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THE REALITY ON SITE: A SUMMARY OF COMMON PROBLEMS

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1. BACKGROUND

Housing Association Property Mutual (HAPM) was established in 1990 to provide a unique major defects insurance tailored to the needs of housing associations. Associations had as a result of the 1988 Housing Act and the advent of mixed funded development to make their own provisions for major defects where previously they would have been eligible for grant (HAG). The two most important features of this new insurance package were (a) cover for 35 years and, (b) cover for non-structural defects. The premium for the insurance was calculated on the assumption that through technical risk management defects (ie., future claims) would be reduced by one half.

Such bold assumptions were considered to require a new and effective approach to defect identification in order to facilitate the designing out of potential problems at the pre-construction stage in addition to the more normal checking on site. HAPM therefore developed a systematic checking process utilising computer data base technology such that every check made, both in the office and on site, was formally recorded whether the assessment was satisfactory, defective or inconclusive due to lack of information or (on site) the inability to inspect.

HAPM therefore is in a unique position in the context of sound insulation in two important ways. Firstly, it is the only major building defect scheme that is 'insuring' dwellings built in the UK for sound insulation deficiencies for the full term of the policy
and secondly, it is the only construction surveillance organisation that operates a fully documented and systematic checking system for sound insulation issues both at design stage and at the point of execution.

As a consequence of the latter HAPM has the ability to search and analyse data on a scale never previously even contemplated, currently in the order of about 50,000 dwellings.

HAPM has not established its own standards of sound insulation but adopted what might be regarded as the industry norm in the form of Approved Document E of the Building Regulations for England and Wales. The data therefore that is reported in this paper reflects on the ability of the construction process as a whole to comply with that criteria. Much could be said on that subject based on the data that HAPM has to hand however this paper is restricted to a review of problems peculiar to construction on site and only masonry construction.

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It will be recognised that sound insulation is a most sensitive issue in the context of social housing in particular. It is no surprise to HAPM that a significant proportion of claims already made relate to deficiencies in sound insulation. It is also the issue most often 'excluded' from cover because the audit process has identified a deficiency too late for correction to be realistically contemplated. The reasons for this are worthy of study in themselves.

2. THE PROCESS OF DATA COLLECTION

Claims are made in section 1 above as to the extent and robustness of the data available to HAPM. The following is therefore a brief insight into the processes operated to collect data.

When faced with the task in 1990 of setting up checking procedures 'tick lists' appeared to be the obvious approach. However, the use of 'tick lists' is difficult to supervise and double check as completion tends to rely heavily on the subjective. Computerized expert systems appeared an attractive alternative, however, given that development time and costs were initially very limited, they were discounted. In the absence of an obvious methodology the problem was redefined in terms of how best to generate a report having audited a scheme. This prompted consideration of an audit system based on standard statements retained in a computer database. Such an approach was tested and found to work. So, for every check point a menu of standard pre-prepared statements was composed and auditing became the process of selecting the appropriate statement from the menu available for the circumstances under consideration. A basic provision of at least four statements was found to be necessary for every point to be checked, on the following lines:

* the building does not contain this feature
* the building does contain this feature but it is not clear how it is to be constructed
* the building does contain this feature and the proposed method of construction appears to be wrong
* the building does contain this feature and the proposed method of construction appears to be correct

The use of standard statements in this way has a number of benefits including;

* reports can be easily generated by printing only the selected statements
* the content of the statements can include the assessment criteria so that the auditor and the recipient of the report can avoid researching the point on every occasion (usually references to or abstracts from Approved Documents or British Standards)

* by adding a coding system to the statements (reflecting the four status conditions explained above) different types of report can be generated (HAPM only issues an exceptions' report to external parties containing only matters of concern - full reports are used for internal purposes only)
* a completed audit can be checked as it is not subjective, it is always a matter of fact and always on record
* the content of the statements can be constantly under review by the audit system controller, and be subject to continuous improvements in terms of technical content and comprehension, the result is a system based on 'corporate wisdom', which is infinitely more comprehensive than the knowledge of any single individual, however well qualified or experienced
* the selected statements particular to each scheme represent data which can be analysed in many different ways

The process described above is operated for checking design and specification issues. A similar approach is used for checking workmanship issues on site. The significant difference being that the process on site is undertaken on bits of paper and the results input into the system after the inspection. Needless to say it is hoped to make use of hand held computers on site in due course.

