STANLEY SIDINGS LIMITED

Condition survey and strength grade assessment of accessible first floor lintel and floor structures at the nos. 26 and 27 Stables Market, Camden Town, London

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CONTENTS

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1 INTRODUCTION

1.1 AUTHORITY AND REFERENCE

Hutton+Rostron Environmental Investigations Limited carried out a timber decay and strength grading survey at The Stables Market, Camden Town on 5 October 2016 in accordance with instructions received from Arin O'Aivazian by email dated 28 September 2016 on behalf of Stanley Sidings Limited. Reference was made to drawings supplied by the client for the identification of structures. For the purpose of orientation in this report the north orientation is illustrated on drawings

1.2 AIM

The aim of this investigation was to identify decay problems and to give recommendations on any remedial works required to correct such problems and prevent damp or decay problems in the future using environmental means as discussed in Appendices A, B, C & D

1.3 LIMITATIONS

This survey was confined to the accessible structures. Concealed timbers and cavities have been investigated where necessary. The condition of concealed timbers may be deduced from the general condition and moisture content of the adjacent structure. Only demolition or exposure work can enable the condition of timber to be determined with certainty, and this destroys what it is intended to preserve. Specialist investigative techniques are therefore employed as aids to the surveyor. No such technique can be 100 per cent reliable, but their use allows deductions to be made about the most probable condition of materials at the time of examination (see Appendix B). Structures were not examined in detail, except as described in this report, and no liability can be accepted for defects that may exist in other parts of the building. Any design work carried out in conjunction with this report has taken account of available pre-construction or construction phase information to assist in the management of health and safety risks. The sample remedial details and other recommendations in this report are included to advise and inform the design team appointed by the client. The contents of this report do not imply the adoption of the role of Principal Designer by H+R for the purposes of the Construction (Design and Management) Regulations 2015. No formal investigation of moisture distribution was made

2 EXECUTIVE SUMMARY

2.1 OBSERVATIONS AND RECOMMENDATIONS

Localised wet and dry rot occurs along the north and north-west parts of the floor structures of building nos. 26 and 27. Large parts of the floor structures had limited accessibility but reliable assumption could be made on condition. It was not possible to examine behind wall panelling where it existed. The probable strength grades ranged between C16 and C24 but access for formal grading was not available

Open up the complete floor and remove panelling where it exists to allow detailed inspection. Repair works are described in the report, predominately along the north wall and north-west corner. No chemical timber treatments or wall irrigations are required. All new timber for repair work or on refurbishment generally should be isolated from masonry with strips of damp-proof membrane

3 OBSERVATIONS AND RECOMMENDATIONS

Some structural timber decay had occurred in the past and there were some areas of active timber decay infection. There were a number of building defects that allowed moisture build-up in the structure and provided the conditions for timber decay organisms to grow (see Appendix A)

3.1 EXTERIORS

The exteriors were not examined for the purpose of this report. It is likely that rainwater ingress has occurred in the past affecting parts of the building. This may have allowed internal timber structures to become damp and vulnerable to decay particularly where resultant dry rot infection to the masonry had occurred in the past

The external fabric of the building should be inspected. Ensure that all rainwater ingress is prevented and all rainwater drainage systems discharge rainwater clear of the building

3.2 INTERIORS

3.2.1 Building No. 26 (first floor)

1 General comment: The floor structure comprised of floor joists, approximate dimensions 170 x 60 at 200mm centres supported on an iron beam along the west side of the area. Significant dry rot fungal decay occurs in the north-west corner. The floor had been partially opened up but the opening-up in this area was not extensive. The deep moisture content was taken and found to be 12-14 per cent indicating that the infection may be inactive. There were no signs of active infection

Open up the complete floor to allow detailed inspection of all floor structures in this area. See drawings in Appendix F for the location of opening up work. No chemical timber treatment or wall irrigation is required on refurbishment but extensive repair and isolation will be required

2 Primary beam: No primary beams were available for inspection in this area. It is likely that there may be a primary beam in the centre part of the area but this was not verified. See drawings for location

Open up the floor and wall panelling if necessary, to allow detailed inspection of the primary beams and plates under, if any exist. See drawing for the locaton of opening-up works. Repair estimates should allow for the inspection and probable repair of a primary beam that bears into the north wall if one exists. All new timber should be isolated from masonry on refurbishment as directed by the Structural Engineer and agreed with H+R on detailing

3 Floor structure: Inspection of the floor joists was undertaken along the west side of the room where opening-up had occurred. This revealed that 5 no. joists were partially decayed by wet rot fungal decay. Some of the joists were doubled-up. The decay extended to approximately 1 to 2.5m from the west wall. The decay was structurally

significant. The deep moisture content was 12-14 per cent which is high enough for timbers to be at risk of further decay

The structurally decayed floor joists (5 no.) should be repaired or replaced at their west bearing ends. The repair may be carried out by cutting back to sound timber and partnering with new timber joists coach bolted to the remaining sound section. Alternatively, it may be more cost effective to replace the decayed joists entirely. Lift all floor coverings to facilitate and allow further inspection of all joists in the room. Repair estimates should allow for the further inspection and probable repair and strengthening of up to 6 no. floor joists. An embedded plate, if one exists, should be removed and the void bricked-in. All new timber should be isolated from masonry by using metal joist hangers with a damp-proof membrane over the end grain or similar form of isolation

4 Lintels: Lintel nos.5 and 6 were comprised of brick arch structures

The lintels may be retained on refurbishment at the discretion of the Structural Engineer

5 Strength grades: Restricted access prevented formal strength grading assessment of the floor joists. Timber sample analysis revealed that the timber species of the joists in this area were European redwood *(Pinus sylvestris*) group. This timber species within this group gives probable strength classes ranging between C16 and C24

Further strength grading assessment could be undertaken when the floor covering is entirely removed and improved access to the joists is available. The requirement for strength grading will depend on the wishes of the Structural Engineer

3.2.2 Building No. 27, first floor

1 General comment: The first floor structure comprised of floor joists, approximate dimensions 180 x 65 at 340mm, spanning north to south and bearing in masonry pockets and supported on 2 no. primary timber beams, (approximate dimensions 230 x 190mm) spanning east to west. The primary beams were supported in masonry pockets within the east external wall. Significant decay occurs to the joists along the accessible north side. Parts of the floor had been opened allowing localised inspection

Repair works are required along the north side of the floor. Open up the entire floor structure to allow inspection and repair

