FEEDBACK FROM BUILDING PATHOLOGY – HELPING OR HINDERING REGULATORS

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ABSTRACT

Building Pathology is concerned with the methodology of investigating defects and failures in buildings. Collection of information enables the construction of databases, analysis of which provides feedback to interested parties. Examples of some of these databases are given.

Proposals for new measures to improve the thermal performance of buildings were assessed at the request of those responsible for creating the regulations for the technical risks involved. Documentation was produced to illustrate the recommendations of BRE on good design and construction practice.

KEYWORDS

Building Pathology, Defects, Databases, Feedback.

INTRODUCTION

Construction is carried out with the best of intentions. The architect wants the building to look good and function well. The builder and sub-contractor want to complete the works on site on time, within their price, hopefully making a profit and without incurring callbacks. The client has high expectations; he probably rarely commissions a building but as we will see, he is often left with a legacy of defects that he has uncovered after occupation. An estimate has been made that 2 – 5% of new construction costs can be considered as building defect costs. Even worse is that many of the defects are infringements of Building Regulations or of recommendations contained in Standards and Codes of Practice. Any move to improve the situation and move towards a zero defect culture will need to take account of past occurrences and examine how required performance can be achieved. Thus the involvement of Building Pathology and its findings, with feedback available in the form of case studies.

BUILDING PATHOLOGY

Building Pathology is essentially concerned with the methodology of investigating defects and failures in buildings (CIB 1993). There is a difficulty in defining what is meant by a defect and what qualifies as a failure. CIB Working Commission W086 discussed definitions at length and a list in their report illustrates the process of ‘birth and life’ of a building defect. Many problems will occur because human activities (titled ‘errors or omissions’) fall well short of planned or anticipated performance. Others will occur through ‘acts of God’. Some visible or measurable indication of inadequate performance (titled ‘anomaly’ by W086 although the terms ‘symptom or sign’ were the first choice of some commentators), will trigger an initial concern, and the requirement for a detailed investigation by a specialist.

The term failure is applied when the item can no longer perform its required function. Defects and failures lead to loss and damages. In the extreme case, the former covers loss of life, or injuries to the person. Further losses will be incurred as a result of the building being out of commission. Damages include the costs of restoring the component or building to be available for use again, plus any costs of legal action, expert witness reports and the time costs for all involved in any such exercise. Attempts

to identify the total costs are usually unsuccessful, and parties would often be horrified if they knew the true costs of rectifying a defect.

DEFECTS SURVEYS AT BRE

BRE was commissioned in the early 1980's to undertake surveys of public and private housing to determine the quality achieved during construction. A total of 15 sites were involved, comprising over 1700 mainly two storey units. Some 955 different types of faults were recorded of which 447 were attributed to the designer. 26% of these design faults types involved infringement of Building Regulations in force at that time, either directly or through codes and standards called up in the regulations. (Bonshor and Harrison, 1982)

This exercise was followed by surveys of 'rehabilitation'; work aimed at extending the useful life of dwellings by raising levels of performance and amenity to acceptable standards. Over 2000 faults were recorded; of these 956 were in the original construction and 1197 resulted from the new works. Rehabilitation did not make older housing as good as new; works were mainly to improve the layout and upgrade amenities and the services. Improvements to performance, such as upgrading the thermal efficiency of the walls, were of a lower priority. Although, in general, Building Regulations do not apply to rehabilitation work, 24% of faults contravened Building Regulations with a further 18% contravening Codes of Practice (BRE 1990).

CONSTRUCTION QUALITY FORUM

Surveys are costly and time-consuming to undertake and the UK government encouraged the construction industry to set up what was initially known as the National Defects Database, with a brief to collect information, provide analysis and feedback to improve construction and reduce the overall number of defects. This exercise evolved to become the Construction Quality Forum, with BRE providing the secretariat. The usual problems of actually persuading members to provide data on defects resulted in slow growth of the database, and much of it was supplied from the BRE Advisory Service records.

Analysis of the database, published in April 1997, produced the alarming fact that 64% of defects were discovered when the building was in use; presumably by dissatisfied clients. Another analysis looked at the 'authority contravened', with concern expressed that 12% of defects did not comply with statutory requirements and a further 35% contravened 'good practice'. Building performance was examined by a 'lack of performance' criterion.. Not surprisingly, bearing in mind the UK climate, 'weathertightness' came top of the list of mentions at 22%, closely followed by 'durability' at 16% and 'maintainability' at 15% (BRE 1997).

