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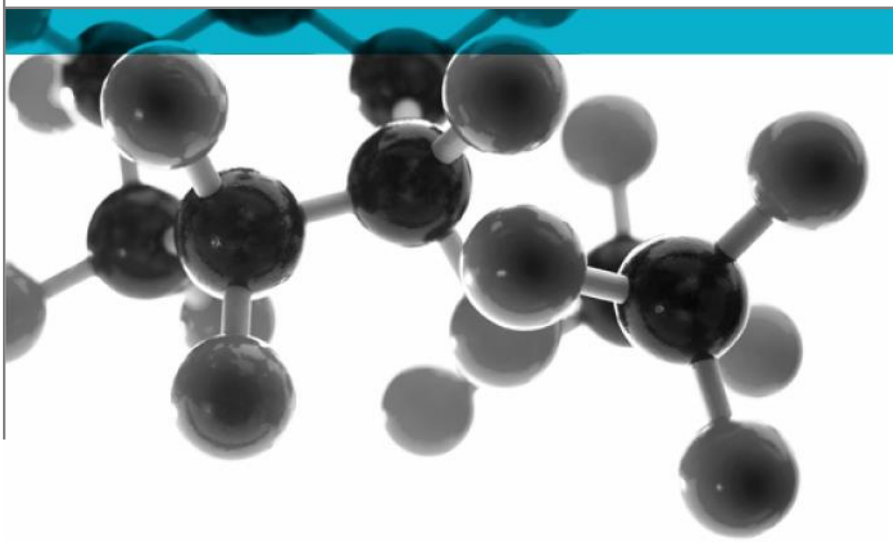
Report addendum

Timber condition survey of
The Smithy, No. 23 Denmark Place



A Report To:

H Smith (Engineers Ltd)
The Manor Gatehouse
Priory Road,
Dartford
DA1 2BJ

Document Reference: TCS/F15420-5 addendum

Date: 07/06/2016

Copy: 1

Issue No.: 1

Exova – the new name for BM TRADA

On December 1st 2015, Chiltern International Fire Ltd and TRADA Technology Ltd (both trading as BM TRADA) commenced trading under the name Exova.

To coincide with this change, our Technical Reports, Test Reports, Product Assessments, company stationery and marketing collateral have been updated to reflect the Exova branding.

The validity of all documents previously issued by Chiltern International Fire Ltd and TRADA Technology Ltd including certificates, test reports and product assessments is unaffected by this change. A letter to this effect is available upon request by e-mailing europe@exova.com

About Exova

Exova is part of the Exova Group one of the world's leading laboratory-based testing groups, trusted by organisations to test and advise on the safety, quality and performance of their products and operations. Headquartered in Edinburgh, UK, Exova operates 143 laboratories and offices in 32 countries and employs around 4,500 people throughout Europe, the Americas, the Middle East and Asia/Asia Pacific. With over 90 years' experience, Exova specialises in testing across a number of key sectors from health sciences to aerospace, transportation, oil and gas, fire and construction.

Be assured that while the name will change, your service provision and primary contacts have not. What will be available to you is a wider team of testing experts and an extended range of testing capabilities.

If you have any questions, please do not hesitate to contact a member of the team and we will do our best to answer them. We appreciate your business to date and we look forward to working with you in the future.

Kind regards

Exova

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Contents

1 Introduction

During September 2015, Exova BM TRADA received a request from Mr Donald O'Reilly (Senior Design Manager) for Skanska UK for advice regarding the inspection of structural timbers in a number of grade II* listed buildings in and around St Giles Circus, central London. Following telephone conversations with Dr John Williams (Senior Technical Consultant) for Exova BM TRADA, a site meeting was arranged for Friday 18th September 2015.

Following this site meeting, Exova submitted proposal for site inspection works at St Giles Circus which was dated 21st September 2015. On 1st December 2015, Exova BM TRADA received Purchase Order No. 31511 from H Smith (Engineers) Ltd (H Smith) confirming Exova BM TRADA 's appointment. H Smith is acting on behalf of Skanska.

This report summarises additional inspection findings to report reference TCS/F15420-5 which summarises our findings of a timber condition survey in The Smithy located at No. 23 Denmark Place.

2 Limitations

1. The findings of this report are based solely upon the information and evidence provided and made available to Exova BM TRADA by the Client and/or the Client's representative(s) at the time that this report was written. Should subsequent information be made known to us we reserve the right to amend our findings.

2. Any information or evidence provided to Exova BM TRADA for the preparation of this report by the Client or the Client's representative(s), or by any third party, has been taken by us at face value, unless we state specifically that we have validated it and include in this report evidence of such validation.

3. This report cannot be used for any purpose other than that for which it is expressly authorised within the contract under which it has been agreed and produced.

4. All advice offered by Exova BM TRADA is offered on the basis that it represents the principles of good practice and that it has not necessarily been validated by Exova BM TRADA.