3. THE PROCESS OF THE AUDIT

The audit of a scheme is an ongoing process that takes place during the construction phase and which commences on receipt of a reasonably comprehensive submission of scheme drawings, specifications, calculations and ground investigation reports. An initial audit report is produced following scrutiny of the submission documentation and this is sent, via the Housing Association, to whoever has design responsibility for the scheme, together with an invitation to provide a considered and professional response to any issues raised in the report. Ideally this first report should arrive with the designer in sufficient time for any design changes deemed necessary, as a result of the audit, to be incorporated before construction commences. Because of the nature and timing of 'design and build' contracts in particular, it is more common for the audit to be undertaken while the initial construction stages proceed, remembering that HAPM does not have to 'approve' construction. A first site visit is then planned to occur at about one third of the way through a typical contract and a further audit report produced subsequently. The second report should benefit from both the information gained during the site visit and the design team's response to the first report. In an ideal world the second report should be largely 'clean' so that the scheme can progress towards practical completion and insurance without further involvement of the audit team. More often one or more issues may need further clarification or some information may be outstanding such that a third and final audit is required.

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Additional site visits may be deemed necessary on larger schemes or where the initial visit raises concerns about workmanship. Each such additional visit generates a further audit report.

Surprise may be expressed at the limited extent of HAPM site inspections. Certainly these are not as frequent as other inspections (such as those made by Building Control officers), however, with the benefit of four years experience, they do seem to serve the insurance needs well. While they are infrequent they are extremely thorough and a whole day is set aside for a visit. The function of the visit is fivefold:

* Firstly, and most importantly the site auditor has to review every 'statement' selected by the office auditor and included within the audit report. Each statement has to be either 'validated' or 'invalidated' in the light of what can be observed on site (and only passed over if nothing can be observed).
* Secondly, the site auditor is required to fill in any information gaps that have inhibited progression of the audit (actual weight of blocks being used to construct a separating wall for example, if the specification was not available to the office auditor - as so often it is not).
* Thirdly, the auditor is required to confirm, correct or advise what key components are being incorporated (ie., actual manufacturer of any sound insulating quilts being laid). This data is used to 'life' the component.
* Fourthly, the auditor is required to complete workmanship sections of the audit, as appropriate, depending on what trades are in progress at the time of the site visit.
* Finally, he is prompted to ignore the discipline of the audit and to report anything that appears to him to be unsatisfactory.

This approach to site inspection is very much a calculated risk management exercise. It assumes that the project structural engineer and the Building Control Inspector will visit and inspect while excavations and foundation works are in progress (bearing in mind that HAPM will have undertaken a very thorough scrutiny of the foundation design) and that final inspections of out-turn quality will be undertaken by architects/clerks of work employed by the client (bearing in mind that there is little insurance risk attached to finishings). It is of course the most relevant time to undertake a site inspection in the context of inspection of issues that are sensitive to the proper achievement of adequate sound insulation between dwellings. The site auditor is equipped with a camera and will make photographic records of both general elevations and construction details to support his written records. It will be recognised that this whole data set gathered on site can significantly advance the progress of the technical audit.

4. SPECIFIC PROBLEMS RELATING TO SEPARATING WALLS

4.1 The Types of Separating Wall

HAPM data indicates that about 50% of all separating walls are constructed of solid blockwork, 23% are constructed of heavy mass cavity blockwork with a minimum 50mm cavity, 15% are constructed of medium mass cavity blockwork with a minimum 75mm cavity and the remaining 12% are constructed of lightweight aircrete blocks again with a minimum cavity width of 75mm. This latter form of construction is not a specification included within the Approved Document but is endorsed by the British Board of Agrement in a number of product specific certificates. The data reported in below is calculated as a percentage of the specific form of construction rather than of all types of wall. Put another way it gives an indication of non-compliance for a specific form of construction.