2 Primary beams: The timber primary beams were drilled at their east bearing ends. This revealed no structurally significant decay. The deep moisture content was less than 12 per cent which is below the decay threshold of 22 per cent. There was no access to the west (internal) bearing ends but fibre-optic borescope in this area revealed no visible signs of decay

The primary beams may be retained at the discretion of the Structural Engineer providing no rainwater ingress occurs

3 Floor joists: Inspection of the first floor joists revealed that 11 no. joists were decayed by wet rot fungal decay at their north bearing ends. There was no access to the south bearing ends where the joists were connected to the primary beam. The deep moisture content at the north bearing ends was found to be 12 to 20 per cent. This is damp enough for the decay to continue. The decayed joists were marked on site with red spray paint. See drawings for the location of the decayed joists. There was no access to the wall plate, if one exists

The structurally decayed first floor joists (11 no.) should be repaired at their north bearing ends or replaced entirely. Remove floorboards and wall panelling to gain *access. The repair may be carried out by cutting back to sound timber and partnering with new timber joists coach bolted to the remaining sound timber. Alternatively, it may be more cost effective to replace the decayed joists entirely. The embedded wall plate, if one exists, should be removed and the void bricked-in. Lift all floor coverings to facilitate and allow further inspection of all joists at their connections to the primary beams. Repair estimates should allow for the further inspection and probable repair and strengthening of up to 6 no. joist at the connections to the primary beams*

4 Lintels: Lintel nos. 1, 2, 3 and 4 were drilled at their bearing ends. No decay was detected. The deep moisture content was less than 12 per cent

The lintels may be retained on refurbishment at the discretion of the Structural Engineer providing no rainwater ingress occurs

5 Strength grades: Restricted access prevented formal strength grading assessment of the floor joists and primary beams. Timber samples were taken from a representative floor joist and tie beam and analysed. This revealed that the timber species was European redwood *(Pinus sylvestris*) group. This timber species gives probable strength classes ranging between C16 and C24

Consideration should be given to a formal strength grading assessment being undertaken when the floor coverings are removed and there is improved access to the joists. Ideally the whole span of the timber elements should be exposed

4 GENERAL RECOMMENDATIONS

All new and refurbishment detailing should be assessed for its effect on environmental and structural health. General principles are set out below. Special care is required when introducing new materials, moisture sources or heating and ventilation systems, for example air conditioning

4.1 ROOF AND SURFACE DRAINAGE

4.1.1 Maintenance

All guttering, hopperheads and outlets should be regularly checked and cleared to keep them free of debris, especially during the autumn months

4.1.2 Protection

Hopperheads, gutter outlets and ground gullies should be protected with metal mesh cages so as to prevent blockage and overflow. These should extend higher than the expected water level to reduce the tendency to block and should be easily removable to allow cleaning and maintenance

4.1.3 Overflows

Hopperheads, parapet gutter outlets and valley gutter outlets should be fitted with overflow pipes to drain water clear of the structure in case of blockage. These should be at a level below that at which water would overflow the roof flashings

4.2 VENTILATION

4.2.1 Structural voids

All structural voids within the building should be provided with adequate through ventilation so as to prevent moisture build-up. This must be done with regard to the applicable fire regulations

4.2.2 Roof spaces

All roof spaces, including flat roof areas and gutter soles, should be provided with adequate through-ventilation. This may occur via the gaps between slates in unsarked pitched roofs. However, flat roofs and pitched roofs with sarking or insulation will require the installation of vents through the roof surfaces or at the eaves and ridges. Insulation material in roof spaces should be kept clear of external walls, gutter soles or timbers in contact with damp or potentially damp masonry

4.2.3 Windows

Windows should be refurbished so as to allow easy and convenient opening and closing by occupants in order to encourage proper ventilation of the building. This is important both for environmental and structural health. Windows should be fitted with security locks so as to allow secure locking in a partially opened position

4.3 STRUCTURAL DETAILING

4.3.1 New timbers

New timbers should be isolated from any damp or potentially damp masonry with a damp proof material or ventilated air gap

4.3.2 Timber repairs

Structurally decayed timbers should be removed or cut back to sound timber unless required for aesthetic reasons. Timbers should then be partnered or spliced as in section 5.3.1 above. If steel plates or hangers are used, they should be detailed so as to allow sufficient ventilated air gaps and drainage to prevent moisture build-up due to condensation. No timber preservation or remedial treatments should be required

4.3.3 Paint finishes

Moisture vapour permeable or 'microporous' paint finishes should be preferred for internal and external surfaces and woodwork. This is especially important on window timbers. To take advantage of the properties of such paints, the complete removal of old alkyd paint systems is recommended. Health and Safety: Special precautions should be taken during surface preparation of pre 1960's paint surfaces as they may contain harmful lead. (Permoglaze MVP System, produced by Akze Nobel Decorative Coatings Ltd, is one example of a suitable opaque high build water-borne moisture vapour permeable paint system, consisting of an MVP primer undercoat and MVP acrylic gloss. There may be other similar products available)

Appendix A

A.1 DRY ROT

Dry rot (*Serpula lacrymans*) belongs to the same group of fungi as most of the common mushrooms and toadstools. Reproduction is by means of spores which are produced in enormous numbers by the fleshy pancake-shaped fruiting body. These fruiting bodies generally only appear when the fungus is stressed or dying off. A well established infestation may produce fruiting bodies more than one metre across and be accompanied by thick layers of rust-coloured spore dust. Each minute spore has an outer coat which affords it some protection against heat and desiccation, and germination has been achieved after a twenty-year latent period. Dry rot spores are ubiquitous and there is no domestic or natural environment entirely free of them. They can be found throughout the environment from high up in the jet stream to the middle of the countryside

Spores will germinate and grow in timber with a moisture content of between 20 and 30 per cent. The fine fungal thread (hypha) digests the cellulose and hemi cellulose fractions of the wood, but is unable to attack the structural linings. These remain as a brittle matrix which cracks into cubes under differential stresses. Cuboidal cracking is also a characteristic of many wet rots and does not automatically indicate the presence of dry rot

Fungal hyphae may clump together into a variety of structures known as mycelia which take various forms depending on the surrounding conditions. They may fill a humid cavity as a cotton wool-like mass, or grow across the surface of the timber, as a grey-white skin. Active dry rot has a fresh white or greyish appearance and smells strongly of mushrooms. Distinctive patches of lilac or canary yellow pigmentation are usually present