5. Statements which appear in this report, which address current or likely future risks, and which project or estimate outcomes, are based on reasonable assumptions from empirical evidence. Such statements by their nature involve uncertainties, which themselves carry the risk that actual outcomes may differ materially from any predicted outcomes. Exova BM TRADA does not guarantee or warrant any projections or estimates of risks or outcomes contained within this report.

6. Any contracted rights to confidentiality will be considered null and void should the report be modified in any way by any party without express permission of Exova BM TRADA.

3 Background information

Following submission of Exova BM TRADA report reference TCS/15420-5, H Smith relayed question from the design team at Skanska to Exova BM TRADA. The questions related to the condition of the timbers at the ridge of the roof and the condition of a number of wall plates that had not been included in the previous inspection report.

4 Findings

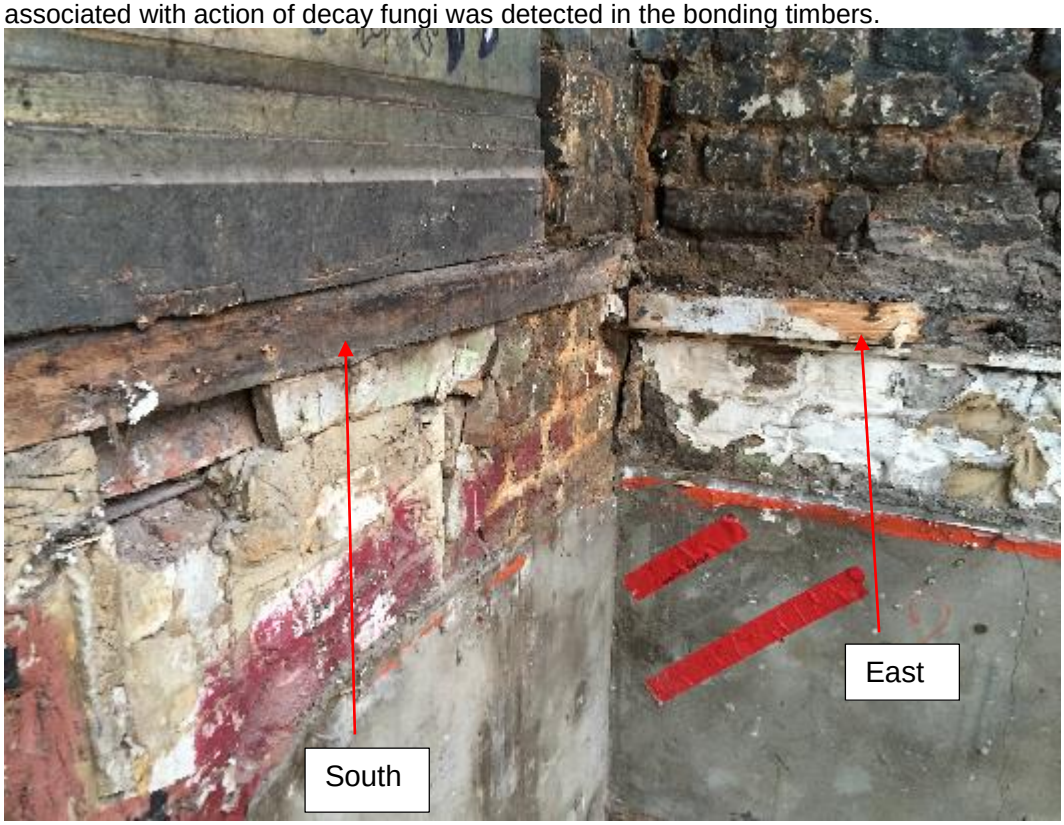
In our report, TCS/F15240-5, we stated that on the basis of a visual examination from the ground, the ridge timbers and common rafters appeared to be in comparatively good condition, i.e. free from decay, although there was sufficient variation in overall quality on the basis that many common rafters had been reinforced to question the viability of their re-use.

We stated that re-use of the common rafters may present significant challenges particularly if the top faces has been affected by 'socketing'. Whilst recognising the historic importance of the grade II* listed structure, we stated that it was our opinion that it could be impracticable to re-use the original common rafters. However, they could be incorporated into a refurbished roof provided that additional support is introduced so the common rafters do not carry the full load of the roof. This assumed that any surface contamination that may be present was not a risk to health.