4.2 Common Workmanship Deficiencies

4.2.1 Wall Tie Types in Cavity Walls. The Approved Document is explicit in requiring the use only of 'butterfly' pattern wall ties to link the two leaves of cavity separating walls. Other types are actually used in the case of 25% of all cavity walls. These will frequently be the heavy vertical twist types or double triangle variety or one of many 'patent' designs, including plastic types, very few of which have been tested to confirm that they will perform in an equivalent manner to the butterfly pattern. Reasons cited for failure to follow the guidance include structural criteria and preference to use a single pattern of tie on a site in which case the ties necessary for the external walls will inevitably dictate the selection.

4.2.2 Perforations Around Built in Joists. The Approved Document rightly warns of the compromised sound insulation that will result where floor joists are built into separating walls and imperfections of fit between the wall and the joist are such as to create air paths. HAPM site inspections reveal that where joists are so built into the wall there will be significant gaps left in 32% of cases. The fact is that the sort of precision required in cutting blocks to avoid gaps is unlikely to be achieved unless site supervision is of the highest order.

4.2.3 Provision of the Vertical Cavity Closer. The Approved Document requires the inclusion of a vertical closer in the cavity of the external wall at the position of the separating wall. This is a relatively new requirement and as such mystifies many as to its purpose and significance. It has been found omitted in 34% of inspected schemes.

4.2.4 Plasterboard Thickness. The Approved Document sanctions the use of plasterboard on dabs as an alternative to 'wet' plastering a wall in certain conditions, however in all instances requires provision of a 12.5mm thick board. Our data indicates that plasterboard is used for 43% of all separating walls and where it is used it is likely to be only 9mm thick in 12% of cases.

4.2.5 Filling of Mortar Joints. It is very difficult to check whether vertical ('perps') mortar joints fully fill the space between the masonry components. Final appearance (before plastering) can be very deceptive and observation as the work proceeds is the only reliable way of checking diligent filling. The reality is that in the case of blocks (rather than bricks) it is very difficult to fully fill the vertical joint using conventional bricklaying techniques. Bed joints are much more reliable (because the mortar is laid and the block placed upon it) and some specifiers require solid block separating walls to be laid with the blocks horizontally inclined rather than vertically. HAPM inspections indicate that 10% of walls are constructed with inadequately filled joints.

4.2.6 Block Substitution. Despite all the efforts of a specifier to ensure that a suitable density block is used for separating wall construction, substitution on site is quite common. HAPM does not have reliable data available to enable a specific failure frequency to be identified. It is quite common to see two quite different blocks (evident from their surface texture/colour) used in the same separating wall. Usually the lighter weight and therefore easier to lay external wall thermal insulating block is used.

5. SPECIFIC PROBLEMS RELATING TO SEPARATING FLOORS

5.1 The Types of Separating Floors

The bulk of HAPM data for new dwellings relates to concrete floors that largely correspond with what are designated 'Type 1' and 'Type 2' floors in Approved Document E. Timber separating floors in new masonry flats are very rare (excluding timber frame construction) and the data is not reliable. However at the end of this section some relevant feedback from a claim is included.

As a percentage of all concrete separating floors, solid concrete with a resilient floor finish (Type 1) account for 13%, concrete with resilient layer and screed for 59%, concrete with resilient layer and timber deck for 19% and a further 9% are of other various constructions not included within the Approved Document.

