panel that, other than the professionals directly involved,

knowledge of the pyrite problem took some time to get through to other professionals. The Panel considered that this is a weakness in the system that should be addressed by the professionals' representative bodies having on-going technical briefing on emerging problems such as issues with pyrite.

Accordingly, the Panel considers that such briefing should form part of the normal continuing professional development of all construction-related professionals and it recommends that the professional institutions should collaborate in the production of a continuing development programme. The Panel welcomes a number of recent initiatives by the professional bodies in dealing with the pyrite issue, including the production by the Association of Consulting Engineers Ireland (ACEI) of a guidance note for its members and the hosting by Engineers Ireland of a one day Continuing Professional Development course on pyrite. The Pyrite Symposium held in Trinity College Dublin in April 2012 also provided an excellent forum for discussions of pyrite issues. The Panel supports these initiatives and considers that there would be huge benefits to be gained if the relevant professional institutions collaborated to develop and deliver such courses making full use of the expertise and knowledge available within the professional bodies.

The Panel accepts the statement by the design professionals and the construction sector at large, that they were unaware of the problems associated with pyritic heave prior to 2007. The subject of 'pyrite' and the consequences of 'pyritic heave' were not adequately covered in third level construction, design and engineering courses prior to 2007. For the most part there was merely a passing reference to it in geology modules. There is little evidence that this has changed significantly since then. The Panel recommends the inclusion of a part-module on this topic in all relevant third level construction, design and engineering courses. The detail of the module to be provided is a matter for those concerned in the establishment of such courses.

### **Recommendation 23: Continuing Professional Development and Education**

The Panel recommends that:

- (a) continuing professional development courses (that deal specifically with pyrite and pyritic heave) should be developed and made widely available by the relevant professional bodies,
- (b) a part-module on pyrite and pyritic heave should be included in all relevant third level construction, design and engineering courses.

### **8.16 Dissemination of information**

Although information on the pyrite problem was communicated to relevant stakeholders in a timely manner, it was suggested to the Panel by a number of groups that this information was not communicated to all professionals and the industry at large. While the Department of the Environment, Community and Local Government is responsible for ensuring that building control authorities are notified of all relevant changes to regulations and the communication of other important notices/information etc, there is no structured system in place whereby other relevant stakeholders are informed of issues similar to the pyrite problem.

All of the parties involved in the pyrite issue, including the construction, quarrying, insurance and professional representative bodies, should look at developing a more effective process for addressing any similar situations in the future. The Panel suggests that the Department of the Environment, Community and Local Government should establish, in conjunction with the professional bodies in the construction sector, a more effective system of urgently disseminating information of relevance to the construction sector.

### **Recommendation 24: Dissemination of important information**

The Panel recommends that:

- (a) a more effective and efficient method of dissemination of information should be established to ensure that information reaches relevant people in a timely manner and that the Department of the Environment, Community and Local Government should take the lead in setting up this system. Consideration should be given to the use of a centralised web-based alert system with a suitable feedback loop with information readily and publicly available via the internet,
- (b) the National Standards Authority of Ireland (NSAI) should provide a single, publicly accessible information point with up-to-date information on standards immediately and readily available to all involved in the construction industry,
- (c) professional bodies should take responsibility for ensuring that their members receive information in a timely manner.

### **8.17 Concluding comments**

The Panel recognises the significant hardship imposed on homeowners affected by pyrite heave and by having reactive pyrite in the hardcore of their houses. This should not have happened in the first place but, after it had happened, the various stakeholders were far too slow in addressing the legitimate concerns of the homeowners. They often appeared to be more concerned about defending possible claims against them rather than in remediating the affected dwellings. Nobody wished to take overall responsibility for solving the problem.

This report contains a comprehensive set of recommendations and the Panel commends the implementation of the recommendations in their totality. The recommendations deal with a complex issue involving a range of stakeholders. The successful implementation of the recommendation will require one body, possibly the Department of the Environment, Community and Local Government, to have responsibility for monitoring, co-ordinating and managing the successful implementation of the report's recommendations in a timely manner. But, the whole of government support and engagement is absolutely critical for the successful implementation of the recommendations of this report - see the Implementation Plan at Appendix 17. The implementation process needs to be focussed on achieving positive outcomes for homeowners quickly and effectively and systems need to be put in place to monitor and report publicly on progress.

This report contains some recommendations which are designed to ensure that the risks of similar problems occurring in the future are minimised. Systems should be developed which deal with problems in a manner that addresses the homeowners' concerns ensuring that they are addressed rapidly and comprehensively, preferably without having to resort to litigation. Such systems should be regularly reviewed by the Minister for Environment, Community and Local Government and modified, where necessary, so that what has happened in the case of pyrite can never happen again.



# Appendices



## Appendix 1: List of individuals/groups who met with the Pyrite Panel

1	Menolly Homes
2	Ballymun Regeneration Limited
3	National Roads Authority
4	Construction Industry Federation
5	Pyrite Action Group
6	HomeBond
7	National Asset Management Agency
8	Irish Concrete Federation
9	Irish Insurance Federation
10	Fingal County Council
11	National Concrete Producers Association
12	Kildare County Council
13	Royal Institute of Architects Ireland
14	Irish Banking Federation
15	Society of Chartered Surveyors of Ireland
16	Golders Associates Ltd
17	Geological Survey of Ireland
18	Kavanagh Mansfield Partners
19	James Elliot Construction
20	Keegan Quarries
21	Aidan O'Connell Associates
22	Kilsaran Concrete
23	Department of Education and Skills
24	Arup
25	Mc Garrell Reilly Builders and Pierce Sutton of O'Connor Sutton Cronin
26	Roadstone Wood
27	Liberty Syndicates
28	Engineers Ireland
29	Department of the Environment, Community and Local Government
30	Irish Building Control Institute
31	PJ Edwards/Earth Science
32	Brian Hawkins
33	County and City Managers' Association
34	Heather Lennon on behalf of Irish Asphalt
35	SLR Consulting
36	National Standards Authority of Ireland
37	Meath County Council
38	Dublin City Council
39	Association of Consulting Engineers Ireland
40	QBE Insurance
41	Geotechnical Branch of Engineers Ireland
42	Liberty Mutual Insurance
43	TDs
44	PO Keenan

<b>Table A2.1</b>	<b>List of Groups who declined invitations to meet with Pyrite Panel</b>
	Ace Ireland
	AIG
	Alianz Insurance
	Murphy Concrete
	Law Society
	Zurich Insurance

\* In the case of two organisations who were invited to meet with the Panel, relevant matters were dealt by phone and e-mail.

Other problems associated with sulfides such as pyrite have occurred around the world and are described below for information and clarification.

### Sulfate attack (United Kingdom)

Between the 1940s (when the use of hardcore and concrete ground floor slabs became common) and the 1960s (when it became common to use a damp proof membrane (DPM)<sup>106</sup> below the concrete floor slab), the UK experienced several issues with sulfate attack of concrete floor slabs. The problem was predominantly due to waste materials from coal mining, heavy industries, iron and steel production, incineration etc., being used as hardcore. The legacy has been a continuing occurrence of damage to floor slabs and abutting walls as sulfate from the hardcore has attacked the overlying concrete. In the past, this was not seen as a major concern for Ireland as the offending materials were not widely available. Typical modern construction detailing now separates hardcore from concrete with insulation and radon or damp proof membranes, thus reducing the likelihood of the problem in new buildings.

### The Mundic Problem (Devon and Cornwall)

There is a legacy issue in Cornwall and Devon which involves pyrite. It is known as the “Mundic” problem. In essence, two types of rocks were used as aggregate for making concrete products which subsequently were used in the construction of houses between 1900-1950. The first rock type is common in tin and copper mining waste material and contains pyrite which will cause concrete degradation over time when exposed to air and moisture. The second rock type is a fine grained sedimentary rock containing clay minerals and micas. These expand and contract as the moisture content varies, gradually weakening the concrete. The deterioration of such aggregates within concrete products undermines the structural integrity of the property as load-bearing and non-load-bearing walls weaken.

### Pyrrhotite (Quebec)

In the last decade, approximately 400-600 houses in Quebec have been damaged due to failure of structural concrete (mostly in foundations) in residential buildings resulting from oxidation of the mineral pyrrhotite contained in the aggregate used in the concrete.

**Note:** Concrete standards in Ireland. The harmonised European Product Standard, *I.S. EN12620:2002+A1:2008 Aggregates for concrete* was adopted, in Ireland, in 2003. This standard along with the national guidance, *Standard Recommendation (SR 16) Guidance on the use of I.S. EN 12620:2002 – Aggregates for concrete*, sets out the aggregate suitable for use in concrete, in Ireland. Aggregates such as those mentioned above would not be suitable for use in concrete in Ireland.

106 Damp Proof Membrane (DPM) is an impervious membrane layer placed below a solid floor designed to resist moisture rising through the structure by capillary action.

### Ground heave (United Kingdom, Quebec and Kentucky)

Buildings have been damaged due to ground heave where the natural bedrock (with high concentrations of pyrite) was exposed, the pyrite oxidised and the associated expansion caused cracking and uplift of floors etc.

In the UK, buildings constructed where shales formed the natural bedrock have experienced ground heave. The Llandough Hospital in Cardiff is an example of this, where part of the building was damaged as it was built in a deep excavation of a weak bedrock (shale) outcrop. For further information, refer to "*Sulphate Generated Heave Resulting From Pyrite Degradation*".<sup>107</sup> Ground heave is also reported to have occurred in Glasgow.