Some hyphae group together to form conducting strands. These have a fairly impervious outer layer rich in chitin, the major constituent of insect cuticle. The strands, which may reach a centimetre in thickness, are flexible when moist, becoming progressively more brittle as they dry out. Their main function is the conduction of nutrients, through or across inert non-nutrient materials (brickwork etc) to other timbers. Their relatively impervious outer layer, together with an unusual alkaline tolerance, allows them to survive in the mortar layers within masonry and walls. An infested area may be full of dry rot strands. The dry rot fungus may tolerate relatively lower moisture contents and, through this, and other quirks in its biology, is potentially capable of considerable destruction. Realisation of this potential, however, requires a narrow range of environmental conditions and, in practice, several factors restrict growth

Dry rot hyphae may attack timber with a moisture content of about 18 per cent; however, spores would not germinate under these conditions. This moisture content is still 5 to 10 per cent wetter than timber should be in a healthy domestic building, and indicates water penetration or, perhaps, faulty plumbing. There is no evidence that dry rot can 'wet up' timber to any appreciable extent under conditions expected in a healthy building, although this is often claimed. The fine attacking hyphae, unlike the coarse conducting strands, are susceptible to desiccation and dry wood may disperse moisture faster than it can be transported. This means they cannot move through dry masonry and wood or across ventilated cavities

The total breakdown of wood by fungus produces considerable quantities of water. It has been suggested that dry rot can sustain itself on this 'metabolic' water alone. However, in practice, external drying factors disperse the moisture so that favourable conditions can be maintained only in exceptional circumstances such as behind impermeable finishes or in sealed cavities

In order to thrive, dry rot requires a moisture content in timber in excess of 20 per cent, and a relative humidity above 95 per cent. Below these levels the fungus will cease to cause current decay problems. Temperature is also a strong regulating factor, and growth ceases at about 25^{o}C, a temperature frequently exceeded in roof spaces, for example. Large radiators can be particularly lethal to dry rot and measurements of 30^{o}C with 20 per cent relative humidity are not unusual in their immediate vicinity

Dry rot is attacked by many other decay organisms which cause particular damage when the fungus is under stress will eventually destroy it. However, under dry conditions, dead dry rot does not disappear. Strands may eventually darken and the fungal mats may lose their fresh appearance, becoming tinged with brown, and leathery or papery in texture. The decayed wood becomes powdery as it dries, shrinks and distorts, which can be the first sign of decay having occurred behind paint finishes

A.2 WET ROT

Wet rot is caused by a number of basidiomycete fungi of which the most important are *Coniphora puteana* (cellar fungus), *Poria fungi*; *Fibroporia vaillantii*, *Poria placenta*, *Amyloporia xantha*, *Geophyllum trabeum*, *Phellinus contiguus*, *Donkiporia expansa*, *Pleurotus ostreatus*, *Asterostroma* and *Paxillus panuoides*. They attack both softwoods and hardwoods causing a darkening of the timber (brown rot) or bleaching (white rot). Wet rot fungi usually occur in persistently damp conditions, needing an optimum moisture content of 50 to 60 per cent. Unlike dry rot, the conducting strands of wet rot fungi do not extend far from their nutrient wood, hence they cannot travel through masonry and brickwork. The fruiting bodies occur rarely in buildings. Wet rot has been known to hollow out giant beams. Wet rot *Coniphora puteana* is responsible for up to 90 per cent of wood decay within buildings but raises less concern than dry rot, possibly because it is more easily controlled by standard building techniques. Some wet rots are also called soft rots as they destroy both cellulose and lignin, leaving the colour of the wood largely unaltered, but producing a soft felty or spongy texture. Soft rot is caused by *Chaetomium globosum* and a number of other fungi also found growing on wet wood in buildings

A.3 WOOD-BORING INSECTS

The common furniture beetle (*Anobium punctatum*) has a life cycle consisting of four stages - egg, larva (which causes all the damage), pupa and adult. The eggs are laid in end grain or in existing flight holes and hatch in 4 to 5 weeks and the new larvae bore directly into the wood. The larvae feed and grow within the wood creating a network of tunnels closely packed with frass (small ellipsoidal pellets). The larvae are whitish, curved, approximately 6mm in length and have well defined dark-brown jaws. When fully grown the larva excavates a small chamber and pupates producing a beetle after 6-8 weeks which bores through a thin layer of wood producing the characteristic emergence holes 1-2mm in diameter. Emergence usually occurs between May and August. The life cycle depends on the condition of the wood, the temperature and humidity. The life cycle usually takes a minimum of 3 years within buildings. Attack is usually confined to the sapwood of softwoods and hardwoods but may occur in the heartwood in timbers such as beech, birch, spruce or in timbers modified by fungal decay. As sapwood only makes up a small cross section of the majority of structural timbers in older buildings, attack is often of little or no structural importance. In most instances of suspected attack, the infestation has died out long ago due to unfavourable environmental conditions. Careful checking is therefore required to establish that living woodworm are present

In cases of active infestation the environmental conditions are often marginal allowing the life cycle to continue but at a very slow rate. Small changes in the environmental conditions can tip the balance against insects. Woodworm attack is often very localised to small areas of high humidity or especially 'palatable' timber and further spread is highly unlikely

In the British Isles, death watch beetle (*Xestobium rufovillosum*) infestations occur most commonly in oak, probably because this wood used to be extensively employed in construction, but infestation can also occur in elm, walnut, chestnut, elder and beech. The life cycle is similar to that of the common furniture beetle but can take many years to complete from one year under experimental conditions, to ten years or more in a building (Ref 11). The hatched larvae wander over the surface of the timber before burrowing into it. When it is fully grown it pupates and changes into the adult beetle which does not emerge until the spring of the following year producing a 3mm diameter hole

In old buildings severe damage can be caused under favourable environmental conditions. Softwoods are occasionally infested where they are in close proximity to damp infected hardwood. Infestation is confined to fungal decayed or damp affected timbers. Many existing cases probably arose from the reuse of infected timbers from demolished buildings and from the use of unseasoned timbers used in their construction. Attack is not confined to the sapwood and often the heartwood is entirely consumed causing severe structural damage. Damage is most severe where ventilation is poor and where timbers are in contact with damp masonry

Death watch beetles are not active fliers. A localised attack of death watch will not automatically spread to the whole house and infest every timber in the building. Lowering of moisture contents of the timber in conjunction with careful observation to determine the level and extent of activity should provide control of the insects. Some severe cases may merit the use of local insecticide treatments as a first aid measure. However, the chemical must be targeted properly or large quantities of toxic pesticides will be used to little effect

