TIMBER ASSESSMENT

COUNCIL OFFICES

&

MARKET HALL
LEDBURY

October 2021

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1.0 **BRIEF:**

1.1 Instructions were received via Hannah Grayson of Caroe & Partners, Architects, to assess decay in the feet of the posts of the Market House, and also to assess dampness and subsequent decay and possible insect attack in several cill timbers to the south elevation of the Ledbury Town Council Offices

2.0 **NOTES:**

2.1. Site Address: Ledbury Town Council Offices, Church Street, HR8 1DH, and 3, High Street, Ledbury, HR8 1DS Herefordshire.

2.2. The site investigation was carried out on 18 October 2021

2.3. The weather was overcast with frequent rain during the site visit.

2.4. *% l.e.s. - loss of effective cross-section* is a figure that combines quantitative data (e.g. size of cavities, variations in density etc) with qualitative judgements (e.g. quality of timber, growth rate, structural role etc).

2.5. All measurements are in millimetres. Where an area of degradation is dimensioned, the dimension defines the limit of the degradation's significance, unless otherwise defined.

2.6. The floor plans used in this report are derived from supplied survey drawings, and are for identification purposes only.

3.0 **SPECIALIST EQUIPMENT USED**

3.1. **Sibert DDD200 microdrill**

The microdrill works by recording the rate of penetration of a 1mm diameter probe as it penetrates into the timber being tested, up to a depth of 200mm. The better the condition and quality of the wood tested, the slower the rate of penetration. The quality and condition of the timber can be assessed, and the presence and extent of any degradation can be measured and located within the cross-section. The hole left by the probe after testing is 1mm diameter, and is indistinguishable from a furniture beetle flight hole.

3.2 **FLIR 540 Thermographic camera**

The thermographic camera measures very small temperature differences at the surface of elevations caused by variations in the thermal properties and moisture content etc of the various materials that make up the fabric of the wall, and which are often concealed behind the surface finishes. The FLIR 540 is capable of identifying temperature variations as small as 0.02^{0}C. Frequently architectural features and historical alterations can be identified, that would otherwise remain hidden behind later surfaces etc. However, absence of 'visible' evidence is not evidence of absence: concealed elements will sometimes show up thermographically in certain conditions and remain completely invisible in other.

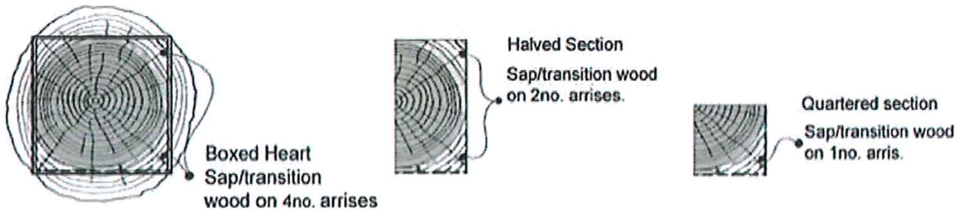
3.3 **Protimeter MS moisture meter**

The Protimeter measures the electrical resistance of the timber between two prongs a fixed distance apart, and correlates this to the moisture content of the timber. In practice, there are many factors, such as salts and surface finishes etc, that will alter the resistance of a material, and therefore the accuracy of the moisture content readings obtained. Moisture meter readings taken at or near the surface of the timber will also vary from day to day, depending on changes in weather and seasonal variations.

4.0 Timber – Terminology

Reference is made in this report to sapwood, transition wood and heartwood. It is important to have some understanding of the processes of timber conversion and frame construction used historically.

Felled trees (i.e. in the round) were generally hewn square and used in that state (i.e. boxed heart) for large section timbers, or further converted by sawing as shown below. It was common for a proportion of the sapwood to be retained after conversion.



Timber Conversion - Retention of Sapwood

Where a timber has been sawn, one of the sawn faces is always used as the upper face (i.e. the reference plane for setting out joints etc). In external walls, the upper face is always outward facing.

Timbers (except lintels) were generally incorporated into a building while still green (unseasoned), and dried slowly *in-situ.* During the drying process, tangential shrinkage can be up to 12% across the grain. In boxed heart sections, radial shrinkage almost inevitably creates one or more longitudinal splits. In most cases, these splits are not structurally significant.

In most circumstances, sapwood degradation is not structurally significant, unless the proportion in the cross-section is too great, or sapwood has been retained in critical areas such as joints. When square baulks are re-sawn to smaller sections, the proportion of retained sapwood varies, with some containing a relatively high proportion.