Feedback was provided to the construction industry in a series of workshops that attracted a wide cross-section of the players in particular topics. Weathertightness highlighted - by the analysis as the number one topic - led to a workshop on 'the cavity wall – building it right'. The UK preference for housing is facing brickwork with filled or partial filled cavity, and the costs of correcting this type of problem were recorded as among the most expensive to rectify, often exceeding £5000 per defect. (Construction Quality Forum 1995)

HAPM DATABASE

The most recent published analysis of defects (HAPM 1997) was undertaken by Housing Association Property Mutual (HAPM) of data collected through a structured technical audit system, operated for technical insurance risk management. The actual analysis was commissioned by the Department of the Environment (now DETR). The data was taken from audits of about 31,000 dwellings, houses and flats, carried out between January and June 1994. Six building elements were reported on, and the method of construction indicated. The report points out that designers generally used solutions described within the Approved Documents to the England and Wales Building Regulations. Non-

compliance arose through missing the small print relating to critical junctions, detailing and workmanship.

Specific problems areas referred to the need for improved levels of thermal insulation, and conflicts in guidance relating to walls, which ideally require low mass for thermal resistance considerations and high mass for acoustic considerations. The report also refers to the continuing appearance of 'old favourites' since, as the author states, the majority of defects occurred through 'failure to achieve adequate standards on construction that have been widely used for at least 30 years in the UK'.

BRE ADVISORY SERVICE DATABASE

Mention has been made before of this collection of inspection reports. Recording of data commenced in 1970, and to date in excess of 4000 reports are filed. The range of defects is wide, and analysis has been undertaken on several occasions to determine trends and to provide feedback to the construction industry (Trotman 1992). Around 50% of the inspections concern dampness in one form or another, with rain penetration accounting for a quarter of the total defects. Condensation occurs in 17% of the cases with the next two categories being cracking at 17% and detachment at15% of the total.

Feedback to the construction industry has always been seen as an important contribution to improving quality and reducing defects. A major output was the well-known BRE Defect Action Sheets, followed more recently by the Good Building Guides and Good Repair Guides. These are illustrated by defects, in the hope that recognition of what can go wrong will encourage greater care in the future to avoid perpetrating the same old mistakes.

THERMAL INSULATION: AVOIDING RISKS – BACKGROUND TO THE DOCUMENT

Moves in 1986 towards reducing energy consumption in buildings, by changes in legislation to reduce heat losses thorough the structure, led the Building Regulations Division of DOE (now DETR) to seek guidance from BRE on what were the likely technical risks from such an approach. The brief was 'to produce a document that describes and gives solutions for the technical risks that arise from energy conservation measures in all relevant building types'. Housing was initially covered, and main issues under consideration were condensation (both surface and interstitial), rain penetration of walling, floor insulation and fire safety. Reference was also given to cost considerations and any likely workmanship problems. A review document was prepared covering all these issues and presented for discussion.

The next stage was to widen the exercise to include non-domestic buildings. No surveys had been undertaken of defects in properties other than housing, so recent data from the BRE Advisory Service was examined. Of the 230 reports examined, 62 covered commercial premises, 40 industrial buildings and the remainder housing. Condensation was the major problem covered by 178 reports, followed by rain penetration in 99 properties. Some buildings had both problems. Examining the element in which the defect had manifested itself, walls recorded 124 defects, roofs 109 and floors only 12; again some defects occurred in more than one element. Attempts were made to search the database for properties which had higher levels of insulation than that required by regulations in force at that time. Little data was found and it was suspected that the need to aim for a better thermal performance was not the prime concern of those commissioning or designing buildings.

As well as the formal organisation of a database, much information and knowledge is with the Building Pathologist. The staff of the BRE advisory Service responded to telephone and written enquiries; these contacts with the building industry and property owners enabled the gathering of much intelligence to build up a feel for problems within their subject area.

This knowledge was tapped by developing a table of the building elements, possible energy actions (mainly increasing the amount of insulation), and seeking opinions on how this would affect performance, the level of additional risk, potential interaction between elements and some concept of

how the risk could be reduced. Opportunities, and needs, for further research were able to be identified.

Typically, the catalogue entry for a pitched roof considered both insulation at ceiling level and above or below the sloping weather resistant layer. Condensation, durability, buildability and stability were all seen as risk areas. Condensation was seen as a high risk, frost attack on roof tiles (durability) as low. With flat roofs, more insulation, together with the possible ineffectiveness of any vapour control layer, led to condensation being seen as a high risk.