Woodworm and death watch beetle infestation will not flourish if the moisture content of timber is below about 14 to 15 per cent. The risk of infestation of insect attack is slight, in timbers with a moisture content at or below 14 per cent and the insect larvae will desiccate below about 12 per cent moisture content. The infestation will eventually die out if the timber moisture content is maintained below this. Healthy roof timbers should have a core moisture content of between 14 to 15 percent, while suspended floor timbers should be between about 11 and 14 per cent. Installation of a central heating system may reduce these moisture contents to about 9 per cent particularly in exposed timbers

It is absolutely necessary to recognise whether an insect infestation is 'active' or 'dead'. The presence of fresh frass (bore dust) in conjunction with damp timbers may be acceptable evidence of active infestation

Appendix B

B.1 PRELIMINARY INSPECTION AND INVESTIGATION

The basis of any investigation is an understanding of building structures and defects and how these may interact to produce the ecological niches in which various decay organisms can thrive. With experience, an initial visual inspection can give a good idea of the areas that will need further study. A check-list for this preliminary investigation includes building defects, significant timber structures and concealed cavities

The condition of concealed timbers may be deduced from the general condition and moisture content of the adjacent structure. Only demolition or exposure work can enable the condition of timber to be determined with certainty and this destroys what it is intended to preserve. A non-destructive approach is therefore required and to help reduce uncertainty, specialist instrumentation and test equipment can be useful. However, it is important to remember that all tests and instruments are only aids to the surveyor, and must be interpreted with experience and care. A slavish reliance on any technique and failure to take into account its limitations is a recipe for disaster. No technique can be 100 per cent accurate or reliable

The techniques that may be used for preliminary investigation include resistance-based timber moisture meters, capacitance masonry moisture detectors, borescopes and Rothounds

B.2 DETAILED INVESTIGATION

The findings from the initial investigations are followed up by more detailed study. The aim is to determine as far as possible the distribution and extent of all significant decay and organisms in the building, the distribution of micro environments predisposed to timber decay and the building defects that cause them. The extent of significant timber decay should also be determined as far as possible. Active decay organisms may not yet have caused significant timber decay. Conversely, there may be significant decay even when the decay organisms that caused it have been dead for many years. This may seem obvious but many expensive 'treatments' are carried out on insect or fungus damaged timber that has not been infected for tens or even hundreds of years. Key factors that may be noted are species and viability of decay organisms, moisture content of materials, ambient relative humidity, and ventilation. Timber species and previous chemical treatments may also be significant

It is important that the results of the investigation are co-ordinated with the building structure bearing in mind the characteristics of particular periods and methods of building. They should also be carefully recorded and quantified where possible. This allows analysis of the results by other experts, reduces the 'grey' area in which disputes of opinion can arise and forms a basis on which future investigations can build. Photography can be especially valuable and may be used when necessary

B.3 ROTHOUNDS

Rothounds are specialist search dogs trained to help find dry rot (*Serpula lacrymans*) in buildings. Rothounds may indicate areas of active dry rot even before they are visible to the naked eye. This will occur if the dry rot is just developing, is inside the substance of the timber, between the timber and another surface or within porous masonry. Such indications may be confirmed by comparing them with measurements of the moisture content of the structure or by the use of a drilled sample. Rothounds will not indicate the remains of dead dry rot infestations

In areas indicated by Rothounds the significant timber structures should be checked for structural decay or high moisture levels. Even if these are not found steps should be taken to reduce moisture levels and increase ventilation. This may be all that is required to stop a developing problem and all that is then required is to check the area in 6 months. For this purpose Hutton + Rostron again favour the Rothounds

1 Capabilities

a May detect living dry rot (*Serpula lacrymans*) by the scent of the metabolites produced by the fungus

b May detect the scent of dry rot even when hidden behind panelling, under floors, behind plaster or in other concealed cavities

c May detect the scent of dry rot at a distance of several metres depending on scenting conditions

d May detect early dry rot growth before it is detectable by the unaided human eye

e May discriminate between living or dead dry rot and between dry rot and other fungi instantly

f Actively search for dry rot in buildings at high speed, covering 20 to 50 rooms in an hour

g May indicate extent and spread of dry rot infestation

h Will search small inaccessible areas and roof spaces

i Will work in furnished and inhabited buildings

j Totally non-destructive

k Will work 2-4 hours per day

2 Limitations

a Trained only to indicate living dry rot, not wet rot or dead dry rot. Will not indicate fruiting bodies on old dead outbreaks of dry rot

b Indicate the scent of dry rot and the point of maximum scent. This may need interpretation as scent can occasionally be moved by air currents from the point of origin

c Scent will not travel through impermeable surfaces such as neoprene. However, it may be detected at the edge of an impermeable barrier, eg around the edge of a room with a rubber-backed carpet covering an infected floor

d Indicate dry rot infection, not decay. Therefore heavily decayed but inactive outbreaks may give a weaker indication than a recent highly active outbreak that has not yet caused significant decay e May not work if there is a corrosive or choking dust or vapour. However Rothounds should not be put off by smells and may detect even small amounts of dry rot in the presence of other strong scents

3 Uses

a Survey of properties prior to purchase, renovation, change of occupancy etc, to quickly check for hidden problems

b Preliminary survey of properties with suspected decay problems to determine existence and extent of dry rot infestation

c Survey of properties with known dry rot problems to determine activity and extent of infestation

d Survey of properties undergoing remedial works to check for additional hidden areas of infestation

e Survey of properties after remedial works to check for efficiency of treatment

f Routine survey of properties with past problems thought to be at risk in order to detect recurrence of infestation at an early stage before significant decay can occur

g Periodic survey of properties with known problems awaiting renovation, to detect 'hot spots' of dry rot activity

These can then be dealt with by 'reactive maintenance' allowing outbreaks to be controlled by minor exposure works and environmental controls. This avoids expensive building or remedial works. Further decay is prevented and infection controlled with significant savings on eventual renovation