Oak and elm were the most common timbers used in traditional framing, but poplar and chestnut were also used. Softwood, mainly imported from the Baltic States, was used increasingly from the mid C18th.

The sapwood of most timbers is not durable, and can readily be attacked by fungi and various insects, including Deathwatch beetle *Xestobium rufovillosum,* furniture beetle *Anobium punctatum* and Lyctus powderpost beetle *(Lyctus brunneus)* Degradation of sapwood will often occur within fifty years of construction, and will often die out naturally as food supply and/or conditions change.

5.0 REPORT

Market House

5.01 A brief visual assessment of the first floor interior was carried out. No significant degradation was identified and surface moisture content was below 18%mc. However, there is a 'musty' smell, and the space does not appear to be adequately ventilated.

5.02 There are some visual indications that degradation is continuing at the junction between the posts and the stone stylobates.

5.03 A 2004 report by Demaus Building Diagnostics identified severe to very severe degradation at the base of most of the 16 posts. The most severe degradation was generally confined to the lowest 50mm. The typical pattern of degradation is illustrated in Figure 1.

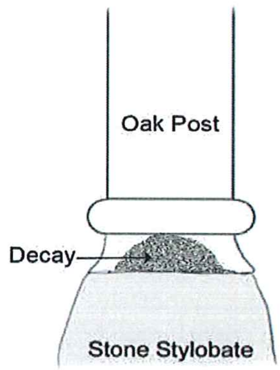


Figure 1. Typical pattern of decay in post base

5.04 Substantial repair works were carried out in 2006; this involved the lifting of the entire building sufficiently to allow the decay within the base of the post to be cut out, leaving an approximately conical void.

5.05 The building was then lowered back to its original height, and the voids filled with a lime-based mortar via holes drilled in the posts above the level of the void. The mortar was specified to have the same crushing strength as the sandstone stylobates.

5.06 The poured mortar presumably forms an approximately conical 'plug' within the feet of the posts.

5.07 By visual inspection, various screws and pieces of stainless steel expanded lath were included in the mortar as reinforcement.

5.08 To achieve the same crushing strength as the sandstone, the mortar would have required a strong to very strong hydraulic lime mix, possibly with additional pozzolans etc. to enhance chemical set. Air carbonation would have been limited within the confine of the post base.

5.09 The specification for the mortar must be on record, and samples were presumably tested to confirm its 28-day and long-term crushing strength. A sample of the mortar used should have been retained for record and reference.

5.10 Lime-based mortars are generally considered to be permeable (i.e. water or vapour can pass through them) although the degree of permeability does vary depending on many factors including hydraulicity – eminently hydraulic limes are stronger, but also less permeable.

5.11 It was apparently assumed that the mortar would not hold moisture against the oak post. It would be interesting to know on what basis this assumption was made.

5.12 Permeability works both ways – i.e. water can be absorbed into as well as lost from the material. Water is most usually lost from a material such as mortar by evaporation to the air. If the mortar is not exposed to the air, as is the case within the base of the post, water will not evaporate whatever the permeability, but will be absorbed by the timber in contact.

5.13 As a consequence, the mortar will absorb any water that might percolate down or be splashed up, or form as condensate on the relatively cold stylobate, thereby effectively acting as a sponge, holding water against the vulnerable timber at the base of the post.

5.14 Close visual inspection does identify areas where current, or at least recent, deformation and/or degradation has occurred. It seems highly probable that fungal degradation is occurring mainly out of sight at the interface between the mortar plug and the timber, caused by moisture absorbed by and/or condensing on the mortar.

5.15 Unfortunately, the presence of the very strong mortar and stainless steel reinforcements makes it virtually impossible to use any non-destructive techniques to assess the condition of the timber at the interface between the timber and the mortar.