Continuing with building elements, rain penetration of cavity masonry walls had been a recurring issue since the introduction of insulation into what started as a clear cavity. Problems of buildability with insulation batts, difficulty of ensuring complete fill with injected materials and the possibility of frost attack were all seen as a high level of risk. Far fewer problems were envisaged with insulated dry linings; a little pattern staining was considered a minor risk.

With flooring, the introduction of insulation would be a new technique for the construction site. The relationship between insulation, the damp-proof membrane and the concrete screed was seen as venturing into the unknown. Consideration of the junctions between the elements was included, as there was a potential for creating cold bridges, usually where there was a lack of continuity of the insulation.

In addition to the various building elements, reduced ventilation resulting from draught stripping was viewed to be a risk, both in terms of condensation and (the less quantifiable) indoor air quality. Services outside the insulation layers, usually cold water tanks and pipes in the loft, were also seen as being at greater risk from freezing.

THERMAL INSULATION: AVOIDING RISKS – THE DOCUMENTS

Much deliberation took place over the best format for a document for use by the construction industry. The scope was seen as a guide to explain the technical risks, which may be associated with meeting the building regulations for thermal insulation (conservation of fuel and power). As in the preceding exercise, the major building elements of roofs, walls, windows and floors were listed in turn. Potential risks were summarised and then expanded together with illustrations, which showed construction principles and examples of good practice detailing. Recommended actions were spelled out with reference to British Standards where appropriate. An appendix to the document gives supplementary data for the calculation of cold bridges, insulation thicknesses for water supply pipes and sizes for electrical cables enclosed within insulation. The document was published in 1989 (BRE 1989).

While much of the data was taken from existing guidance presented in a consistent way, new data was given on geographic exposure and types of wall construction considered appropriate for locations throughout the UK. As mentioned before, many failures of insulation had been experienced and the problem usually comes top of any analysis of defects databases. Design and workmanship requirements were highlighted, together with the suggestion that if good quality could not be guaranteed, then the exposure rating of the wall should be reduced.

A revision was undertaken, and published in 1994 (BRE 1994), changing the format to improve the links between risks, causes and solutions. More feedback from site investigations, changes in materials and construction techniques were incorporated. Additional information was given on non-domestic buildings and clauses marked that were considered appropriate to buildings bring renovated, converted or altered. A new chapter was included that dealt with the building as a whole in addition to those covering individual elements.

The chapter on windows was revised to cover the increased use of double glazed units. Any failure of these is immediately obvious as misting of the glass between the panes results. Analysis of data indicates an early life failure, within the first two years, of 0.5%. The overall failure rate is between

2.5% and 3.0%. The greater use of 'the room in the roof' design greatly complicates the construction, and more guidance on ventilation and breather membranes to address this is also given. Designs which incorporate insulated sarkings are more common and several condensation problems have been reported. The document (BRE 1994) is now double the number of pages of the first edition. A further revision is underway at the present time.

W086 BUILDING PATHOLOGY FORUM

Internationally, the CIB Working Commission W086 has recognised that the data collected by its members has many uses. The first is obviously to report to the client commissioning the inspection to work towards a solution to correct the defect. This may involve litigation if parties cannot agree. The next step will be to add the information to a databank. This may only be a personal one, so that next time the problem is seen, there is a ready-made reply waiting. Of more value to a greater number of people is to contribute to a larger database, as is done with the BRE Advisory Service. Analysis will never be straightforward, but as has been seen in this paper, weight of numbers can illustrate where problems are likely to occur.

W086 is in process of setting up a Building Pathology Forum to collect and circulate to participants, through an Internet World Wide Web, information about:

- Significant building failure cases
- Associations, professionals, researchers and their expertise in building failure diagnosis and treatment
- Diagnostic methods and tools
- Scientific literature and other bibliographic data

Discussion is in progress about what information to collect, format for the data and how the web site will be managed. It is recognised that a peer review process will have to be established, and some part of the CIB W086 meetings will be used for this process. Strong links with other CIB Working Commissions have been maintained for a long time and contacts will establish the value of material to assist with their projects.

CONCLUSION

It is hoped that this paper has demonstrated that those practising as Building Pathologists collect material of considerable importance and that the passing of concise data to those preparing performance regulations is of great help in supporting any proposals that they put forward.

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