B.4 FIBRE OPTIC BORESCOPE EXAMINATION

A technique we have found routinely useful over the last 15 years is the use of fibre optics. We use long reach, fixed side view, rigid borescopes and high power light sources. Although this is comparatively expensive it is essential for getting a clear view across a cavity such as a floor space. It also minimises the time spent and the number of holes drilled. Fibre optic inspection can reveal extensive decay and the consequences of water penetration. However, most wood-destroying fungi will not live on the face of timber which is exposed to air movement because this produces a drying effect. It is always a possibility that a fungus, especially dry rot, is travelling behind a wall plate, for example, and is not detectable from the cavity. Fibre optic inspection may not, therefore, find a minor attack which is developing, but it should indicate where these might be initiated so that faults can be identified and remedied. The siting of inspection holes depends on the points at risk within the room and will usually be located adjacent to balcony floors, flat roofs, cracks in rendering and other points where faults may have resulted in water penetration. Inspection may also be limited in areas of tiled and glued flooring materials and ornate or special wall coverings. Inspection holes are numbered and capped off for future use

B.5 THE MEASUREMENT AND SIGNIFICANCE OF MOISTURE CONTENT

The moisture contents in timber, mortar and plaster are measured by a variety of methods. Timber moisture content might be ascertained by the use of a standard resistance-type moisture probe which measures the moisture content at the surface of the wood. However, this moisture content will be subject to considerable fluctuation, depending on current relative humidity and temperature. A rafter in a roof in summer may, for example, have a moisture content at the surface of 16 per cent which might rise to over 20 per cent in winter. This difference would not necessarily reflect increased water content resulting from a fault in the roof, but might simply be a redeposition of water resulting from a considerable drop in temperature

The condition in the core or subsurface of a timber will remain relatively stable which is why the centre of thick timbers may be preferentially decayed. It is this 'deep' moisture content which must be measured if results are to be meaningful. For this reason a hammer probe with insulated electrodes or deep moisture probe is used to measure the moisture content within the timber. Healthy roof timbers should maintain a stable core moisture content of between about 12 per cent and 16 per cent, whilst suspended floor timbers (excluding ground floors) should be between about 11 per cent and 14 per cent. Central heating will usually reduce this figure to around 9 per cent

Similarly, surface moisture content readings in plaster and mortar are of limited value except for purposes of comparison. A surface capacitance meter may be used on plastered walls. For further investigation absolute measurements of moisture content may be made on site by means of a carbide-type gas pressure meter

Alternatively, samples are taken back to the laboratory in sealed vials, and the moisture contents are measured by the oven and balance method. For this, mortar samples are obtained by drilling holes in the wall and dust from the first inch of each hole is discarded. Dry mortar and plaster should have moisture contents below about 2 per cent. At levels much above this the moisture content of incorporated timbers will exceed 20 per cent and may easily reach levels at which fungal decay is likely

B.6 OTHER TECHNIQUES

Other techniques that may be used include microscopy, laboratory culture, hot wire anemometry and electronic RH measurement. We have also developed special instruments for measuring 'available' water in materials and for ultrasonic detection of timber-boring insects. More exotic techniques may sometimes be useful such as pheromone insect traps, infra red thermography, shortwave radar, automatic weather stations and total building monitoring using specialist data loggers

Appendix C

The most critical factors for the environmental control of decay organisms are available moisture and temperature. The former is dependent on such factors as moisture content, relative humidity, micro-ventilation, and salt content. In simplistic terms it is necessary to correct building defects leading to high moisture contents in timber and to increase ventilation around timber at risk

In practice there are two problems; first it is necessary to identify the significant building defects and then the best techniques must be chosen to control the environment at each point. This may be achieved by analysing the building in terms of moisture sources, moisture reservoirs and moisture sinks

It is not possible to prevent moisture entering a building entirely and often attempts to block the movement of moisture through a building structure using impermeable materials are ineffective. They may also be counter-productive as they can prevent moisture being dissipated, resulting in high moisture levels and decay in adjacent materials. The more effective and robust approach is that used in traditional buildings. Here, porous materials are preferred, and every moisture source is balanced by a moisture sink. Thus ground water may penetrate masonry but is evaporated off before it reaches timber structures. Similarly, water vapour is introduced by occupation, but is ventilated out via windows, chimneys and other passive and active forms of ventilation. Failure to balance a moisture source with an appropriate sink may result in moisture moving into vulnerable materials and eventually causing decay and other problems

Moisture reservoirs occur when a moisture 'source' has not been balanced by a 'sink' and water has accumulated in a porous material. Typical examples of this are to be found when thick masonry walls have been soaked by persistent leaks or when chimney breasts have been filled with rain water from uncapped chimneys. Such reservoirs may take years to dry out, even when the source has been dealt with. As a result they can act as a source of moisture for recurrent timber decay over a long period. A special case of this phenomenon occurs when large quantities of water have been used in fighting a fire

In practice then, each area of decay is associated with a building defect, resulting in an increased moisture source, a blocked or inappropriate moisture sink or a moisture reservoir. The appropriate building measures should then be specified to correct that defect

A common example might be the bridging of a damp proof course by raised ground levels. This will act as a moisture source and may result in decay of timbers in an adjacent floor space. Reducing the ground level will cut off this source and will also provide a sink of moisture by allowing evaporation from the exposed wall. The sub-floor moisture level might also be controlled by increasing the other available moisture sinks. Cleaning pre-existing airbricks or inserting additional sub-floor ventilation would be a common measure. In general it is important to increase evaporative surfaces and avoid obstructing them during refurbishment

Another common example would be a blocked and overflowing parapet gutter acting as a moisture source. This could wet up gutter soles, joist ends and wall plates as well as any other structure in an expanding cone extending from the leak down through the building. Preventing this moisture source may require a number of measures such as increasing the capacity of down pipes, re-lining the gutters and fitting thermostatically controlled trace heating tape to increase free flow of snow melt water

Any failure in a roof finish, gutter or coping will generally result in significant water penetration into the masonry wall beneath, which will then act as a moisture reservoir. Any timber in contact with this reservoir will be at risk of decay as it will tend to 'wick' moisture from the masonry. Steps must therefore be taken to isolate in-contact timber from the masonry using such measures as DPC membranes or joist hangers producing an air gap. It will also be necessary to ensure the timbers are adequately ventilated so that any moisture that is absorbed can be breathed off. Closed cavities or water-impermeable layers over timbers at risk must therefore be carefully searched out and rectified using knowledge of historic methods of construction. Bricked-in lintels and sealed up emulsion-painted sash windows are typical examples of structures at risk in this way