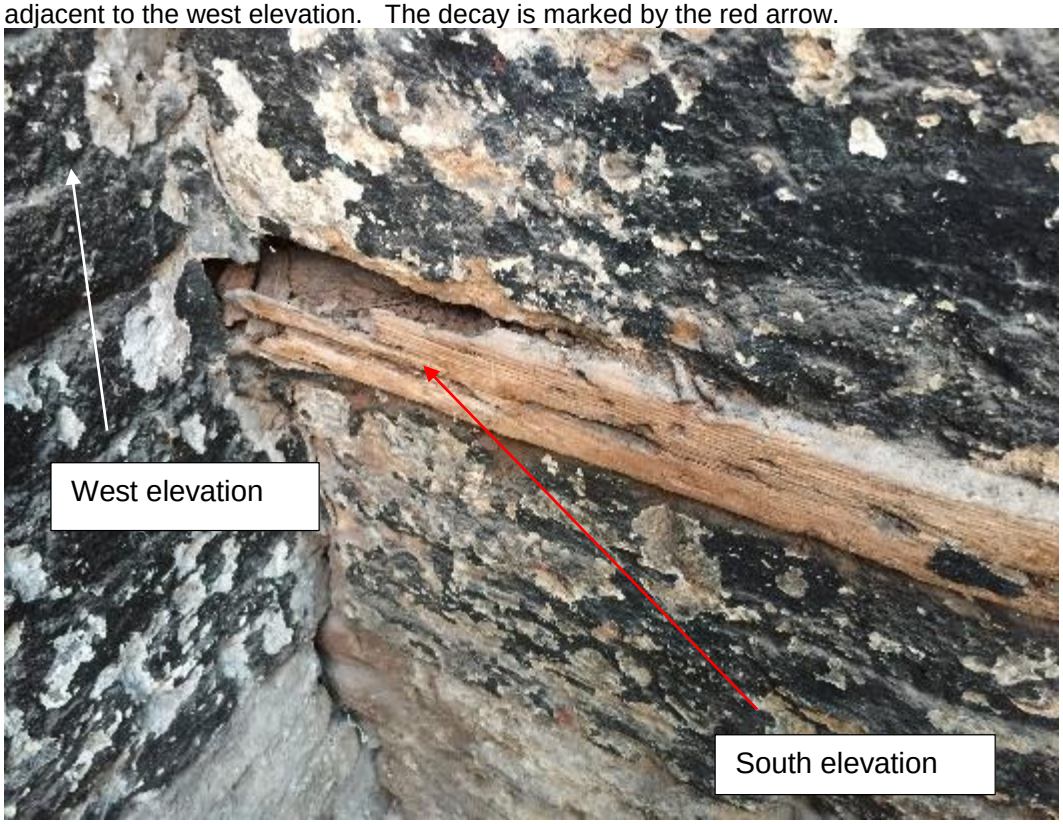
Since our inspection in May 2016, the roof covering of The Smithy have been removed and the internal floor space has been cleared of debris which allowed a further inspection to be carried out from an aluminium scaffold tower. The following annotated photographs present supporting evidence to our conclusions in report reference TCS/F15240-5 which stated that it was our opinion that it was unlikely that the common rafters could be re-used successfully. The annotated photographs also include an assessment of bonding timber embedded in the walls timber wall plates and a timber lintel located on the east elevation.

Photograph 1: Evidence of decay observed in the bonding timber in the wall of the south elevation of the smithy. The void caused by decay is marked by the arrow.

Photograph 2: Bonding timbers observed along the south and east elevations. Significant softening associated with action of decay fungi was detected in the bonding timbers.