5.16 Some of the more obvious faults, identified by visual inspection, are shown below:

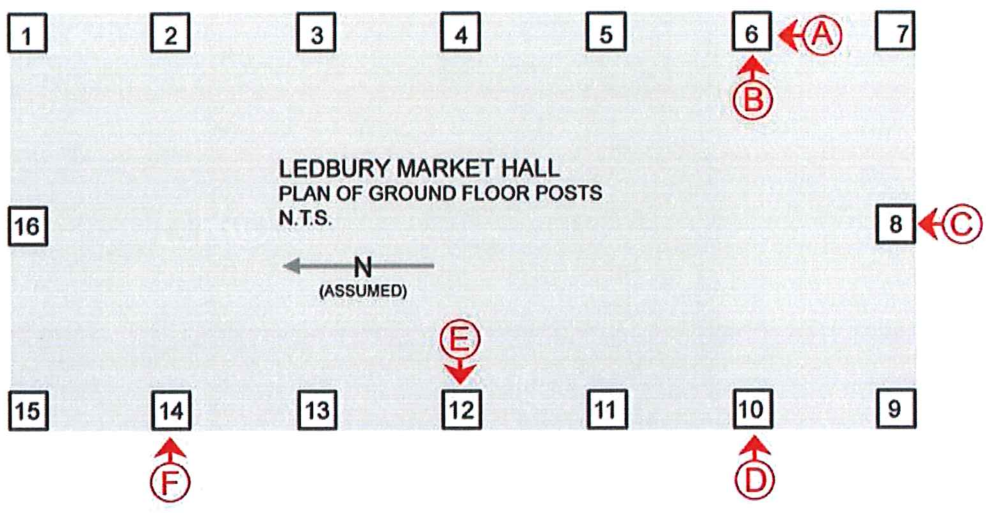


Figure 2. Location plan of Market House posts.

Post 6

5.17 The south face of Post 6 has been lost since the repairs of 2006. Presumably it split off either because of continuing fungal degradation, and/or because compression of the post on the wedge-shaped cone of hard mortar split the section off.

Figure 3. Location A. South face of Post 6

Figure 4. Location B: Post 6 base from the west.

Post 8

5.18 On the south face of Post 8, the mortar, which has emerged from the base of the post (presumably when first cast), acts both as a gutter tending to channel water into the centre, and as a dam, preventing water from escaping.

Figure 5. Location C The mortar at the base of the post creates a gutter

Post 10

5.19 The large split in the timber on the west (i.e. exposed) face of Post 10 has been filled with a mortar fillet including stainless steel mesh reinforcement (circled) which is now breaking up.

5.20 It is not clear what the intended purpose of this fillet was. Gaps very quickly form at the interface between the mortar and the timber, which encourage moisture (often by capillary action), but also by percolation and penetration deeper into the cross section, where it is held by the mortar against the timber, The same mortar prevents, or greatly restricts, any evaporation.

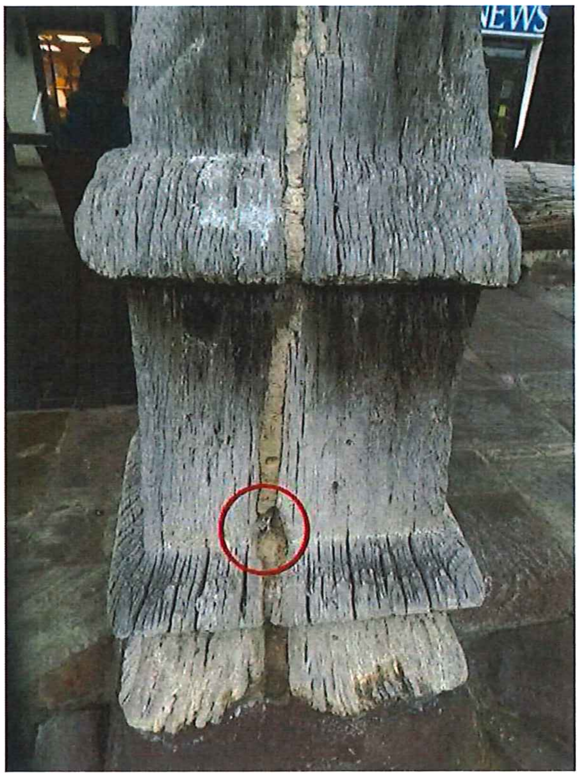


Figure 6. Location D.