Having cut off the moisture source to a moisture reservoir and protected the 'at-risk' timbers it is next necessary to provide safe 'sinks' for the moisture. This will ensure that the reservoir is dried out in the long term. In some cases the reservoir can be removed entirely, for example damp pugging can be dug out and replaced. In most cases it is a matter of promoting ventilation around a wicking surface on the reservoir and ensuring that the moisture-laden air can be vented to the outside. Dry lining systems can be useful for this purpose as can the good old-fashioned chimney. Raising the temperature will promote the process of wicking and evaporation. General house heating can help but care must be taken to ensure that water vapour is not being 'pulsed' into other parts of the building by a sequence of evaporation and condensation down a temperature gradient. Heating can be especially useful if it is possible to heat the reservoir material itself. We have devised special systems for heating large section timbers and masonry for this purpose but again the old-fashioned fire-place and chimney is very useful

In some cases dehumidifiers can be used in the short to medium term, but care must be taken. They often require special 'tenting' and monitoring so that moisture is removed from the appropriate material and not from the world at large. They also require high air temperatures and high RH's to extract moisture efficiently

In all cases most of the remedial building works that may be required are quite within the capacity of the general contractor. Most are traditional repairs though some may take advantage of new materials or techniques such as dry lining, joist hangers and tanking. New and potentially useful products are coming into the building market all the time, for example, time controlled automatic fans, hollow ventilating plastic skirting boards, plastic masonry drains, roof space ventilating systems and moisture permeable paints. All such products and techniques can be used to help in making the environmental control of timber decay even more efficient and economical. All that is required is careful analysis of each situation and a little scientific understanding

Appendix D

The investigation and building works described in the previous appendices should put a building back into a state of structural and environmental health. The environmental control approach will also mean that a building is less likely to develop problems in the future. This is because the effect of minor building failures should be 'buffered' by the robustness of the systems established. Fortunately most traditional systems are robust in this way. This is why older buildings may tolerate a considerable amount of neglect and abuse before developing severe problems. However, the long-term health of the building will always depend on adequate maintenance. This is no less true of buildings treated with timber preservatives

A detailed investigation carried out as part of an environmental control policy provides an excellent basis on which to plan the most cost effective maintenance program. Indeed the building works required for environmental control are often best integrated into such a program. Short-term 'emergency' measures can be taken to simply halt further decay and measures to replace damaged structures or prevent future problems can be delayed to fit into a longer term plan of works. This flexibility in scheduling work as a result of the environmental approach allows further saving of costs and inconvenience

A maintenance program must also include provision for the routine inspection of all significant parts of the building at appropriate intervals. This should aim to detect and correct problems developing before they cause significant damage. Again the information gained in the investigation can be used to decide on the most cost effective inspection interval

In many cases remote monitoring systems can be very useful in increasing the efficiency and reducing the cost of maintenance programs. They can be especially useful for checking the moisture content of inaccessible timbers in roof spaces, behind decorative finishes and in walls. H+R have developed the Curator building monitoring systems for this proposal

Sensors can be placed at all critical points after the investigation or after the remedial building works. Areas can then be closed up and finishes re-applied, for example sensors may be placed in lintels, joist ends, valley gutter soles or in damp walls to monitor drying. It is important to use enough sensors and to place them with an understanding of the moisture distribution processes because conditions can vary even in a small area. It is these local variations in conditions that produce the environmental niches which decay organisms exploit

If more than 30 sensors are deployed, taking the readings can become onerous and this may result in human error or negligence. In these situations automatic monitoring systems become desirable. H+R have developed a number of specialised 'Curator' data logging systems to do this. With larger systems, the wiring of sensors can also become a problem. For systems requiring 100 or more sensors we can use a 'Curator A' unit working via a single 4-core main cable connecting up any number of nodes, each supporting 4 sensors. This system can be programmed with logging intervals and alarm limits for each sensor and can be read via the telephone system via its own modem. Data from the system can then be analysed using CAD and programs for statistical interpretation on a remote computer

Appendix E

E.1 HAZARD: Irritant dusts

Risk:	disturbance of building material or debris by exposure works, cutting, drilling etc could produce airborne dusts which may be irritant to the skin, eyes, nose and respiratory system, and may be a health hazard if breathed in by workers or others in the area; particular hazards include the disturbance of mineral/glass fibre insulation and/or chemically contaminated dust (resulting from remedial timber treatments) in roof spaces or other voids, the disturbance of materials containing asbestos, especially in boiler rooms, flues and pipework installations and the disturbance or removal of faeces deposited by birds or animals
Reduce risk by:	carrying out a COSHH assessment (the duty of the employer under the COSHH regulations) to determine the health risks and necessary measures to protect employees and others. This may include: correct identification of building materials, if possible before works commence (this may require research into record drawings/specifications for previous building refurbishments/repairs/refits; contacting HSE if the presence of asbestos is suspected; avoiding disturbance of hazardous materials; containment of dust within localised areas of the building by creating dust-proof envelopes; ventilation of working areas (may need to be mechanical and may need filtration for the retention of hazardous particulates); provision by employer and use by the operatives of personal protective clothing, goggles and breathing apparatus/masks suitable for the particular type of dust

E.2 HAZARD: Working in confined spaces

Risk:	there may be a build-up of toxic gases (eg from chemical remedial treatments or from site contamination) or a depletion of oxygen in the atmosphere of a confined space; restricted working space may be awkward and lead to injuries; escape may be difficult, causing overexposure to adverse conditions or delay to medical treatment; communication with persons outside the confined space may be difficult

Reduce risk by:	testing the atmosphere for toxic gases and if present, carrying out a COSHH assessment; providing a supply of fresh air into a confined space, if necessary; ensuring that work only proceeds with at least two persons - at no time should a person work alone in a confined space; ensuring that there are emergency procedures in place before work commences, for rescue from confined spaces

E.3 HAZARD: Collapse: renewal of lintels and beams

Risk:	improperly sequenced works during the renewal of decayed roof trusses, rafters, joists or lintels could lead to collapse of structure causing injury to workers or others
Reduce risk by:	specifying a correct sequence of propping, removal and replacement of structural members to maintain stability during refurbishment

E.4 HAZARD: Collapse: dangerous structures

Risk:	unstable structures which are the result of decay, fire damage, impact damage or partial demolition, could collapse causing injury to workers or others
Reduce risk by:	shoring up the structure to ensure its overall stability and prevent loose parts falling off; demolition of parts of an unstable structure which are not to be retained, but only if they are not of historical value and only with instruction from the Supervising Officer. Unstable structures should be made inaccessible to workers and others by means of barricades and warning notices until they have been stabilised/demolished. Barriers to comply with BS 6180:1995 Code of Practice for barriers in and about buildings