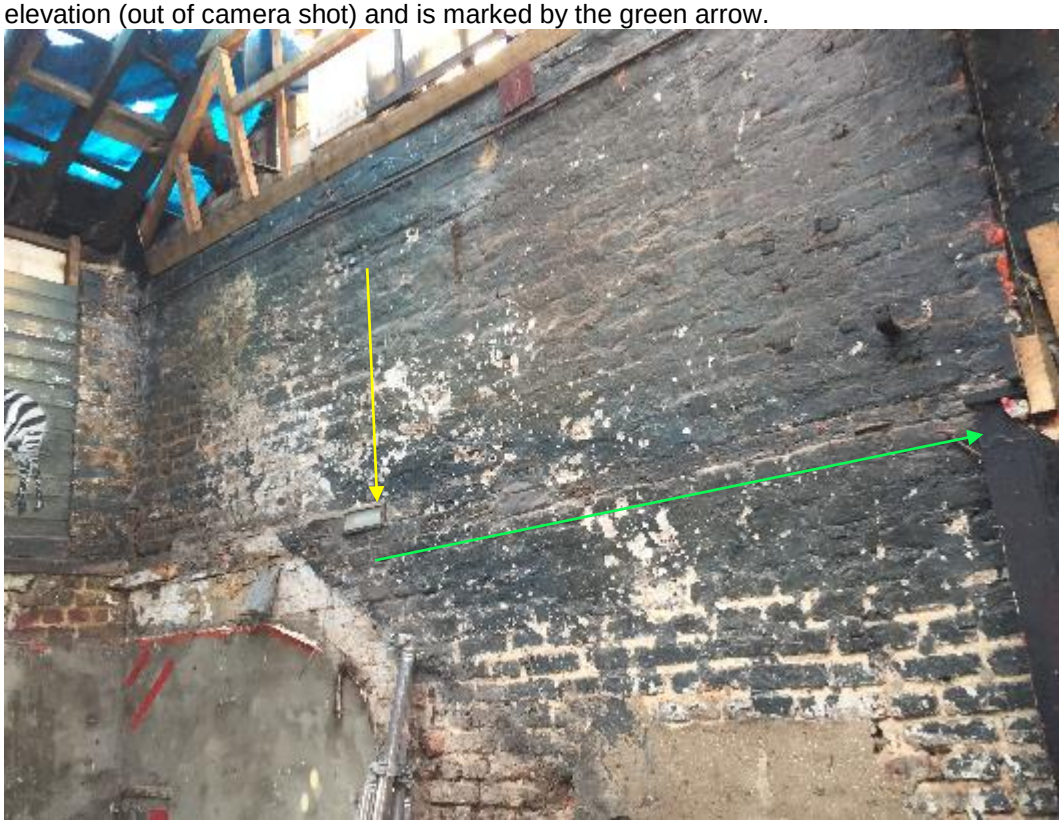


Photograph 3: Severe decay detected in a bonding timber located along the south elevation and adjacent to the west elevation. The decay is marked by the red arrow.



Photograph 4: Poor condition of the lintel observed over the doorway located on the east elevation. The photograph shows that the lintel has failed in service as illustrated by the fracture (arrowed).

Photograph 5: Bonding timber present along the east elevation. The bonding timber positioned to the right of the light (yellow arrow) was in good condition and free from any softening associated with decay. The sound section extended from the wall light to the door opening on the east elevation (out of camera shot) and is marked by the green arrow.



Photograph 6: General erosion caused by surface decay and loss of cross section (arrowed) observed on the common rafters at high level when viewed from a scaffold tower.

Photograph 7: Mechanical damage resulting in significant loss of section (arrowed) to this common rafter. This loss of section would prevent a strength grade from being assigned.

Photograph 8: Significant void resulting in loss of cross section (arrowed) to this common rafter. This loss of cross section may prevent a strength grade from being assigned.

Photograph 9: Possible compression failure observed in the common rafter (arrowed) which would prevent the timber from being assigned to a visual strength grade. The timber batten fixed to the underside suggests that this is an ad-hoc structural repair.

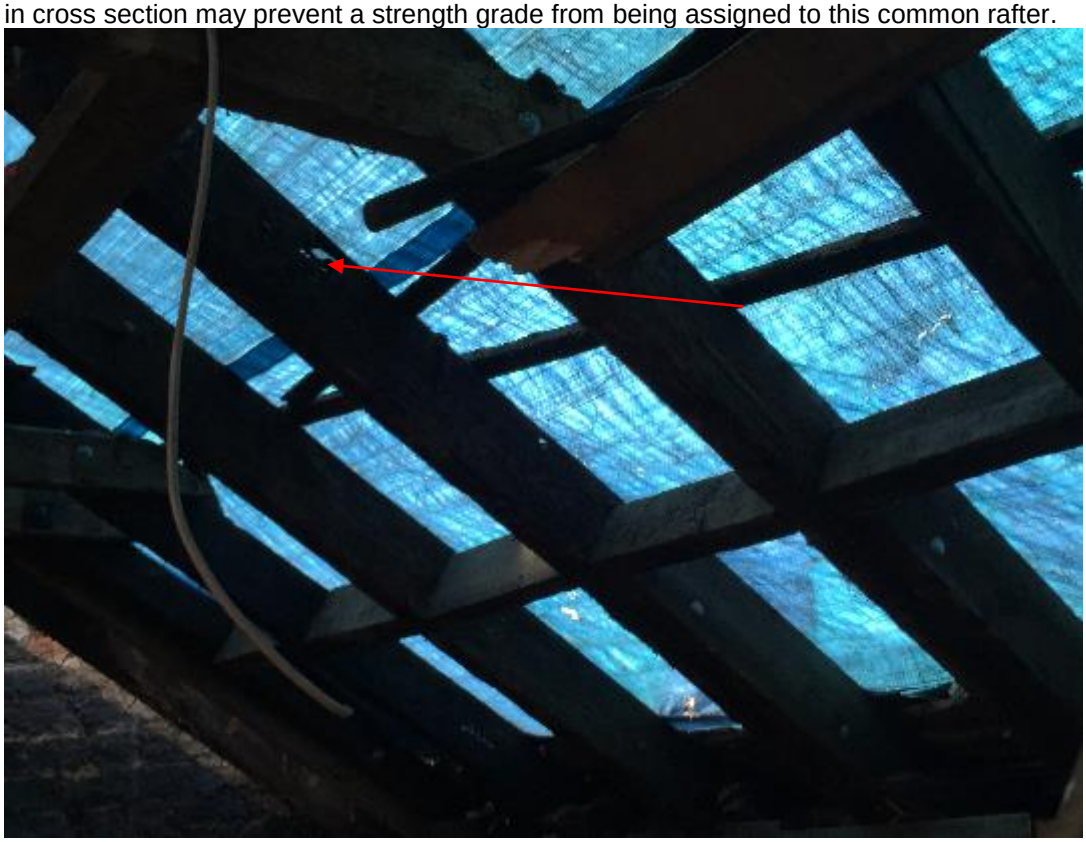
Photograph 10: Evidence of movement and dislocation of common rafters from the ridge as marked by the arrows.