In Canada, the Bell Canada building and the Rideau Health Centre building, in Ottawa, were both founded on fresh mudrock and consequently suffered damage due to ground heave.

Ground heave has also caused damage in the state of Kentucky in the United States of America where buildings have been founded on newly exposed black shale. For further information [www.uky.edu/kgs](http://www.uky.edu/kgs)

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107 Hawkins, A. B & Pinches G.M. (1997), *Sulphate Generated Heave Resulting From Pyrite Degradation*, in Hawkins, A. B (Ed.) *Ground Chemistry Implications for Construction*, A. A. Balkema, Rotterdam.

## Appendix 4: Table A4.1 Geological formations with known presence of pyrite

<b>Table A4.1. Geological formations with known presence of pyrite. Lithologies that are Pyritiferous</b>		
<b>Formation name</b>	<b>Primary Lithology</b>	<b>Total area (km<sup>2</sup>)</b>
Lucan Formation	Limestone	1,534
Ballysteen Formation	Limestone	922
Ballyhoge Formation	Slate	275
Loughshinny Formation	Limestone, Shale	183
Dergvone Shale Formation	Shale	176
Coolbaun Formation	Shale, Sandstone	165
in Waulsortian Limestones	Dolomite	165
Clare Shale Formation	Shale	163
Oghill Formation	Sandstone, Conglomerate	149
Visean Limestones (undifferentiated)	Limestone	146
Derravaragh Cherts	Chert	140
Finnalaghta Formation	Greywacke	129
Boyle Sandstone Formation	Sandstone, Mudstone	115
Tober Colleen Formation	Shale	98
Ballynash Member	Limestone	91
Ballymore Limestone Formation	Limestone, Shale	84
Gowlaun Shale Formation	Shale	75
Mullaghmore Sandstone Formation	Sandstone, Siltstone, Flagstone	58
Carrickateane Formation	Greywacke	49
Denhamstown Formation	Greywacke	49
White Strand Formation		37
Ards Pelite Formation	Schist	36
Murvey Granite	Microgranite	29
Lower Limestone Shale	Siltstone, Mudstone, Limestone	26
Avoca Formation	Rhyolite, Slate	24
Ballymartin Formation	Limestone, Shale	23
Kebernaghkilly Formation	Shale	22
Carrickatee Formation	Shale	21
Lakes Marble Formation	Marble, Grit, Amphibolite, Basic metavolcanics	17
Crossdoney Granite	Granodiorite	14
Reenydonagan Formation	Mudstone	14
Meath Formation	Limestone	14
Lispatrick Formation		13
Cornamona Marble Formation	Pelite, Semi-pelitic schist, Marble	11
Laragh Formation	Shale	10
Tawnyinagh Formation	Tuff	8
Glen Lodge Formation	Shale	7
Tramore Shale Formation	Shale	7
Dunabrattin Formation	Shale, Siltstone, Sandstone	7
Aghamore Formation	Basalt, Conglomerate	7
Finlough Formation	Limestone	4
Ballymalone Formation	Shale, Chert	3
Greyfield Formation	Breccia, Conglomerate, Shale, Limestone	3
Toberelatan Formation	Shale, Siltstone, Sandstone	2
Parsonage & Corrig Lodge Formation	Limestone	2
Carrighalia Formation	Mudstone	2

<b>Table A5.1. Geological formations with potential presence of pyrite Lithologies that are potentially Pyritiferous</b>		
<b>Formation name</b>	<b>Primary Lithology</b>	<b>Total area (km<sup>2</sup>)</b>
Lucan Formation	Limestone	2,268
Ballysteen Formation	Limestone	2,111
Calp	Limestone, Shale	422
Boston Hill Formation	Limestone	186
Boyle Sandstone Formation	Sandstone, Mudstone	173
Ballymartin Formation	Limestone, Shale	77
Butlersgrove Formation	Limestone	64
Ballymore Limestone Formation	Limestone, Shale	62
Boyne Formation	Limestone	8

Construction House,  
Canal Road,  
Dublin 6.



Tel: 1850 306300  
Fax: (01) 496 6548

Email: [info@HomeBond.ie](mailto:info@HomeBond.ie)  
Website: [www.HomeBond.ie](http://www.HomeBond.ie)

June 2007

Dear Sir(s)

HomeBond has encountered a number of incidences where hardcore/aggregate material is not suitable for its use in that it contained material which was liable to expansion.

As a result, HomeBond has prepared the attached Circular concerning Hardcore Backfill.

Please ensure that a copy is given to your supplier of hardcore backfill as it is vital that you are supplied with appropriate material suitable for its use.

Yours faithfully

**Managing Director**

Directors: F. Fahy (Chairman), J. Tieran (President), E. Farrell, B.E., M.Eng.Sc., M.Sc.Mgmt.,  
Ph.D., Dip. Arb., MCI Arb., C.Eng., F.I.E.I. (Managing Director & Secretary), M. Browne, F.C.A., (Treasurer),  
P. Raggelt (Vice - Chairman), M.J. Coleman, E. Gardley, M. Gosno, B.L., B.Comm., M.Econ. Sc.,  
S. McKeon, N.M. Mooney, B.E., Eur Ing., C.Eng., F.I.E.I., S. Neville, F. Rhatigan.



National House Building Guarantee  
Company Limited Registered Office  
Construction House, Canal Road, Dublin 6  
Registered in Dublin No. 61063

International Tel. No. 353 1 491 0210

**TO BE TYPED ON THE HEADED PAPER OF  
HOMEBOND MEMBERS AND SENT TO SUPPLIERS OF  
STONEFILL AND AGGREGATES**

**Supply of Stonefill and Aggregates**

Dear Sirs

As you are aware, clean, well graded, non reactive crushed stone is required to be used for backfill under concrete floors, paths, roads or driveways and for all other purposes on our sites. We are advised that inappropriate material can be liable to expansion in certain circumstances thereby rendering the material unsuitable for the purpose intended.

We write to advise you that we expect, and have always expected, that you, as the manufacturer or supplier of stone fill to us, arrange for appropriate tests to be undertaken by an independent laboratory experienced in the examination of both rocks and aggregates to confirm that material supplied by you is not liable to expansion. All stone supplied by you must be suitable for its intended use as backfill under concrete floors, paths, driveways or elsewhere in construction of dwelling units and associated works and not liable to expansion. Similarly, all other aggregates supplied must be suitable for their intended use.

We look forward to continuing to do business with you in the future.

Yours faithfully



### Fingal County Council Notice

To:

- All developers, designers and/or private individuals who submitted commencement notices to Fingal County Council from the 1<sup>st</sup> June 2007.
- The suspected quarry,
- The Construction Industry Federation,
- Homebond, and
- The Department of the Environment, Community and Local Government (DECLG)

26th July 2007

It has come to our attention the problem of pyrites in hardcore in foundations in certain housing developments in Fingal. While it appears that this pyrite emanated from one particular quarry it may be that it is prevalent in other quarries in the area. Fingal County Council Building Control Section has issued the notice below and I would be grateful if you could circulate this to all your members and any other relevant agencies you may know of.

Notice issued

“Specifiers of building and builders are required under Building Control Acts 1990/2007 to make sure that materials used in the construction of a building should be of a suitable nature and quality in relation to the purpose and conditions of their use. It has recently come to our notice that hardcore material containing certain concentrations of the metal pyrites used in house construction expands when well compacted within confined areas under certain conditions. Best building practice now requires that all hardcore materials requiring high compaction within confined areas should be chemically analysed to check if such materials contain any chemicals or metals that may render this material unsuitable for the purpose intended.”

Yours sincerely,

---

Senior Engineer, Building Control, Fingal County Council.

## Appendix 8: Circular Letter: BC 6/2007 (issued by the Department of the Environment, Community and Local Government)

16<sup>th</sup> August 2007.

Circular Letter: BC 6/2007.

Re : Underfloor Hardcore Filling

A Chara,

I am directed by the Minister for the Environment, Heritage and Local Government to say that the attention of the Department has been drawn to certain defects, which have arisen in a private housing development where the underfloor hardcore filling used contained the mineral "pyrite".

Pyrite is a commonly occurring mineral in rock. In certain conditions, oxidation of pyrite and further chemical reaction between the oxidation products and other components of underfloor filling can occur, leading to a volume increase, causing the floor slabs to lift and crack, and with a knock-on effect of distorting walls etc. For this reason, pyritic rock should not be used as hardcore filling under ground bearing concrete floors.

In the light of these developments, Authorities are reminded of the existing requirements under the Building Regulations and the EU Construction Products Directive (89/106/EEC).

### **Building Regulations.**

The national Building Regulations set out the legal requirements for the construction of new buildings (including houses), extensions to and material alterations of existing buildings and certain material changes of use of existing buildings. The related Technical Guidance Documents (TGDs) provide technical guidance on how to comply with the Regulations. The following paragraphs highlight general and specific requirements under the Building Regulations in relation to hardcore filling.

### **Part C/TGD-C (Site Preparation and Resistance to Moisture)**

Part C /TGD-C set out the legal requirements/ technical guidance for Site Preparation and Resistance to Moisture. Part C 3 stipulates that *"the floors, walls and roof of a building shall be so designed and constructed as to prevent the passage of moisture to the inside of the building or damage to the fabric of the building"*.