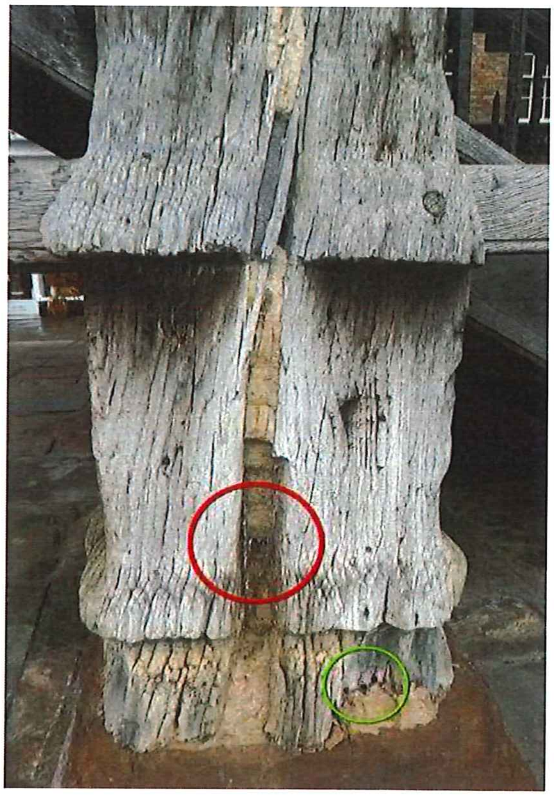
Post 12

5.21 The lowest section of the post on the east face (outlined in red in Figure 7) appears to have broken off, possibly due to the wedging action of the cone-shaped hard mortar plug.

Figure 7. East face of Post 12

Post 14

5.22 As with Post 10, the mortar filling the split is starting to break up. The holes (circled green and enlarged in Figure 9) may well be emergence holes of wood wasps (Siricidae spp) or similar that have re-colonised the degrading timber of the post foot.



Figures 8 & 9. The west face of Post 14 showing the mortar fillet breaking up (circled red) and probable emergence holes of colonising insects (circled green and enlarged in Figure 9).

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<u>Cills along Church Lane Elevation</u>

Figure 10. Part south elevation identifying cills.

5.23 Cill Section A: There is minor degradation in the lowest 15mm of the cill, immediately above the plinth masonry. Degradation is likely to be slow, but continuous, and over time the degraded wood will compress.

5.24 Cill Section B: There is 20-30% l.e.s. concentrated along the lower outer area of the cross section as shown in Figure 11.

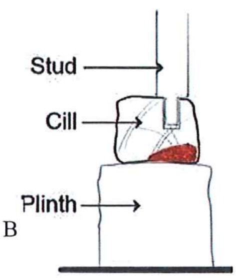

Figure 11. Decay in cill at Section B

Figure 9.

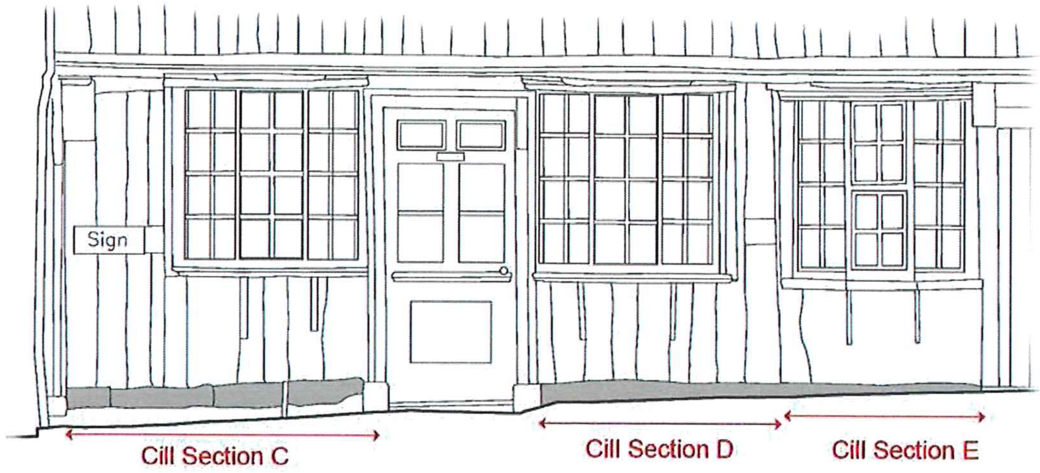

Figure 12. Part south elevation identifying cills.

5.25 Cill Section C: There is typically 40-50% l.e.s. caused by a pattern of degradation running along the line of the mortices, which have enlarged to create a hollow section as sketched in Figure 12.

5.26 Cill Section D: There is 40-50% l.e.s. along the length of the cill.

5.27 Cill Section E: There is typically only 30mm of reasonably sound timber at the outer edge. It appears that an additional timber section has been applied to the inside, but there is no way of confirming the structural fixity

5.28 An internal and external thermographic survey was carried out, but did not identify any significant concealed anomalies.

5.29 The staining visible internally at the north west corner (location shown in Figure 13) of the second floor has not changed since it was photographed as part of Caroe & Partners 2018 quinquennial survey, and there is no evidence of current or recent water penetration.