Photograph 11: Large knot area observed on the common rafter and evidence of failure in service as marked by the arrow.

Photograph 12: An example of erosion caused by surface decay and loss in cross section observed on a common rafter as marked by the arrow.

Photograph 13: Evidence of mechanical failure in a common rafter as marked by the arrow.

Photograph 14: Significant void resulting in significant loss of cross section (arrowed). This loss in cross section may prevent a strength grade from being assigned to this common rafter.



Photograph 15: Evidence of mechanical failure expressed as a fissure through the thickness of a common rafter as marked by the arrow.

Photograph 16: Erosion caused by surface decay and loss of cross section observed on a common rafter.

Photograph 17: Significant loss of cross section (arrowed) to this common rafter. This loss of cross section could prevent a strength grade from being assigned.

5. Conclusions

Based on our survey findings, Exova BM TRADA concludes the following:

1. Our condition survey findings presented in this addendum have been based upon observing the roof from a scaffold tower. The observations summarised in this addendum support our conclusions in our report TCS/F15420-5.

2. The timber lintel observed on the east elevation had failed in service.

3. The bonding timbers were generally in poor condition with extensive softening associated with fungal decay detected in the bonding timbers along the south elevation.

4. The common rafters are in variable condition and we observed many mechanical defects during our second visit in June 2016 which were not visible in May 2016. Examples of these defects are presented in the annotated photographs in Section 4 of this addendum. The extent and type of mechanical defects present in the common rafters lead us to form the opinion that they are in too variable a condition, in terms of strength, to be re-used without additional support.

5. It should be noted that we did not observe significant evidence of systemic decay in the common rafters. The principal reason for advising against their re-use is mechanical failure. However, it should also be noted that we have not examined the top edges of the common rafters and it is likely that the top edges may be affected by localised decay around fixings, i.e. 'socketing' and this would also prevent their re-use.

6. It should be noted that the conclusion in point 4 above differs from our conclusions in TCS/F15420-5 in terms of timber condition and strength. This is because better access and better lighting conditions in The Smithy has revealed further damage that was hitherto unobserved.

7. We maintain our view that despite the low levels of decay in the roof timbers, the combination of decay, notching, erosion, mechanical failure and exposure to atmospheric pollutants and the risks of damage during deconstruction and the likelihood of 'socketing' of the timber present significant challenges for the re-use of these timbers. It is our opinion that it is unlikely that these timbers could be re-used successfully.

6 Authorisation

	Issued by:	**Under the authority of:**
Signature:		
Name:	Dr John Williams	Philip O'Leary
Title:	**Senior Technical Consultant** **Timber Technology Investigations**	**Head of Section** **Timber Technology Investigations**

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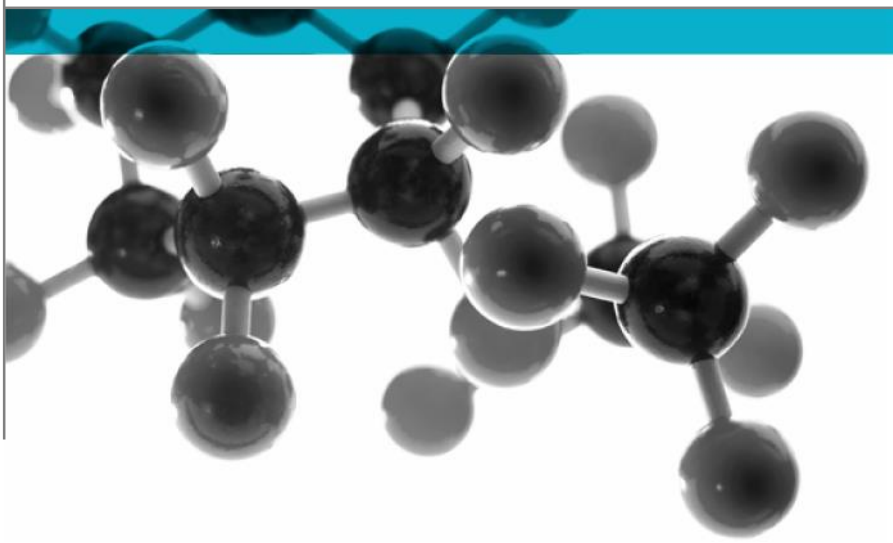
Timber condition survey of the smithy, No. 23 Denmark Place



A Report To:

H Smith (Engineers Ltd)
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Dartford
DA1 2BJ

Document Reference: TCS/F15420-5

Date: 19/05/2016

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Be assured that while the name will change, your service provision and primary contacts have not. What will be available to you is a wider team of testing experts and an extended range of testing capabilities.