**Subsection 3.1.4(a) (b) (Ground Supported Floors) of TGD-C** requires that *"The hardcore bed should be at least 150mm thick and should be of broken stones, broken brick or similar suitable material well compacted and clean and free from matter liable to cause damage to the concrete"*

Part D/TGD-D (Materials and Workmanship)

Part D and TGD-D of the Building Regulations set the legal requirements/ technical guidance for Materials and Workmanship. Part D 1 requires that *"All works to which these Regulations apply shall be carried out with proper materials and in a workmanlike manner"*.

Part D 3 defines “*Proper Materials*” as “*materials which are fit for the use for which they are intended and for the conditions in which they are to be used*”.

**Construction Products**

Under the European Communities (Construction Products) Regulations, 1992 (S.I. No. 198 of 1992), as amended by the European Communities (Construction Products)(Amendment) Regulations, 1994 (S.I. No. 210 of 1994), a “*product*” is defined as “*any construction product to which these Regulations apply which is produced for incorporation in a permanent manner in works*”.

The Regulations require that “*a person shall not place a product, other than a minor product, on the market unless it has such characteristics that the works in which it is to be incorporated, assembled, applied or installed can, if properly designed and built, satisfy the essential requirements when, where and to the extent that such works are subject to regulations containing such requirements*”. In the case of hardcore filling, the relevant Regulations are those highlighted above in the paragraphs under Building Regulations. The Building Control Officers in each Local Authority have been appointed as the Authorised Officers for the purposes of implementation of these Regulations. The Regulations set out the procedures to be followed.

Where an authorised officer is of the opinion that a person is placing a product that does not comply with the above requirements, the authorised officer can request all the information (s)he may require for the purposes of establishing whether the product satisfies the foregoing requirements.

Your co-operation in the enforcement of the relevant requirements outlined above is requested. In this regard, I enclose for your information a copy of a Notice issued by Fingal County Council, through the construction industry representative groups, arising from the problem of pyrites in hardcore in foundations in certain housing developments in that County.

Mise le meas,

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**Principal Officer,  
Building Standards/Environmental Assessment Section.**

To: City and County Managers, Building Control Officers

In the 1970s and 80s, isolated incidents of heave in buildings were reported in the Ottawa and Montreal regions of Quebec. In 1997, the Montreal section of the Association of Engineering Geologists held a scientific conference on the subject. In autumn 1998, the media highlighted the problem. It was only then that the true extent of the problem began to unfold.

Following the media reports, over 1,000 people notified the Consumer Agency that specialises in Construction, *Association des consommateurs pour la qualité dans la construction* (ACQC)<sup>108</sup> that their houses seemed to show symptoms of pyritic heave e.g. rising of the floor slab and interior partitions resting on it.

In Canada, the damage was identified as being caused by one or more of three problems;

- swelling of backfill containing pyrite (traces of it were found in the sedimentary rock used to make crushed stone for backfill),
- sulfate attack on the concrete slabs (commonly no Damp Proof Membrane<sup>109</sup> (DPM) was used) and /or
- swelling of subsoil (causing foundations to heave).

In terms of location, the entire Saint-Laurence River valley was considered the risk zone, and, in particular, around the city of Montreal.

While damage was reported in buildings less than 5 years old and more than 30 years old, most cases occurred in buildings between 8 and 20 years old. In general, damage attributable to pyrite, in Canada, did not usually appear for 10 years or more after construction.

In Quebec, there were very few problems in buildings constructed before 1970 as the layer of backfill under the basement slabs of residential buildings constructed before then was either non-existent or quite thin. The early 1980s saw an expansion in the construction of new residential units which peaked at nearly 75,000 in 1987. There was a proportionally higher number of “pyritic houses” dating from that period. By 1999, the problem had been identified and controls put in place to enable buyers to avoid backfill containing excessive amounts of reactive pyrite. In terms of the scale of the problem, approximately 2,600 dwellings (built pre 1999) were remediated between 2000 and 2011 in the Quebec region.

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108 ACQC was founded in 1994 in Quebec by consumers who had serious problems with construction contractors. It is a non-profit organization..

109 Damp proof membrane is a membrane layer placed below a solid floor designed to resist moisture rising through the structure by capillary action.

## Appendix 10: Building Regulations – 12 Parts

<b>PART</b>	<b>TITLE</b>
Part A	Structure
Part B	Fire Safety
Part C	Site Preparation and Resistance to Moisture
Part D	Materials and Workmanship
Part E	Sound
Part F	Ventilation
Part G	Hygiene
Part H	Drainage and Waste Water Disposal
Part J	Heat Producing Appliances
Part K	Stairways Ladders Ramps and Guards
Part L	Conservation of Fuel and Energy - Dwellings Conservation of Fuel and Energy - Building other than Dwellings
Part M	Access and Use

## Appendix 11: Notice added to Fingal County Council's Commencement Notice form from July 2007

Fingal County Council -

Notice, To mitigate against future degradation of building elements and prevent risk to health and safety, details of site conditions and hardcore material may be requested/ checked as part of a building control inspection, therefore it is recommended that.

The developer shall satisfy himself of the suitability of the ground conditions for the purpose of supporting the development, by carrying out necessary site investigations including chemical analysis of soils to ensure that there are no harmful contaminants or hazards, which could cause deterioration of any element of the development.

Hardcore materials used in backfill, excavations, floors, road bases etc should be certified by a competent laboratory that they are of a suitable nature and quality in relation to the purpose and conditions of their use. They should be chemically analysed to check if such materials contain any chemicals, which should also include the petrographic indicator of swelling potential.

### A) Construction Products Directive (89/106/EEC – CPD)

The European Communities' Construction Products Directive (CPD) 89/106/EEC was adopted to address the problem of technical barriers to international trade caused by varying national standards in the construction sector. In this regard it makes provision for the following framework:

- A system of harmonised technical specifications,
- An agreed system of Attestation of Conformity for each product family, and
- A framework of Notified Bodies.

The harmonised technical specifications for construction products, cover the methods of testing, the method of declaring product performance values and the method of conformity assessment. Construction products complying with technical specifications within the scope of the Construction Product Directive (CPD) can bear the “CE Marking”.

“CE Marking” is a “passport” for construction products that allows them to be legally placed on the market in any Member State. It is not a quality mark – it simply shows that the regulatory provisions have been met, for example the product has been tested in conformance with the technical specification, and the results from these tests (good or bad) are declared.

“CE Marking” is not deemed to be mandatory for construction products, in Ireland, in relation to the CPD.

Member States are free to set their own requirements on the performance of building works, construction products and the required values for intended uses. However, Member States cannot impose additional testing requirements on a product covered by the harmonised technical specifications. Therefore, when a product is used, for example, in a building, the declared values must be analysed by the end-user (designer, contractor, et al) to ensure fitness for use, for particular applications and for conditions of use in compliance with Part D of the Buildings Regulations where applicable.

Ireland's European Communities (Construction Products) Regulations 1992 (S.I. No. 198 of 1992) and European Communities (Construction Products) Regulations 1994 (S.I. No. 210 of 1994) implemented the CPD in Ireland. Under this legislation a “product” is defined as “any construction product to which these Regulations apply which is produced for incorporation in a permanent manner in works”.

The Regulations require that “a person shall not place a product, other than a minor product, on the market unless it has such characteristics that the works in which it is to be incorporated, assembled, applied or installed can, if properly designed and built, satisfy the essential requirements when, where and to the extent that such works are subject to regulations containing such requirements”.

Building control authorities are the principal enforcement agencies for these Regulations. In general, building control officers have been appointed as the authorised officers under these Regulations by the local building control authority. The Regulations set out the specific powers of an authorised officer. However, in brief, where an authorised officer is of the

opinion that a product (covered by this Regulation) is placed on the market in contravention of the Regulation, s/he has the following powers;

- to access, examine, test, inspect, seek documentation /information etc about products to establish if the product complies,
- to seek a warrant, from the courts, to enter and search a premises,
- to request the Minister<sup>110</sup> to prohibit (or apply conditions to) a product being placed on the market, and
- to prosecute for an offence.

These Regulations came into effect on 1<sup>st</sup> January, 1993. However, existing national provisions continue to apply where European technical specifications are not available. In such cases, products may be placed on the market in accordance with these national provisions.

The Construction Products Regulation (305/2011/EU - CPR) was adopted on 9 March 2011 and repeals the Construction Products Directive (89/106/EEC – CPD).

### **B) Construction Products Regulation (305/2011/EU - CPR)**

The aim of the Construction Products Regulation (305/2011/EU - CPR) is to ensure the availability of reliable information on construction products in relation to their performances.

While using much of the existing framework of the CPD, the CPR's new provisions are tailored

- to clarify the meaning of CE Marking,
- simplify procedures,
- reduce the cost burden for small and medium sized businesses, and
- increase the credibility for the whole system.

The CPR, for the most part, will come into force on 1<sup>st</sup> July 2013. The key element of the CPR is the requirement for construction products, when placed on the market in the EU, and covered by a harmonised standard, to be accompanied by a Declaration of Performance (DoP) and to carry a CE marking. This effectively makes CE Marking for construction products mandatory in Ireland for the first time.

As with the CPD, the common technical language in harmonised technical specifications is intended, under the CPR, to be applied by:

- the manufacturers when declaring the performance of their products,
- the authorities of Member States when specifying requirements for them,
- their users (architects, engineers, constructors...) when choosing the products most suitable for their intended use in construction works.