E.5 HAZARD: Electricity

Risk:	of electrocution by cutting through electric cables
Reduce risk by:	locating cables before excavation work or cutting into or drilling the existing building fabric, using a cable locator and cable plans, marking their position and taking precautions to avoid contact with them; supplying all portable tools and equipment with 110v transformers, not 240v; ensuring proper connections to equipment. All temporary electricity installations for construction sites should comply with BS 7375:1996

E.6 HAZARD: Falls from height (over 2 metres): scaffolding

Risk:	undertaking inspections or carrying out work from inadequately designed or erected scaffolding could cause persons to fall or injure themselves or others below
Reduce risk by:	use of properly designed and erected scaffold with adequate access; baseplates to uprights; adequate ledgers, braces, struts, ties; fully boarded platforms; guard rails and toe boards to prevent falls of more than 2 metres; frequent inspections of scaffold. Also personal protection such as safety harness and safety line. Scaffolding to comply with BS 5973:1993 Code of Practice for access and working scaffolds etc

E.7 HAZARD: Falls from height (over 2 metres): ladders

Risk:	undertaking inspections or carrying out work from improperly positioned or inadequately secured ladders could cause persons to fall or injure themselves or others below
Reduce risk by:	use of properly positioned ladders secured at the top, and which project at least 1.07 metres above any landing

E.8 HAZARD: Falls from height (over 2 metres): flat roof

Risk:	inadequate edge protection can allow persons to fall off the edge of a flat roof or through openings or fragile roof coverings
Reduce risk by:	installation of edge protection such as guard rails around the perimeter of flat roofs, and around openings or areas of fragile roof coverings within flat roofs; providing safe walkways, platforms, travelling gantries across fragile roofs. Barriers to comply with BS 6180:1995 Code of Practice for barriers in and about buildings

E.9 HAZARD: General

Risk:	general accidents in the course of work such as cuts, impacts, muscular strains etc
Reduce risk by:	providing first aid facilities; providing welfare facilities; providing personal protective equipment and ensuring that the workers use it; ensuring adequate lighting of all access areas and work areas; ensuring that emergency procedures are in place prior to site work commencing

Appendix F

Fig 1:

House 26, south-west corner; showing a joist supported on the west iron beam

Fig 2:

House 26, west wall; showing the floor structural joists bearing on the west iron beam

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Fig 3:

House 26, floor structure; showing the floor void

Fig 4:

House 26, north-west corner; showing the structurally decayed floor structure

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Fig 5:

House 26, east side; showing the inaccessible parts of the floor

Fig 6:

House 27, north side; showing decayed joists bearing in the north wall

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Fig 7:

House 27, south side; showing joists bearing in the south wall

Fig 8:

House 27, south side; showing the floor void

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Fig 9:

House 27, east side; showing the east bearing end of the south primary beam. Access to the beam was restricted

Fig 10:

House 27, east side; showing the east bearing end of the north primary beam

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Fig 11:

House 27, north side; showing the minimum bearing end of a joist

Fig 12:

House 27, north side; showing the structurally decayed north beams

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Fig 13:

House 27, lintel over window no. 1

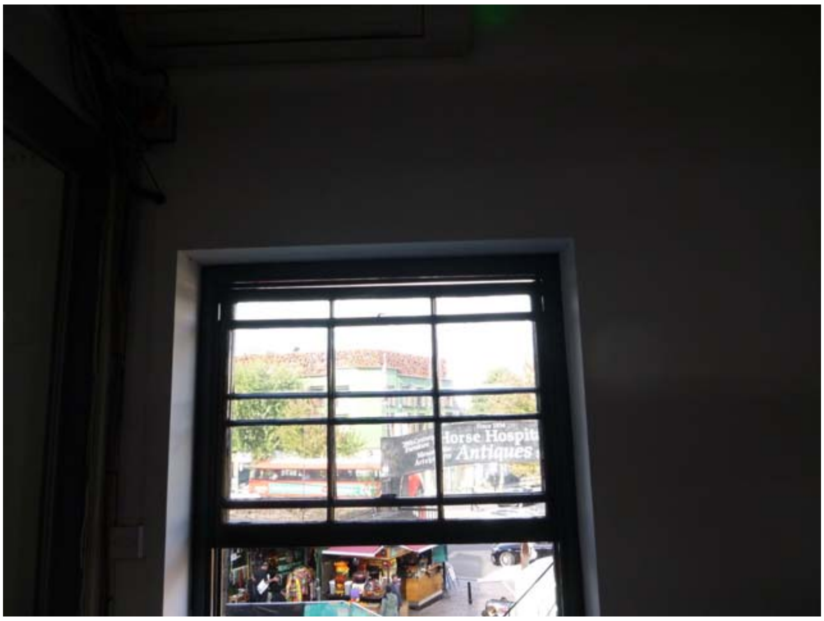

Fig 14:

House 27, lintel over window no. 2

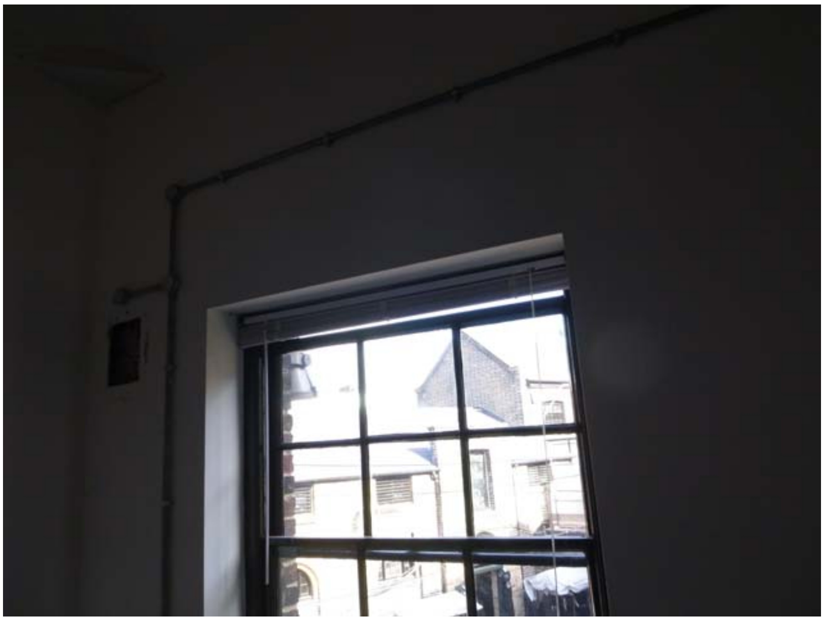

Fig 15:

House 27, lintel over window no. 3

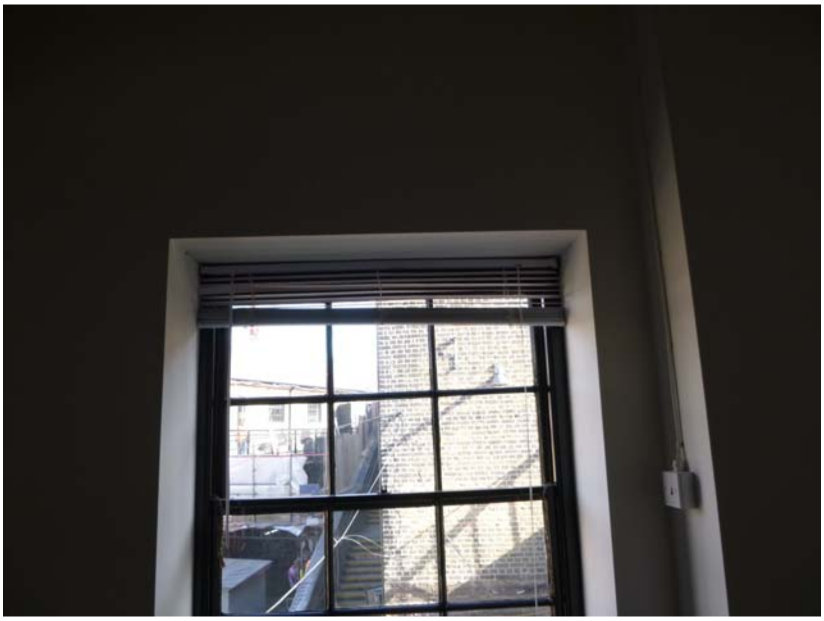

Fig 16:

House 27, lintel over window no. 4

Fig 17:

House 27, lintel over window no. 5

Fig 18:

House 27, brick arch over window no. 6

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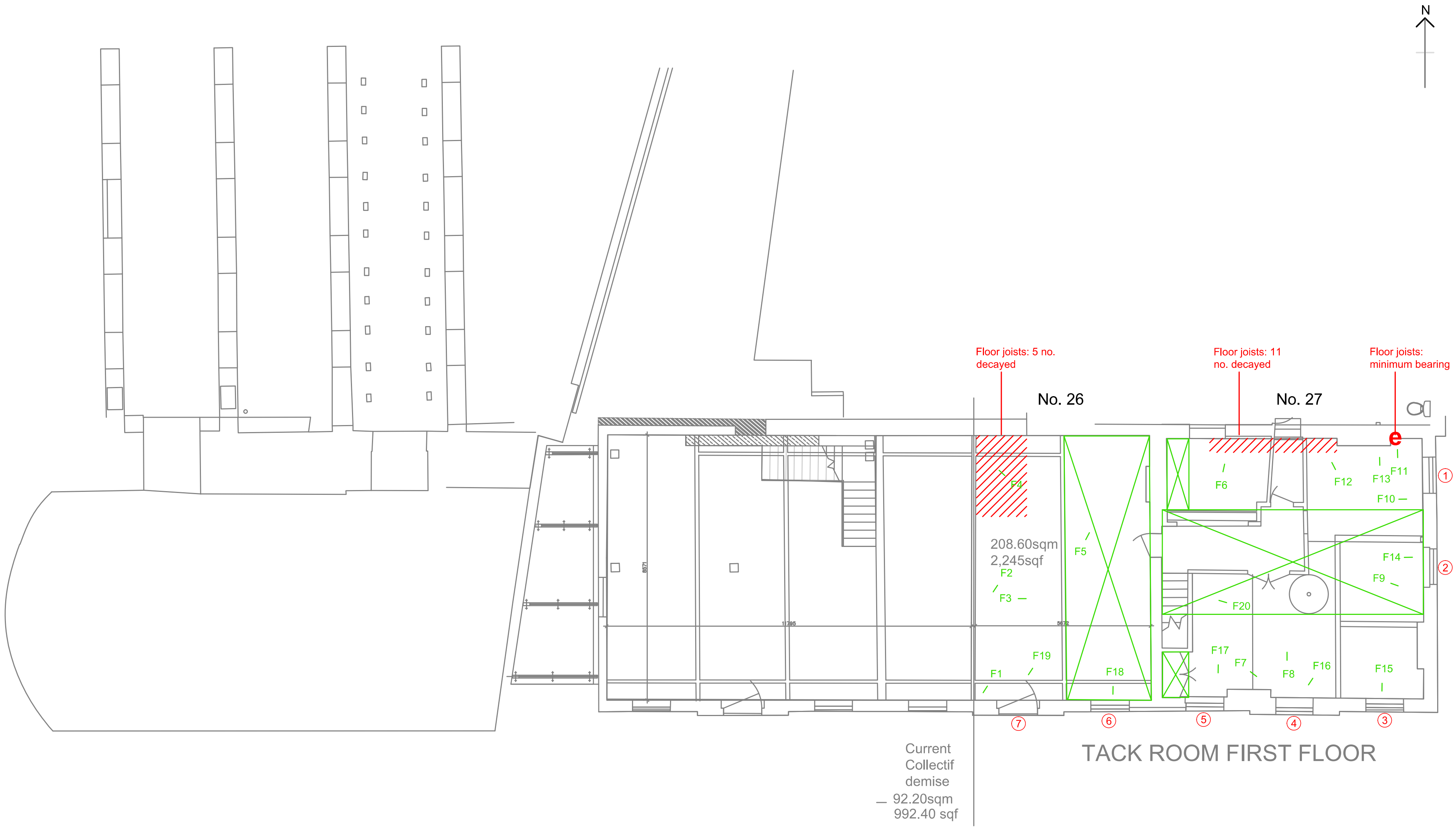
Fig 19:

House 27, brick arch over window no. 7,

Fig 20:

House 27, west side; showing borescope inspection of the floor void

Appendix G



Key: Decayed timber elements
e Structural engineer to inspect
① Lintel number
Further inspection is recommended
— F Photograph location

Stables Market, Tack Room - First Floor
Assessment of floor and lintel structures
05 October 2016

Hutton + Rostron Environmental Investigations Ltd
Netley House, Gomshall, Surrey, GU5 9QA Tel: 01483 203221 Fax: 01483 202911
146-09 Report October 2016 -Not to scale-