If you have any questions, please do not hesitate to contact a member of the team and we will do our best to answer them. We appreciate your business to date and we look forward to working with you in the future.

Kind regards

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Contents

1 Introduction

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This report summarises our inspection findings in the smithy which is located in No. 23 Denmark Place.

2 Scope of Work

Exova BM TRADA's scope of work may be described as follows:

1. To carry out a timber condition survey of 7 No. buildings along Denmark Street and Denmark Place of Grade II* listed buildings.

2. To use non-destructive survey techniques with the objective of justifying retention of sound, original fabric. The timber condition surveys will be carried out using out using a range of non-destructive techniques including: visual examination, probing with hand held tools, hammer soundings and decay detection drilling. The survey will include all accessible and visible structural timbers which are joists, spine beams, roof timbers and timber lintels.

3. Where defects are identified, we will provide guidance on appropriate remedial/repair/replacement options.

4. To identify the location, type and extent of any defects associated with the action of fungal decay, insect attack, mechanical damage and/or water ingress.

5. To carry out in situ visual strength grading of the structural timbers using the requirements of the relevant standards for guidance (BS 4978 and BS 5756) and to, consider the effect of existing and visible notching for services on the visual strength grade of the joists.

6. Small specimens will be taken from the structural timbers (estimated at one specimen per component per floor of each building) so that the correct strength class (BS EN 1912) for the grade/species combination can be assigned to the structural timbers.

7. To consider the condition and strength grade of internal timber frame walls as part of the survey and to consider the condition of non-structural timbers such as timber panelling throughout the properties.

8. To prepare a report for each building which will include a photographic record of the defects. The reports will also include guidance on appropriate remedial strategies.

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4 Background information

Based on information provided by Skanska we understand the following:

No. 59 St Giles Circus
Nos. 20, 26, 27 and 28 Denmark Street
Nos 16 and 23 Denmark Place

are grade II* listed buildings and are within the site curtilage of the St Giles Circus redevelopment. The objective of the condition survey is to provide an indication of the extent, type and severity of deterioration within these buildings which will help inform repair/refurbishment strategies.

5 Procedures

5.1 Timber condition survey

Timber condition was assessed using a variety of *in situ* non-destructive techniques which included: visual survey; probing with a bradawl; decay detection drilling using 6.0mm diameter 230mm long wood augers used as decay probes and 1.0mm diameter 300mm long decay probes. The timbers were drilled by applying constant hand pressure to a battery powered drill.

Timber that was free from significant softening associated with decay in the core of the component was considered to be free from decay (i.e. was sound) was assigned '✓✓' in the results tables.

Timber that was characterised by surface softening penetrating to a depth of more than 5mm was considered to have been affected by superficial fungal decay and/or insect attack and such superficial damage was considered to be insignificant.

Locations that were not accessible for a detailed 'hands on' survey were classified as inaccessible. These areas were subject to a visual examination only. Unless specifically referred to in the tables of results and marked on the roof plans, the timber in these locations was considered by BM TRADA to be in good condition. These timbers were assigned '✓' in the tables of results.

Timber that was characterised by significant internal softening, or surface softening penetrating to a depth of more than 10mm was considered to have been affected by severe fungal decay and/or insect attack and classified as unsound and assigned '××'.

The plan in the Appendix identifies the approximate positions where opening up works were carried out and the approximate positions where photographs were taken.

Locations considered to be free from decay (i.e. in good condition) and characterised by low timber moisture content are identified with green shading.

Locations considered to be affected by decay are identified with red shading.

Areas that were inaccessible but were considered by BM TRADA to be at risk of decay and requiring additional examination to confirm condition were marked with yellow shading.

Areas affected by water ingress and/or high timber moisture content were marked with blue shading.

5.2 Moisture content survey

Timber moisture content readings were taken from locations which had been drilled with a 6mm diameter auger. Insulated probes were inserted into these holes and readings were taken with a calibrated Protimeter Timber master electrical resistance type moisture meter. The meter was calibrated against the manufacturer's check box before and after use.

In addition to 'core' readings, surface timber moisture content was also recorded to differentiate between superficial wetting and wetting through the timber section.

5.3 Visual strength grading

With reference to visual strength grading of softwoods, there are two grades. These are GS grade and SS grade. The combination of visual strength grade (GS or SS) and the timber species allows the designer to select the correct strength class. The rules for the visual strength grading of softwood are detailed in British Standard BS 4978:2007+ A1 2011 *Visual; strength grading of softwood. Specification.* This standard requires that all six surfaces of the timber must be visible for examination.