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110 Minister for the Environment, Community and Local Government



The National House Building Guarantee Company Ltd. (NHBGC) was set up under the Companies Act 1963 and was registered on 22 December 1977. The Memorandum of Association of the company sets out the purpose for which it was set up:

*“to promote good building practices in Ireland and elsewhere” and “to found and administer a scheme for guaranteeing purchasers against defects in dwellings built, completed or sold or arranged to be sold by members of the scheme by way of compensation for or making good of such defects and accordingly to issue guarantee certificates to purchasers of such dwellings”*

It was established by the Construction Industry in consultation with the Department of the Environment, Community and Local Government to provide a structural guarantee scheme for purchasers of dwellings registered by Members (developer or builder) under a Warranty Scheme. Purchasers of new dwellings could make a claim under the Warranty Scheme, subject to the terms and conditions of the Agreement relevant to each dwelling covered, including exclusions from, and limits of liability, if major defects (as defined) appeared in their dwellings within a set period after purchase, which the builder did not fix. It was not an insurance product and the terms of the scheme placed the obligation, in the first instance, on the builder to remedy major defects covered by the agreement and it was only if the builder did not deal with a complaint that HomeBond got involved.

The Memorandum of Association for National House Building Guarantee Company makes provision for it to:

- to receive, apply and collect grants, gifts, donations, subscriptions, fees and funds for the furtherance of the objects of the company;
- to invest the moneys of the company not immediately required for its purposes in or upon such investments, securities or property as the company may think fit.

Department of the Environment Inspectors carried out inspections for structural guarantee purposes, as agents for the NHBGC, outside Dublin City and County on a *fee* basis up to December 2004. After that date HomeBond managed its own inspection system.

The NHBGC is self-financing from fees charged to registered house builder members and for the registration of individual new dwellings.

HomeBond has two categories of membership:

- (a) Builder member: this category is for individuals or companies who are building dwellings either directly for clients or to sell themselves;
- (b) Developer member: this category is for individuals or companies who are involved in promoting building but engage member builders to undertake the construction.

The HomeBond Warranty Agreement provides cover for the following:

- Cover for 10 years in respect of the repair of major structural defect;
- Cover for 2 years in respect of remedial work in the event of water ingress / smoke penetration caused by major structural defects for dwellings registered prior to 2004 and for 5 years for dwellings registered after 2004;
- Deposits and Stage Payments Cover for the loss of money.

“Major Defect”, in the case of a Dwelling (not an apartment) is defined as:

*(a) A major defect*

- *in the foundation of a Dwelling or*
- *in the load bearing parts of its floors, walls and roof or*
- *in any retaining walls necessary for the Dwelling’s support*

*which defects affects the structural stability of the Dwelling;*

*(b) any major defect in the Dwelling directly resulting in smoke penetration from a chimney breast into the habitable areas of the dwelling; or*

*(c) any major defect in the Dwelling directly resulting in water penetration through the main structural elements, flashing or roof valleys of the dwelling.*

“Major Defect”, in the case of an Apartment, means

*(a) A major defect*

- *in the foundation of the building in which the Apartment is situated or*
- *in the load bearing parts of its floors, walls and roof of the building in which the Apartment is situated or*
- *in any retaining walls necessary for support of the building in which the Apartment is situated*

*which defects affects the structural stability of the building in which the Apartment is situated;*

*(b) any major defect in the building in which the Apartment is situated directly resulting in smoke penetration from a chimney breast into the habitable areas of the Apartment; or*

*(c) any major defect in the building in which the Apartment is situated directly resulting in water penetration through the main structural elements, flashing or roof valleys of the said building.”*

Under Section 3.6 “Exclusions from/Limitations to Liability – Major Defects” the HomeBond Agreement provides for a number of exclusions including the following:

- any defect which is the result of negligence on the part of someone other than the member or his sub-contractor;
- any defect which is covered by insurance, or in relation to which legislation provides for compensation;

- minor structural defects;
- hair cracks, shrinkage, expansion, dampness caused by normal drying out of the dwelling or condensation;
- any defect in central heating.

The Warranty Agreement also provides for general limits on HomeBond's liability. The amount available to each claimant depends on the cost of the repairs, the level of cover applicable to the particular dwelling as specified in the Warranty Agreement and the claims made, or anticipated claims, against the Member.

The terms and conditions of the cover also specify that funds may be held back for future claims on other dwellings registered by that Member.

The level of cover applicable is dependent on the date of registration of the dwelling:

- For dwellings registered before 1 October 2004, the limit of cover for Major Defects is €38,000 per dwelling, subject to a cap of €508,000 per Member.
- For dwellings registered after 1 October 2004, the limit of cover for Major Defects is €200,000 per dwelling, subject to a cap of €2,000,000 per Member.

The 2010 accounts for the National House Building Guarantee Company indicate reserves of €21m approximately with provision for future claims of €17m

Since November 2008 the HomeBond Warranty Scheme does not accept any new registration of dwellings. HomeBond Insurance, was set up in June 2008 and its principal activity is as an insurance intermediary and is underwritten by Allianz covering dwellings registered after that time.

The remit of HomeBond Insurance includes:

- to carry on the business (whether in Ireland or elsewhere in the EU) of an authorised insurance intermediary (including acting as an insurance agent...)

HomeBond Insurance qualifies as a small company and only submits an Abridged Balance Sheet; this has very limited financial information.

HomeBond Insurance provides structural defect insurance with deposit and stage payment cover for new homes. Once the Final Certification issues, HomeBond Insurance provide financial cover for relevant structural and other defects, should they arise within the liability period.

HomeBond Insurances Services and HomeBond Technical Services were set up in 2008 and HomeBond Group Services in 2010.

The remit of HomeBond Group Services Ltd includes:

- promote a scheme or schemes of insurance (to be underwritten by an authorised insurance undertaking) to cover purchasers against defects.....
- carry on the business of a holding company and to acquire the issued capital in HomeBond Technical Services Ltd and Homebond Insurance Services Ltd.

31 August 2011

**Re: Above dwelling. Claim ref:  
Member/Builder:**

Construction House,  
Canal Road,  
Dublin 6.



Tel: 1850 306300  
Fax: (01) 496 6548

Email: [info@HomeBond.ie](mailto:info@HomeBond.ie)  
Website: [www.HomeBond.ie](http://www.HomeBond.ie)

Our previous correspondence and communications refer.

We wish to advise you that we have examined HomeBond's liability under the terms and conditions of the HomeBond Agreement for damage arising from heave of the concrete ground floor in the above dwelling, taking into consideration legal opinion, expert technical advice and the decision of Mr Justice Charleton delivered 25 May 2011 ("the Decision") in the case James Elliott Construction Limited ("Elliott Construction") .v. Irish Asphalt Limited ("Irish Asphalt") High Court Record No. 4767P/2008 ("the Case").

The Case considered the supply of certain stonefill material pursuant to a contract between Elliott Construction and Irish Asphalt ("**the Contract Material**"), used as 'hardcore' infill beneath a concrete floor slab in a building in Dublin, where damage to the building had occurred due to the oxidation of pyrite in the hardcore infill. The reasoning behind the Decision was based on breach of contract by Irish Asphalt in supplying material which did not meet the specification for the Contract Material and which breached terms implied into the contract under the Sale of Goods Act 1984. The following extract is taken from paragraph [270] of the Decision:

*"The material supplied by Irish Asphalt to Elliott Construction was not of merchantable quality. Therefore, there was a breach of contract. In addition, the implied condition as to fitness for purpose was an obligation by Irish Asphalt to Elliott Construction under the contract. The material was not fit for purpose".*

The Decision refers to the following:

- (1) that "Building materials are purchased by builders on the basis that they are reasonably sound and reasonably durable" and that "Inertness, durability and strength are relevant to implied terms as to merchantability and fitness for purpose".
- (2) that "it is reasonable, in this context, for a quarry to test what it is proposing to sell to multiple users. This checking is not unreasonable at all given the potential of the infill to wreck roads and buildings if it swells.....".
- (3) that "it would be unreasonable for the purchaser to start testing quarried stone which was sold pursuant to a specification as being [the Contract material]. Any testing requirement would reasonably, in that regard, fall on the quarry".

Directors: F. Rhatigan (Chairman), J. Tiernan (President), M. Browne, F.C.A., (Treasurer),  
N.M. Mooney, B.E., Eur Ing., C.Eng., F.I.E.I., (Vice-Chairman), M. Cosgrave, F. Fahy, E. Gantley, J. Kennedy, CPA,  
S. McCarthy, S. McKeon, S. Neville, C. Taaffe, B.E., M.Eng.Sc., Dip. Public Admin., Dip. Legal Studies, BL, (Managing Director & Secretary).



National House Building Guarantee  
Company Limited Registered Office:  
Construction House, Canal Road, Dublin 6.  
Registered in Dublin No. 61063

- (4) that *“it was not reasonable for Elliott Construction, as the purchaser of material, to carry out a suite of tests on the material, costing somewhere in the region of €4,000, on a lorry load of hardcore costing somewhere in the region of €190”*.
- (5) that *“any builder would have expected that it would fulfil the purpose of holding up a floor slab and, even more so, that it would not expand and ruin a carefully constructed building. In the terms of the difference in bargaining powers and knowledge between the parties, the party to the sale of contract which is producing the material in volume has clearly the greater responsibility to enquire”*.
- (6) that the Contract Material was *“not inert if it changes in volume and shape and randomly causes heave contrary to the purpose for which it was so obviously used in relation to this building project.”*

It is the view of HomeBond that the statements outlined at (1) to (6) above are also equally applicable to the supply of the hardcore material used as infill under concrete floor slabs in the construction of dwellings. We are of the firm belief that the potential problems with the use of hardcore infill which was not sound, not durable or not inert should have been identified by the quarry supplier of the material used in your dwelling by performing a suite of standard tests.