5.2 Common Workmanship Deficiencies

5.2.1 Grouting of PC floor components. The current most popular form of concrete deck construction is that known as 'beam and block'. This comprises pre-cast pre-stressed concrete joists (inverted T sections) spaced apart with concrete blocks placed to span between the joists. For structural reasons it is necessary to 'grout up' the floor after it has been assembled from the dry components to 'lock' the parts together in order that composite structural action can be achieved. However this grouting is important for sound insulation also, most particularly when a timber deck on resilient layer (or resilient battens) is proposed in order to seal the hundreds of air paths between separate the concrete components. Unfortunately this grouting process is haphazard at best. Sometimes it will be done by the concrete supplier as part of a supply and erect package (and the supply companies will admit that should it rain soon after laying it may be

washed away). More often it is the responsibility of the main contractor who will be left to select a grout mix and method of application - a semi-dry sand/cement mix brushed over the floor is the best that can be expected. It is a matter of fact that it will be forgotten completely in some instances. In any event the probability is that the site applicator is unlikely to understand the need for vigilance in filling all the interstices. Checking of workmanship is virtually impossible unless the work can be observed in progress. HAPM site auditors judged the grout to be missing in 21% of such floors and inadequately applied in 33% of inspections. There is a similar requirement to grout between concrete plank floor units which was found to be deficient in 14% of cases.

5.2.2 Sealing open ends of hollow planks. Hollow pre-cast concrete plank floors that are built into separating walls are required to have the open ends of the voids solidly filled to limit sound transmission (BS 5268:Part 3:1985, Clause 26.2.2.1). This is of course easily over looked on site and frequently not identified in specifications. HAPM data indicates that 45% of plank floors do not have the voids so sealed.

5.2.3 Treatment of Resilient Layers at Perimeters. It is important that floating screeds and floating decks are isolated from perimeters by turning the resilient layers up against the wall or partition. HAPM data indicates that the layer was not properly isolating the screed/deck in 18% of such floors.

5.2.4 Prevention of Screed from Bridging the Separating Layer. It is recommended that where a screed is to be placed over a separating layer a membrane is used beneath the screed to prevent screed entering gaps between the joints, alternatively where the separating layer is a rigid foam board joints may be taped. Such measures were seen to be omitted in 7% of screeded floors.

5.2.5 Reinforcement of Floating Screeds. It is generally accepted that in order to minimise cracking and control curling at edges, floating screeds should incorporate a light steel mesh (BS 8203 & 8204). While omission of the mesh occurs very occasionally, misplacement of the mesh within the screed has been seen to be incorrect in 50% of observations. The problem is that while the correct method of construction (BS 8000) is to place and compact half the depth of screed, lay the mesh and place and compact the second half, it is much easier to lay out the mesh and place the whole depth of screed above. By a process of tramping and compacting the mesh ends up bound into the lower part of the screed.

5.3 Feedback on a Failure of a Timber Separating Floor

While there is insufficient data on timber separating floors for robust statistics one of the first claims that was settled by HAPM related to an interesting workmanship issue in connection with a timber floor.

The floor comprised timber joists, a mineral wool quilt resilient layer laid over the joists and battens laid on the resilient layer to support the floating chipboard deck. Ignoring the fact that the quilt was of the wrong density and the ceiling below lacked a layer of plasterboard it transpired that the carpenters had placed the battens that supported the deck across the timber joists rather than immediately on top of the joists. As a consequence the mineral wool was highly compressed

at the intersection of each batten and joist and was effectively crushed, whereas had the battens sat along the length of each joist the floor load would have been distributed over a much greater area of the quilt.

Reference to a sketch in the Approved Document properly shows a batten sitting along the length of a joist, however the casual observer could be forgiven for not recognising the subtlety, which is not explained in the text. Consider also the practicalities of laying such a floor; battens laid loose because they cannot be nailed into position perched on joists which have been obscured by the quilt on which sheets of chipboard have to be manhandled into position! Perhaps solutions included within the Approved Documents should be tested for 'buildability' before endorsement.

6. THE SIGNIFICANCE OF THE FINDINGS

Some of the statistics reported in this paper may be deemed to be at least 'worrying' in terms of the reliability of sound resisting construction. Most industries measure failure rates in terms of fractions of one percent. How can construction justify to its customers failure rates approaching 50%.

This paper has focused on workmanship issues and there may be a tendency to conclude therefore that it is the builders who are responsible for such problems. This would not be a fair assessment. HAPM data on design issues in the context of sound insulation is equally concerning and indicates that matters such as flanking wall construction, the principles of isolation and construction mass are poorly understood and design is similarly unreliable.