However, it is usually possible to assign an indicative visual strength grade to exposed sections of timber *in-situ* provided at last three faces are visible and free from paint and dirt. Throughout the visual grading process, BM TRADA took into consideration the effect of notching and cut outs on timber grade.

5.4 Species identification

Two small specimens of timber were removed from common rafters supporting the roof and were then analysed at Exova BM TRADA's High Wycombe laboratory so that the timber species could be formally determined. The samples were assessed visually using a x10 hand lens prior to using microscopic techniques. Thin sections were produced from the samples in order to determine the main anatomical features of the timber. These characteristics were then compared with published information and with those of reference timber samples held by Exova BM TRADA.

6 Findings

The inspection was carried out by Dr John Williams (Senior Technical Consultant) on Friday 13th May 2016. It should be noted that the inspection of the smithy in No. 23 Denmark Place had been previously suspended due to the exposure of a material consistent with asbestos. Further delays were incurred when demolition works were carried out in adjacent buildings because the smithy was located inside an exclusion zone.

6.1 General observations

Photograph 1: General view of the roof along the front elevation of the smithy looking towards Denmark Street. Viewing from left to right, note the mixture of plastic sheeting, timber sarking boards and exposed slates along the elevation. In addition, roofing battens were heavily decayed (arrowed). This photograph illustrates the mixture of materials used to construct the roof.

Photograph 2: General view of the roof at the rear of the smithy looking towards the Denmark Place elevation. The photograph clearly shows that the roof has undergone many interventions with some comparatively recent as can be seen from the paler coloured timber frame just below the ridge (arrowed). This has been installed to support a lighting rig when the smithy was the former 12 Bar music venue.

Photograph 3: General appearance of the roof facing the west elevation. The common rafters were in good condition although there was evidence of superficial chemical attack resulting in surface softening.

Photograph 4: General view of the ridge of the roof. The photograph clearly shows that the roof has undergone many interventions with some comparatively recent as can be seen from the paler coloured timber frame intervention just below the ridge. This has been installed to support a rig when the smithy was the former 12 Bar music venue. Also note the use of plastic sheet materials as a roofing material (arrowed).

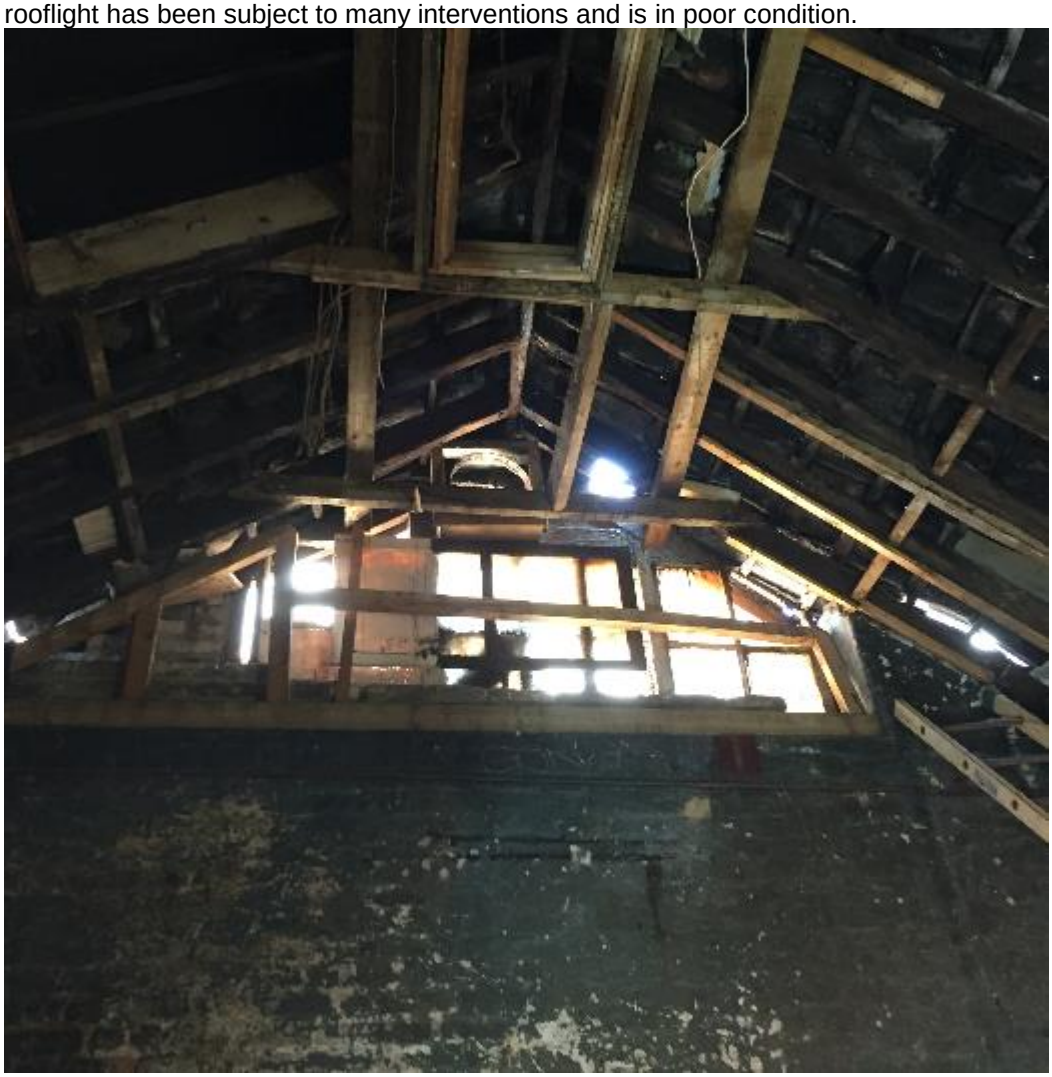
Photograph 5: General example of localised repair to a common rafter. Note the addition of new, pressure treated green colour timber – yellow arrow) alongside the original common rafter. The photograph also shows the extent of deterioration of the sarking boards. This surface softening was consistent with defibrillation of the outer timber layers (arrowed), probably as a consequence of exposure to atmospheric pollutants from the smith forge.