In our view, the quarry supplier has breached a duty of care owed to both the Member/Builder and to you and has negligently supplied hardcore infill to the Member/Builder which was not of merchantable quality or fit for purpose, which has resulted in damage to your dwelling. Furthermore, it should be noted that the Liability for Defective Products Act, 1991 provides a strict liability remedy so that a producer is made liable for damage caused wholly or partly by a defect in his product, regardless of whether or not he was negligent. It is also our view that the quarry supplier of the under-floor infill material for your dwelling falls within the ambit of this legislation.

We wish to bring to your attention the following exclusions in Section 3.6 of the HomeBond Agreement relevant to your dwelling:

- *any defect which is the result of negligence on the part of someone other than the Member or his sub-contractor;*
- *any defect ..... in relation to which legislation provides for compensation;*

We confirm that as:

- (a) the quarry supplier of the hardcore infill acted negligently in our view in supplying material that was not of merchantable quality and fit for purpose; and
- (b) supplied a defective product in circumstances where legislation provides for compensation;

HomeBond's liability for Major Defects is specifically excluded. Accordingly, HomeBond does not propose to take any further action in this case.

Please note that any prior representation by any agent or employee of HomeBond, whether oral or written or whether in express or implied terms, to accept liability or to carry out testing or remedial works or to pay a monetary sum in relation to your dwelling, is hereby withdrawn. HomeBond relies, and will continue to rely, on the full terms and conditions of the HomeBond Agreement.

Yours faithfully

**HomeBond**

## Appendix 15: Financial Assistance Scheme (Canada)

In the spring 2000, the Quebec government announced its intention to offer, over a period of ten years, financial assistance to homeowners where houses were damaged by the oxidation of pyrite. The program ran between October 2001 and October 2011. The last applications must have been made by October 2011. This program provided financial assistance for the owners of residential buildings to cover the cost of replacing the floor slabs and underlying fill in a damaged building with new pyrite-free materials (garage floor slabs are excluded). The building permit must have been issued before April 15, 1999.

Between 2000-2011, grant aids were provided to 2,584 individual dwellings to carry out remediation work. The works in total cost approximately CAN\$50million and the grants paid out totalled CAN\$20million.

The grant only applied to owners of residential buildings in which at least one dwelling is or has been used as a principal residence. The Société d'habitation du Québec managed the program but entrusted its application to the municipalities that signed management agreements.

- The Québec government provided at least 62.5% of the financial assistance granted.
- The Canadian government contributed 25%.
- The participating municipalities provided up to 12.5%.

The financial assistance varied according to the type of building and the municipality's level of participation in the program. For single-family dwellings, the maximum grant was \$18,000 and, for multiple family dwellings, the maximum grant was \$45,000.

Certain other factors also affected the total cost of the eligible work. The owner may have been entitled to receive a subsidy equal to the amount paid by the governments of Québec and Canada where the municipality did not contribute to the program.

The application process was divided into six steps:

**Step 1** - Check the participating municipalities list of this program.

**Step 2** - An accredited municipal inspector will visit the home to see whether or not the damage qualifies for the program.

**Step 3** – the home owner must then, at their own expense, obtain an analysis report from a laboratory with pyrite-related expertise. The report must conclude that the damage to the home has been caused by pyrite oxidation.

**Step 4** - Using the specifications drawn up by the municipal inspector, the home owner must obtain two standard bids from contractors holding appropriate licenses, along with the required warranty plan, and send them to the municipality.

**Step 5** - The municipality will complete the file and, if everything is in order, will issue an eligibility certificate indicating the amount of assistance to which the home owner is entitled and authorising the home owner to begin work.

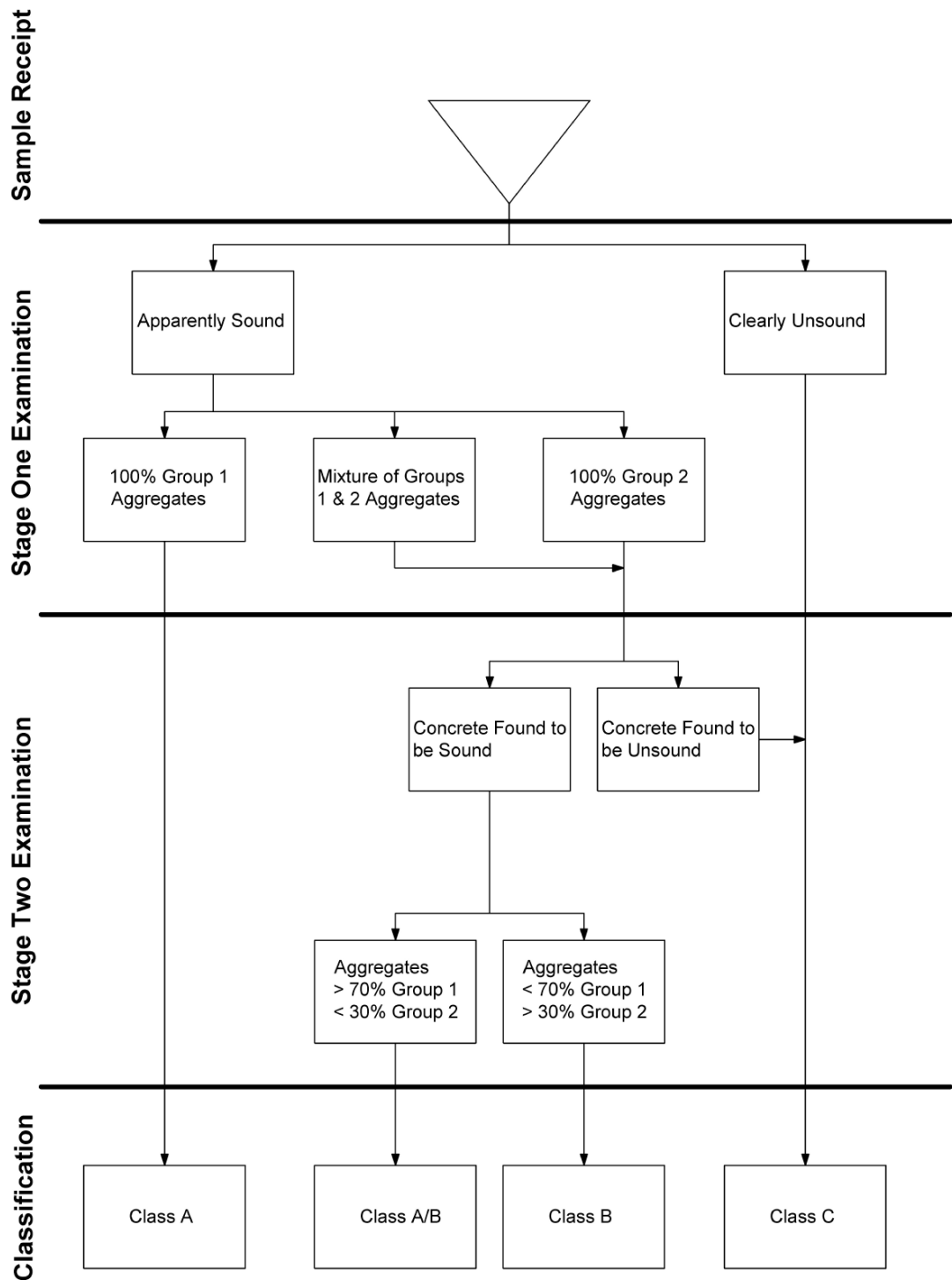
**Step 6** - When the work is complete, an accredited municipal inspector will examine it to ensure that it complies with the specifications. The Société d'habitation du Québec will then pay the home owner the financial assistance to which they are entitled.

In the 1980's, the property transaction market, in the Devon and Cornwall areas of Wales, effectively ground to a halt when the banks would no longer issue mortgages for houses, built between the years 1900 to 1950. Eventually, an agreed testing procedure to establish the presence and concentration of deleterious concrete in individual dwellings was published by Royal Institute of Chartered Surveyors. This became part of the conveyancing process for pre-1950 dwellings thus allowing the property market to operate normally for dwellings not affected, i.e. where the classification is Class A or Class A/B in accordance with diagrams below.

For properties affected, either in Class B or C the story is different. In some cases, the deleterious concrete may be identified and replaced, but for most, the objective is to reduce the risk of the onset of degradation by keeping the structure dry through regular maintenance. Economically, the value of the property declines and the ability to sell is diminished.

While the mundic problem is not technically a pyrite problem the potential outcome for owners is similar and the specific approach adopted is of valued assistance in developing solutions to resolve the pyrite issue in Ireland.