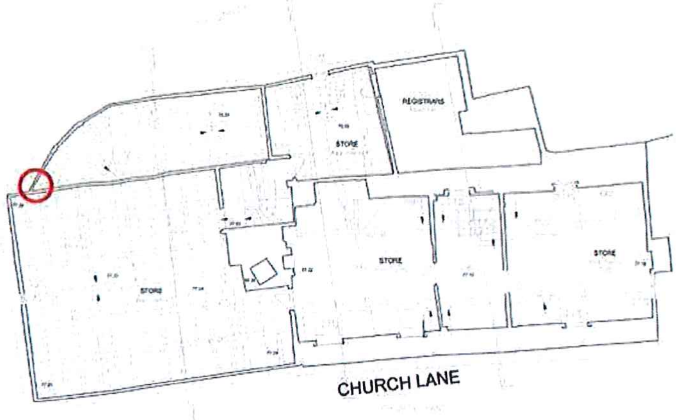

Figure 13. Location of old leak at second floor level.

5.30 The glazing of the 'fixed' casement of the 2nd floor dormer shown in Figure 14 is very poorly fixed and could be sucked out in some wind conditions.

Figure 14 Loose glazing in dormer window circled in red.

5.31 The cellar floor and walls are damp and the space is poorly ventilated. Moisture content at and near the surface of the timbers was typically 19-21%mc: this is just below the moisture content at which any fungus can survive. It is possible that moisture content deeper within the timber is higher, but there is no evidence of fungal activity.

6.0 Conclusions & Recommendations

Market house

6.1. The degradation visible in the bases of the posts is concerning. There has been some deformation and loss of historic fabric, although it is difficult to assess just how much.

6.2. Record photographs should have been taken of each elevation of each post at the time of completion of the major repair works in 2006. It would be very helpful to use these (if available) to make a detailed comparison with the present condition to assess the extent of any deformation and other changes.

6.3. It seems almost certain that there is significant and active fungal degradation in the base of the posts. This is almost certainly caused, or at least exacerbated by, the use of a strong mortar that is capable of absorbing moisture from above (percolation), below (capillary) and possibly also through condensation.

6.4. A relatively small amount of fungal degradation at the interface between the oak post and the mortar plug would be sufficient to cause deformation and settlement, but would be very difficult to locate and quantify.

6.5. The likely shape of the mortar plug (an inverted wedge) will tend to split the timber as it compresses.

6.6. The loss of some sections of Posts 6 and 12 may indicate that this process is already happening.

6.7. Wood wasp (or similar) activity was noted in 2004, and it appears that these insects have re-colonised some of the posts. Wood wasps do not actively damage the timber, but will colonise and consume timber that has already degraded due to significant fungal degradation. Their presence is a useful indicators that a problem exists.

6.8. It is important that the extent and rate of degradation is accurately quantified and monitored. Detailed discussion will be required to develop a methodology that is sufficiently accurate and robust, but which minimises destructive intervention.

6.9. Once the extent and rate or deterioration is established, it will then be necessary to develop a methodology of repair and conservation that retains the maximum of surviving historic fabric, but which also slows down if not completely stops the degradation.

6.10. Any attempt to 'waterproof' the post base to stop, or at least slow down, the deterioration is more likely to further entrap moisture and exacerbate the problem than to prevent moisture entry and/or absorption.

6.11. A possible short-term 'holding' solution might be to drill out the mortar-filled holes used to inject the mortar and inject an embodied boron-based biocide such as Probor 20 or similar.

6.12. It should be stressed that this is not a long-term solution.

Council Offices

6.13. The cills at the base of the timber-framed south elevations will require some interventions a) to provide necessary structural integrity and
b) to reduce the risk of further degradation.

6.14. At the moment, there are some relatively minor cracks and distortions in the infill panels and internal plaster, but there is no evidence of significant deformation or dislocation. However, without intervention the problem will get progressively worse, and more expensive to repair.

6.15. If the rate of degradation can be reduced, Cill Sections A & B could be retained without structural intervention. The simplest and most cost-effective way to reduce moisture ingress and retention would be to fit pentice boards to protect the existing cills from wetting by rainwater falling directly on the elevation and also (probably more frequently and with greater intensity) splashing up from the surface of Church Lane.

6.16. Pentice boards were once a very common sight on timber-framed buildings including at cill level. When fitted, they protect not only the cill but also the plinth wall below. A generic example is shown in Figure 15.