Figure A16.1 The Mundic Problem - Classification system



**Note:** Extract from The “mundic” problem, A guidance note – Recommended sampling, examination and classification procedure for suspect concrete building materials in Cornwall and parts of Devon 2<sup>nd</sup> Edition The Royal Institution of Chartered Surveyors, London 1997



**Figure A16.2 The Mundic Problem - Concrete Condition**

<b>Aggregate/s</b> (See Section 3.8.1)	<b>Concrete Condition</b> (See Section 3.8.2 and 3.8.3)	<b>Concrete Class</b>
Group 1 only	Sound	A
Group 2 plus up to 30% Group 2	Sound †1	A/B*1*2
Greater than 30% Group 2	Sound †2	B*1
Mainly Group 2	Unsound	C (i)
Mainly Group 1	Unsound	(ii)
<p>*1 Class A/B and B shall only be determined after Stage Two examination (except for mass concrete footings, see *2).</p> <p>*2 Class A/B should be allocated to mass concrete footings samples which are judged to be sound by Stage One examination and exhibit a dry density of 200 kg/m<sup>3</sup> or more.</p> <p>†1 Appears sound and likely to remain so, subject to regular protective internal and external maintenance to prevent water/ damp ingress and to preserve durability and stability of all walls.</p> <p>†2 Currently appearing sound but, owing to the percentage of Group 2 aggregates, retains potential for degradation with possible consequent loss of structural strength and integrity</p>		

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<b>Recommendation 1</b>  <b>Development of a testing protocol</b>	An expert industry group should be established immediately by the National Standards Authority of Ireland (NSAI) to develop an Irish testing protocol (within a three month timeframe) capable of determining whether:  (a) there is reactive pyrite in sub-floor hardcore material, and  (b) if it has caused pyritic heave.	The National Standards Authority of Ireland (NSAI)	To enable the testing and categorisation of dwellings so that appropriate remediation options can be chosen.  Reduce the cost on homeowner to prove the presence of pyrite through having a standardised protocol that is accepted by all  Facilitate certification for insurance, mortgage and conveyancing purposes.
<b>Recommendation 2</b>  <b>Guidance on approaches to remediation</b>	(a) dwellings in the “red” category should be remediated immediately; (b) dwellings in the “amber” category should be monitored and remediated if and when they exhibit pyrite-related damage; (c) alternative preventative solutions (certified by an approved body), which prevent pyritic heave occurring, should be considered as less costly and less disruptive remediation method for the “amber” category.	NSAI ( to set out the approaches in the new Irish testing protocol in Recommendation 1 above).	Adopting a risk-based approach to remediating pyrite affected dwellings will:  Enable homeowners to determine the appropriate course of remediation action based on the categorisation;  Target the remediation of dwellings that are exhibiting damage from pyrite in the first instance;  Focus on the most effective utilisation of any remediation fund.
<b>Recommendation 3</b>  <b>Development of a method statement for remediation works</b>	An expert industry group should be established immediately by NSAI to develop a method statement for remediation works. Compliance with the method statement should be a prerequisite for the issue of any certification.	NSAI	Provide guidance to homeowner/builder for the remediation of pyrite-damaged dwellings.  Provide confidence to homeowners that work has been carried to a recognised standard.  Facilitate certification of the remediation works.
<b>Recommendation 4</b>  <b>Certification of dwellings</b>	(a) A series of certificates should be developed for dwellings affected by pyrite; (b) the certificates should be in standardised format and acceptable to key stakeholders; (c) certification would only be necessary for dwellings in estates where pyrite damage has been proven and where dwellings were constructed during a similar defined period.	NSAI (develop certificates as part of the testing protocol in Recommendation 1)  Banking/insurance/legal/professions	Provide confidence to homeowners that remediation has been carried out properly.  Avoid unnecessary constraints with insurance.  Remove impediments to sale of property.  Restore confidence in the housing market.

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<b>Recommendation 5</b>  <b>Insurers and mortgage providers</b>	<p>(a) the insurance industry should not penalise homeowners in estates where pyrite damage has been proven and should continue to provide standard insurance cover for all dwellings (including those in the red category).</p> <p>(b) The mortgage providers should not penalise in any way homeowners simply because of the presence of pyritic material in the floor construction (i.e those dwellings in the amber category);</p> <p>(c) Dwellings in the 'green' category should be treated no differently to any other dwelling that has no pyrite present.</p>	<p>Mortgage providers /Irish Banking Federation</p> <p>Insurance companies</p> <p>Irish Insurance Federation</p>	<p>Enable homeowners to obtain insurance without restrictions.</p> <p>Remove blockages to the conveyancing of property and thus restore confidence to the housing market.</p>
<b>Recommendation 6</b>  <b>Responsibilities of stakeholders in the construction industry (including the quarrying sector)</b>	<p>Stakeholders in the construction industry (including the quarrying sector) should re-assess their positions and follow up on their positive statements in relation to the responsibilities of the relevant stakeholders and outline how they envisage funding the costs of the remediation.</p>	<p>Construction Industry Federation/ Irish Home Builders Association</p> <p>Irish Concrete Federation</p> <p>National Concrete Producers Association</p> <p>HomeBond</p> <p>Irish Insurance Federation</p>	<p>Provide clarity for homeowners regarding funding for remediation works.</p> <p>Provide appropriate funding for the necessary remediation</p>
<b>Recommendation 7</b>  <b>Immediate engagement by builders/ developers/ insurers to facilitate remediation</b>	<p>In the first instance, builders, developers (and/or their structural defect guarantee provider or insurer) should immediately engage with homeowners to remediate the damage due to pyritic heave. The builder/developer/structural guarantee provider/insurer, in turn, may seek to pursue other parties that may have a liability.</p>	<p>Builders, Developers, Structural Guarantee Providers, Insurance companies.</p>	<p>Facilitate a speedier remediation process of dwellings allowing the options to seek recovery at a later date from those deemed to be responsible.</p>
<b>Recommendation 8</b>  <b>Engagement by the Construction Industry representatives</b>	<p>The Government should ensure that strong leadership is provided to influence the engagement of the construction industry representative bodies and other relevant parties in facilitating a resolution of the pyrite problem. While the Minister for the Environment, Community and Local Government has an important role in this process, whole of Government support is essential to deliver an effective overall solution.</p>	<p>Government</p> <p>Minister for the Environment, Community and Local Government</p>	<p>Remove current obstacles to remediation being carried out.</p> <p>Facilitate a focused co-ordinated approach from all the key stakeholders (in the construction and quarrying sector) resulting in an effective solution to the remediation of dwellings affected by pyrite.</p>

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<b>Recommendation 9</b>  <b>Re-engagement by HomeBond in facilitating remediation</b>	HomeBond should review its position on cover as articulated in its letter of 31 August 2011 and, as a matter of urgency, it should re-engage with homeowners in facilitating the remediation of pyrite- damaged houses. This should be addressed, in the first instance, by the members of HomeBond and, in turn, they should be supported in this process by the overall construction industry, which was involved in the establishment of the HomeBond structural guarantee Scheme. This would not preclude HomeBond seeking to recover costs from other parties whom they consider may have a liability.	HomeBond, Members of Homebond, Construction Industry Federation	Enable dwellings covered by a HomeBond Warranty to be remediated.  Utilise the expertise of HomeBond in dealing with structural claims.  Provide assurance for homeowners that there is a mechanism in place to have their dwellings remediated, if required.  Restore confidence in the HomeBond warranty scheme and, by association, in the construction industry.
<b>Recommendation 10</b>  <b>Engagement by the insurance Industry</b>	The Insurance Industry Federation (IIF), as the representative body of the insurance industry, together with its relevant members, should immediately engage with solving the problems caused by pyrite and for which some insurers have provided insurance cover.  The Panel exhorts the IIF to encourage its relevant members to respond with greater sensitivity and urgency to the homeowners and to explore the options for a collective solution to the pyrite problem, as opposed to just awaiting the outcomes of lengthy legal processes currently underway.	Insurance companies, Irish Insurance Federation	Provide cost effective solutions for homeowners to have their homes remediated.  Encourage their members to take collective responsibility and provide cost effective insurance without restriction to dwellings in pyrite-affected areas.  Remove blockages to the conveyancing of property and thus restore confidence to the housing market.
<b>Recommendation 11</b>  <b>Funding by mortgage providers</b>	Subject to whatever legal constraints exist on the members of the Irish Banking Federation (IBF), mortgage providers should consider providing funding for pyrite-related remediation work, including testing, to homeowners.	Irish Banking Federation/ Mortgage Providers	Reduce financial burden on homeowner by providing cost effective options to undertake pyrite related remediation work to their homes and provide a mechanism to fund testing.  Enhance the value of the mortgaged homes for the banks
<b>Recommendation 12</b>  <b>Role of Government</b>	The Government should take the necessary steps to ensure that:  (a) those who have responsibility for the pyrite problem should bear the costs of remediation;  (b) remediation is carried out in a timely manner;  (c) that comprehensive measures are put in place to minimise the risk of this or similar problems occurring in future.	Government  Minister for the Environment, Community and Local Government	Ensure that those who have responsibility for the pyrite problem bear the costs of remediation.  Adequately effect remediation of pyrite-damaged homes.  Measures put in place to prevent similar problems in the future.

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<b>Recommendation 13</b>  <b>Exemption from proposed property tax</b>	The Minister for the Environment, Community and Local Government should consider providing an exemption from the proposed property tax for a set period, for dwellings where damage from pyritic heave has been proven by testing, in accordance with the protocol mentioned in Recommendation 1.	Minister for the Environment, Community and Local Government	Provide temporary relief from property tax for homeowners who have proven pyrite damage under the national testing protocol referred to in Recommendation 1.
<b>Recommendation 14</b>  Establishment of a Resolution Board	The Government should establish a Resolution Board which would not be funded by the Exchequer but could be funded by, for example an appropriate levy on the quarrying and construction sectors and the related insurance cover for those sectors. This Resolution Board should be established under the aegis of the Minister for the Environment, Community and Local Government.  The Panel would caution that this Resolution Board should not delay any on-going remediation that is currently underway and the Board should only be the last resort for dealing with pyrite problems and related issues, where no other solution is possible.	Government  Department of Finance  Department of the Environment, Community and Local Government	Provide a fall back mechanism for homeowners to get remediation works done when all other avenues have been fully exhausted without success.  Those responsible for causing the problem would be responsible for paying for the remediation.

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<p><b>Recommendation 15</b></p> <p><b>Specification for hardcore</b></p>	<p>(a) In light of the knowledge and experience gained since 2007, the National Standards Authority of Ireland should initiate a review of Standard Recommendation S.R. 21.:2004+A1:2007 <i>Guidance on the use of I.S. EN 13242:2002 -Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction.</i></p> <p>(b) The National Standards Authority of Ireland should develop a standalone specification for hardcore for use under concrete floors, which should become the source of guidance on hardcore.</p> <p>(c) The expertise developed, the scientific data gathered and research carried out over the last 5 years should be made available to NSAI in order to ensure the best outcome from the review and development of a specification for hardcore.</p> <p>(d) Following the publication of a Specification for hardcore referred to in (b) above, the Department of the Environment, Community and Local Government should review the guidance provided in Technical Guidance Document to Part C of the Building Regulations and, if required, it should issue amendments to the Technical Guidance Documents.</p>	<p>National Standards Authority of Ireland</p> <p>Minister for the Environment, Community and Local Government</p>	<p>Ensure that the specification for hardcore is robust and takes account of up to date knowledge and experience, particularly in relation to pyrite.</p> <p>Help restore confidence in the construction industry.</p> <p>Strengthen consumer protection.</p>

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<p>Recommendation 16</p> <p>Requirements for quarries supplying hardcore</p>	<p>(a) Quarries should be required to demonstrate, by regular testing and appropriate certification, that the hardcore material they are supplying is in compliance with the recommended specification for hardcore (Recommendation 15).</p> <p>(b) Quarries should be required to furnish to purchasers and, when requested, to building control officers, the certification, together with the results, in accordance with the specification for hardcore (Recommendation 15)</p> <p>(c) Quarries should ensure that all hardcore supplied to others is traceable to the quarry of origin which has certified it in accordance with the specification for hardcore. This information should be readily available to the building control authorities and others who may require it.</p> <p>(d) Quarries should have adequate insurance for the scale and type of work being undertaken.</p> <p>(e) The data in relation to products used in the house construction (including copies of delivery dockets) should be readily available to the building control authority in digital format and it should be readily accessible by homeowners as appropriate.</p>	<p>Irish Concrete Federation</p> <p>National Concrete Producers Association</p> <p>Construction Industry Federation</p> <p>Quarry owners</p> <p>Insurance industry</p> <p>Building Control Authorities (in respect of follow up inspections)</p> <p>Builders</p> <p>Designers and certifiers</p>	<p>Provide assurance that the hardcore material is fit for purpose.</p> <p>Create an audit trail and traceability of product.</p> <p>Facilitate availability of relevant data to building control, builders and homeowners.</p> <p>Help restore confidence in the construction industry.</p> <p>Strengthen consumer protection.</p>

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<b>Recommendation 17</b>  <b>Enforcement of Building Control legislation</b>	<p>(a) Building control authorities should adopt a risk-based approach to the enforcement of Building Regulations and take appropriate enforcement action for serious breaches of Building Regulations following consideration of the particulars of each individual case;</p> <p>(b) In local authority areas where pyrite has been shown to be a problem, the building control authorities should consider using the enforcement provisions of the Building Control Acts 1990 – 2007 to require builders to remediate defects in pyrite damaged dwellings;</p> <p>(c) The Minister for the Environment, Community and Local Government should reconsider the 5 year time limit for prosecutions under the Building Control Act, with a view to extending it.</p> <p>(d) Building control authorities should require evidence of periodic testing and certification of hardcore used on sites, to demonstrate compliance with the Building Regulation.</p> <p>(e) The County and City Managers' Association should review its guidance (as articulated in its submission to the Panel) in relation to building control enforcement.</p>	<p>Building Control Authorities</p> <p>Minister for the Environment, Community and Local Government</p> <p>County and City Managers' Association</p>	<p>Facilitate a more effective and efficient enforcement regime.</p> <p>Strengthen consumer protection.</p> <p>Ensure that those responsible for causing problems are pursued through the appropriate channels.</p>
<b>Recommendation 18</b>  <b>Mandatory certification system</b>	<p>The development of a mandatory certification system that recognises the importance of inspections, product certifications and site supervision and takes proper account of the risk associated with design, materials and construction. In addition, the Panel recommends that the system of independent inspections, carried out by the building control officers, is strengthened to complement the proposed mandatory certification process for buildings.</p> <p>The guidance on the level and objectives of inspections undertaken by building control authorities should be reviewed by the County and City Managers' Association.</p>	<p>Minister for the Environment, Community and Local Government</p> <p>County and City Managers' Association</p>	<p>Enhanced system of building control giving better protection to the consumer.</p> <p>More robust system of inspections by building control authorities.</p> <p>More Structured inspection and certification input by competent professionals.</p>



## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<p><b>Recommendation 19</b></p> <p><b>Registration of builders</b></p>	<p>A mandatory registration system should be established for builders with specific requirements for appropriate insurance cover (supported by regulation) Registration of builders should require demonstration of technical competence, financial capacity and adequate insurance cover.</p> <p>Evidence of registration and of insurance of builders should be publicly available on appropriate websites so that the public can easily access the information.</p> <p>More generally, the use of information and communication technologies and the internet for providing readily accessible public information on the construction sector (including registered builders) should be addressed.</p>	<p>Construction Industry Federation</p> <p>Minister for the Environment, Community and Local Government</p>	<p>Strengthen consumer protection.</p> <p>Help restore confidence in the construction industry.</p>
<p><b>Recommendation 20</b></p> <p><b>Statute of Limitations</b></p>	<p>The current legislation governing Statute of Limitations should be reviewed with a view to ensuring that latent defects in buildings, such as those experienced from reactive pyrite, remain covered for a reasonable period during which the defects might be expected to manifest themselves. The Panel notes that work has been done by the Law Reform Commission (LRC) and it would ask that the LRC address this issue.</p>	<p>Law Reform Commission</p> <p>Department of Justice and Defence</p>	<p>Improved protection for consumers.</p>
<p><b>Recommendation 21</b></p> <p><b>General Insurance issues</b></p>	<p>(a) the standard limits in the Contractor's All-Risk Policy and Public Liability Policy should be reviewed on a regular basis by the construction industry and the Central Bank so as to ensure that the policies offer sufficient protection to the builders and consumers. The level of cover should be specified as part of the registration process.</p> <p>(b) consideration should be given to specifying a requirement for project-related insurance whereby the cover for each specific project is available and adequate and is related to the project only.</p> <p>(c) consideration should be given to options to provide a fund for the resolution of major unforeseen incidents in which the consumer is exposed, without adequate recourse, such as happened with pyrite.</p>	<p>Financial Regulator</p> <p>National Consumer Agency</p>	<p>Improved protection for consumers.</p>

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<p><b>Recommendations 22</b></p> <p><b>Home Insurance Issues</b></p>	<p>(a) the Central Bank/Financial Regulator and the National Consumers Agency, in consultation with relevant Government Departments, should undertake a review of structural guarantee policies examining, in particular, the level of cover provided and the exclusions contained in those policies.</p> <p>(b) the Government should examine and introduce measures to ensure that adequate structural guarantee policies, in line with the outcome of the review at (a) above, are required as part of the conveyancing of new dwellings.</p> <p>(c) the Central Bank/Financial Regulator and National Consumer Agency, in consultation with relevant Government Departments should address the issue of having a minimum cover with any household insurance policy advertised and, if companies wish to add more to that, they would be entitled to do so but the policy could not offer less than that.</p> <p>(d) the insurance industry should remove any additional restrictions on dwellings that have been certified in accordance with the certification process set out at section 8.6 as not having pyrite or having been cleared of pyrite.</p> <p>In relation to overseeing of this condition, the Central Bank/Financial Regulator/National Consumer Agency should engage with the insurance industry with a view to preventing any exclusion for pyritic heave in a house insurance policy for remediated dwellings.</p> <p>(e) the insurance industry should not withhold household insurance cover to dwellings specifically affected by pyrite .</p>	<p>Central Bank Financial Regulator National Consumer Agency Relevant Government Departments</p>	<p>Minimum level of cover available to homeowners.</p> <p>Removal of insurance restrictions on homeowners (due to pyrite).</p>

## Appendix 17: Implementation plan for recommendations

Recommendation Number and title	Details of recommendation	Primary Responsibility for action	Impact
<p><b>Recommendation 23</b></p> <p><b>Continuing Professional Development and Education</b></p>	<p>(a) Continuing professional development courses (that deal specifically with pyrite and pyritic heave) should be developed and made widely available by the relevant professional bodies,</p> <p>(b) A part-module on pyrite and pyritic heave should be included in all relevant third level construction, design and engineering courses.</p>	<p>Engineers Ireland</p> <p>Association of Consulting Engineers of Ireland</p> <p>Royal Institute of Architects of Ireland</p> <p>Society of Chartered Surveyors Ireland</p>	<p>All design and construction professionals will have up to date knowledge of pyrite and the consequences of pyrite heave.</p> <p>Awareness amongst undergraduates in construction, design and engineering courses</p>
<p><b>Recommendation 24</b></p> <p><b>Dissemination of Information</b></p>	<p>(a) A more effective and efficient method of dissemination of information should be established to ensure that information reaches relevant people in a timely manner and that the Department of the Environment, Community and Local Government should take the lead in setting up this system. Consideration should be given to the use of a centralised web-based alert system with a suitable feedback loop with information readily and publicly available via the internet.</p> <p>(b) the National Standards Authority of Ireland (NSAI) should provide a single, publicly accessible information point with up-to-date information on standards immediately and readily available to all involved in the construction industry.</p> <p>(c) Professional bodies should take responsibility for ensuring that their members receive information in a timely manner.</p>	<p>Minister for the Environment, Community and Local Government</p> <p>NSAI</p> <p>Professional Bodies</p>	<p>Relevant bodies and individuals have timely access to important and pertinent information and enables appropriate responses to be taken quickly thereby minimising risk to the consumer.</p>