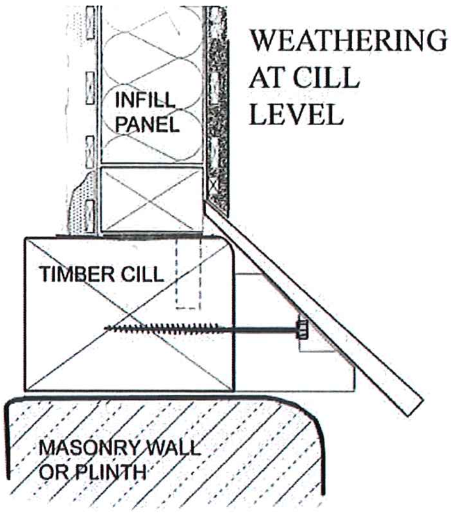

Figure 15. Typical example of pentice board at cill level.

6.17. The pentice board can either be rebated into the panels or fitted with a lead flashing, or carefully scribed to the face of the frame.

6.18. The fitting of pentice boards is a reversible intervention that involves no, or minimal, loss of original fabric and greatly improves the long-term conservation of the building at very low cost. There are numerous examples in Ledbury, including on the west elevation of the Council Offices, although in this case, they are incorrectly fitted and of poor quality.

6.19. Where cill sections have become more severely degraded, an adaptation of the traditional pentice board can be used to introduce sufficient additional strength to allow the retention of the degraded cill.

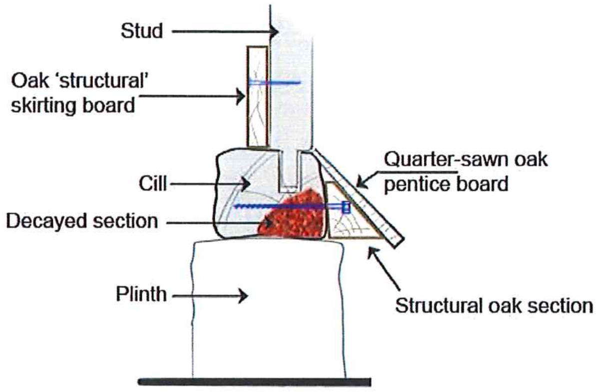

Figure 16. Generic example of cill repair using structural pentice board.

6.20. In many cases, this work can be carried out with minimal disturbance to, or loss of, existing fabric. The internal oak 'structural' skirting board is not always required.

6.21. By comparison, the wholesale replacement of cills causes a great deal of damage to, and loss of, surviving historic fabric and usually requires substantial temporary support works etc.

6.22. More generally, the frame has been 'repaired' with numerous mortar fillets and patches, making good where timbers have degraded and/or joints opened.

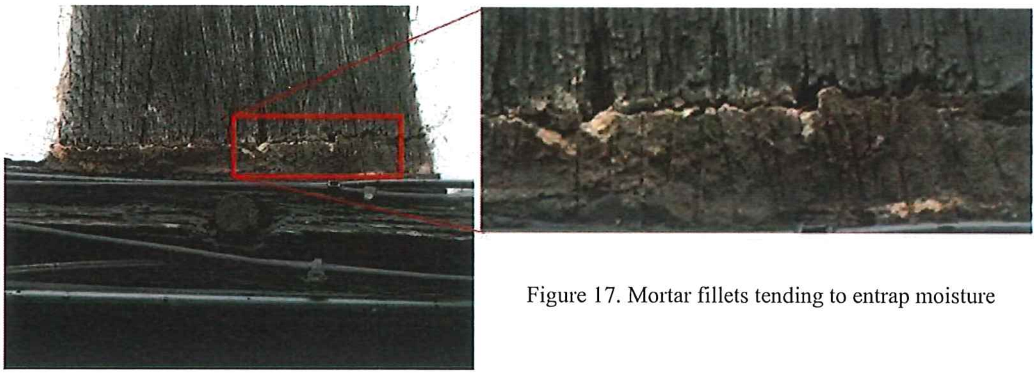

Figure 17. Mortar fillets tending to entrap moisture

6.23. These mortar repairs are often carried out with the good intention of preventing moisture entering through open joints etc, but in almost every circumstance they trap moisture rather than disperse it, channelling any water percolating down the surface of the frame deeper into the cross-section. The mortar acts as a sponge, holding moisture against the timber and preventing any evaporation.

6.24. Timber patch repairs usually have exactly the same damaging effect.

6.25. Wherever possible, such fillets should be removed. Where necessary, other measures such as pentice boards or carefully detailed flashings provide much better protection.

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Demaus Building Diagnostics Ltd *November 2021*