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The following terms are defined for the purposes of this report:

<b>Accredited laboratory</b>	A laboratory possessing a third party formal recognition of the laboratory's competence to conduct a specific activity such as testing, inspection, reporting or certification.
<b>Aggregate</b>	The general term for any unbound granular material used in construction.
<b>Arbitration</b>	Adjudication or mediation
<b>Blinding layer</b>	Layer comprising of fine sand laid on top of hardcore in order to protect a radon barrier or damp proof membrane from puncture.
<b>Building Control system</b>	The system governing the enforcement of Building Regulations.
<b>Building Regulations</b>	A set of legal requirements for the design and construction of new buildings, extensions and material alterations and material changes of use of existing buildings.
<b>Building Regulations Advisory Body (BRAB)</b>	A statutory body appointed by the Minister for the Environment, Community and Local Government, under Section 14 of the Building Control Act, 1990 to advise him on matters relating to the Building Regulations
<b>CE Marking</b>	Marking of a construction product which indicates a product's compliance with EU legislation and enables the free movement of products within the European market.
<b>Cementitious material</b>	Material like or relevant to or having the properties of cement.
<b>Circular Letter</b>	A formal letter issued by a Government Department and circulated in relation to the statutory role of the receiving authority.
<b>Clause 804</b>	Refers to Clause 804 of the National Roads Authority (NRA) <i>Manual of Contract Documents for Roadworks. Volume 1 - NRA Specification for Road Works Series 800 - Road Pavements, Unbound and Cement Bound Mixtures (2000, amended in 2004, 2010 and 2011)</i> which refers to an unbound material used in road construction for sub-bases and road-bases. It is made from crushed rock and must meet a number of physical and chemical requirements as set out in the specification of the National Roads Authority..
<b>Commencement notice</b>	A notification to a Building Control Authority that a person intends to carry out either works or a material change of use to which the Building Regulations apply.
<b>Compaction</b>	The process of densifying soils or aggregates by some mechanical means such as rolling, ramming or vibration to reduce the volume of voids.



<b>Consolidation</b>	A reduction in the volume of ground resulting from the expulsion of pore water due to imposed static loading or reduction in ground water pressure (drainage).
<b>Conveyancing</b>	The transfer of legal title of property from one person to another, or the granting of an encumbrance such as a mortgage.
<b>Crystalline pyrite</b>	Pyrite with a crystal structure.
<b>Damp Proof Membrane</b>	An impervious membrane placed below a solid floor designed to resist moisture rising through the structure by capillary action.
<b>Department of the Environment, Community And Local Government</b>	Department of the Environment, Heritage and Local Government. Includes the former title of the Department, i.e. Department of the Environment, Heritage and Local Government
<b>Engineered-fill</b>	Fill that is selected, placed and compacted to an appropriate specification, so that it will exhibit the required engineering behaviour.
<b>Fill</b>	Ground that has been formed by material deposited by human activity rather than geological processes. It is a general term which embraces backfill, infill and landfill. When placed within an enclosed space, it is termed 'infill'.
<b>Framboidal pyrite</b>	Pyrite with a texture that superficially resembles raspberries, reflecting the appearance of the pyrite structure under magnification.
<b>Geology</b>	The science of studying solid Earth, both in its present status and in terms of its long-term evolution.
<b>Guarantee providers</b>	Companies which provide warranties and/or insurance against major structural defects of a dwelling, e.g. HomeBond Warranty Scheme and Premier Guarantee Scheme.
<b>Hardcore</b>	A construction term used to denote 'engineered' infill material that is placed within the confines of a building foundation (after removal of any unsuitable natural ground layers) in order to support a ground-bearing floor slab.
<b>HomeBond</b>	The trading name for the National House Building Guarantee Company Limited
<b>Lithologies</b>	The physical characteristics of a rock, including colour, composition and texture.
<b>Non-reactive Pyrite</b>	Pyrite that reacts very slowly at a rate that may not be noticeable over a normal lifetime. Non-reactive pyrite largely occurs as crystals.
<b>Ortho photography</b>	Aerial photography geometrically corrected ("orthorectified") such that the scale is uniform: the photo has the same lack of distortion as a map.

<b>Petrography</b>	The branch of geology that describes and classifies rocks, usually after microscopic study.
<b>Protocol</b>	Defined set of rules or procedures.
<b>Pyritic heave</b>	A general term that describes the swelling of hardcore due to the presence of an unsuitable concentration of pyrite in the hardcore material, resulting in upward pressure being applied to floor slabs and lateral pressure being applied to the rising walls in buildings.
<b>Pyritiferous</b>	Containing or producing pyrites.
<b>Radon</b>	A naturally occurring radioactive gas. It enters buildings from the underlying soil and in certain cases can accumulate in a building to such a concentration that it is deemed to constitute a potential health hazard. Radon is deemed to be a risk factor for lung cancer, particularly for smokers.
<b>Radon sump</b>	A void formed within a sub-floor to facilitate the collection of radon gas for extraction to the external environment.
<b>Reactive Pyrite</b>	Pyrite structure that affords a large surface area which facilitates the oxidising reactions. Reactive pyrite generally has a framboidal texture i.e. resembling raspberries.
<b>Registration (Dwelling)</b>	Registration of a dwelling with the Guarantee provider (generally) before work commences on that dwelling.
<b>Remediation</b>	Means the use of remedial methods to reverse environmental or structural damage.
<b>Statute</b>	A formal written enactment of a legislative authority.
<b>Sub-floor</b>	The build-up beneath the floor slab.
<b>Sulfur</b>	The chemical element of atomic number 16, a yellow combustible non-metal. In general, the standard British spelling is sulphur and the standard US spelling is sulfur. In chemistry, however, the -f- spelling is now the standard form in all related words in the field in both British and US contexts and has been used throughout this report (including quotations) for consistency <a href="http://oxforddictionaries.com/definition/sulphur?q=sulfur">http://oxforddictionaries.com/definition/sulphur?q=sulfur</a>

**Technical Guidance Documents**

Under Article 7 of the Building Regulations, the Minister for the Environment, Community and Local Government may publish, or arrange to have published on his behalf, documents to be known as “technical guidance documents” for the purpose of providing guidance with respect to compliance with the requirements of any of the provisions of the Second Schedule of the Building Regulations. Subject to the provisions of sub-article (3) of the Regulations, where works or a building to which the Building Regulations apply is or are designed and constructed in accordance with any guidance contained in a technical guidance document, this shall, prima facie, indicate compliance with the relevant requirements of the Building Regulations.

**Unbound mixtures**

This is the term used by current standards for materials made up of graded or blended aggregates that are used in construction without the addition of a binding agent such as asphalt or cement. Hardcore is generally such an unbound material.

## Abbreviations

<b>ACEI</b>	Association of Consulting Engineers Ireland
<b>ACLE</b>	Canadian Association of Testing Laboratories
<b>ACQC</b>	Association des consommateurs pour la qualité dans la construction
<b>BRE</b>	Building Research Establishment Limited
<b>CCMA</b>	County and City Managers Association
<b>CIF</b>	Construction Industry Federation
<b>CPD</b>	European Communities' Construction Products Directive 89/106/EEC
<b>CPR</b>	Construction Products Regulation (305/2011/EU - CPR)
<b>CTQ-M200</b>	Comite Technique Quebecois d'étude des Problemes de Gonflement Associities a la Pyrite: Appraisal procedure for existing residential buildings, Procedure
<b>DECLG</b>	Department of the Environment, Community and Local Government
<b>DoP</b>	Declaration of Performance
<b>DPM</b>	Damp Proof Membrane
<b>DPP</b>	Director of Public Prosecutions
<b>EDAX</b>	Energy Dispersive Analysis by X-ray
<b>EI</b>	Engineers Ireland
<b>FCC</b>	Fingal County Council
<b>GNP</b>	Gross National Product
<b>GSI</b>	Geological Survey of Ireland
<b>IBCI</b>	Irish Building Control Institute
<b>IBF</b>	Irish Banking Federation
<b>ICF</b>	Irish Concrete Federation
<b>IIF</b>	Irish Insurance Federation
<b>I.S. EN</b>	Irish Standard adopting a European standard
<b>JEC</b>	James Elliott Construction Limited
<b>LRC</b>	Law Reform Commission
<b>NAMA</b>	National Asset Management Agency
<b>NCA</b>	National Consumer Agency
<b>NHBGS</b>	National House Builders' Guarantee Scheme
<b>NRA</b>	National Roads Authority
<b>NSAI</b>	National Standards Authority of Ireland
<b>OPW</b>	Office of Public Works
<b>PPP</b>	Public Private Partnership
<b>PSPI</b>	Petrographic Swelling Potential Indicator
<b>RECO</b>	Ballymun Central Youth Facility
<b>SEM</b>	Scanning Electron Microscopy
<b>SR</b>	Standard Recommendation
<b>TGD</b>	Technical Guidance Document to the Building Regulations 1997-2012

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