Photograph 6: General appearance of the common rafters along the rear elevation (facing Denmark Place) of the smithy. The rafters are supported by a timber wall plate. This photograph illustrate typical surface erosion of the common rafters (arrowed).

Photograph 7: Example of excessive notching (arrowed) observed on a number of the common rafters which affected indicative visual strength grade. Also note the chemical attack in the surface of the common rafter resulting in a woolly appearance caused by defibrillation of the outer layer of timber (arrowed).

Photograph 8: Close up view of the front elevation of the smithy (Denmark Street) illustrating the common rafters bearing onto a timber wall plate. Also note the severe decay in the roofing battens (arrowed) and evidence of localised repair to a decayed rafter (arrowed).

Photograph 9: Construction of the roof along the east elevation of the smithy. Also note the rooflight has been subject to many interventions and is in poor condition.



6.2 Detailed observations

In addition to the notes below, our detailed observations are summarised in Table 1.

The ridge was inaccessible to a hands on survey so was limited to a visual examination only. There was no evidence of decay at the ridge. However, we are of the opinion that the roof is in a poor state of repair although severe decay was localised in the common rafters and wall plates. We also observed minor localised insect attack.

The surface of many of the common rafters had a woolly appearance and this was consistent with defibrillation of wood fibres associated with chemical attack caused by atmospheric pollutants from the smithy forge. Generally, sound common rafters (Refer to Table 1 ✓✓) were characterised by surface softening which was approximately 5mm deep. Extensive decay was observed in the roofing battens.

There was evidence of extensive structural intervention and modifications and also the use of modern materials such as plastic sheeting and pressure treated timber.

We observed instances where notching of the common rafters affected the visual strength grade. Furthermore, there was extensive reinforcement of many of the common rafters by the addition of new common rafters.

Table 1 summarises our detailed observations. All components were referenced left to right when looking towards the exterior of the building. The front elevation faces Denmark Street and the rear elevation faces Denmark Place.

Table 1: Detailed condition survey findings.

Location	Component	Reference	Condition	Moisture content (%)	Comments
Rear elevation	Common rafter	1	✓✓	-	The common rafters were supported by a timber wall plated that was in good condition although high timber moisture content of 20% was detected at the east elevation. The condition survey findings refer to the bases of the common rafters. Some rafters were also affected by chemical attack to the surface. There was evidence of notching and repair work. The ridge of the roof was inaccessible. However, the ridge appeared to be in good condition. A number of the common rafters had been reinforced with new structural timber positioned alongside them. The roofing battens were in variable condition with extensive decay evident.
		2	✓✓	14	
		3	✓✓	14	
		4	✓✓		
		5	✓✓	-	
		6	✓✓	-	
		7	××	-	
		8	✓✓	-	
		9	✓✓	-	
		10	✓✓	12	
		11	✓✓	14	
		12	✓✓	-	
		13	××	-	
		14	✓✓	23	
		15	✓✓	24	
West elevation	Common rafter	1	✓✓	12	No decay was evident in the common rafters although some surface softening was detected.
		2	✓✓	-	
		3	✓✓	-	
		4	✓✓	-	
		5	✓✓	-	
		6	✓✓	12	
Front elevation (lower)	Common rafter	1	✓✓		The common rafters were supported by a timber wall plate which was in good condition with the exception of the section supporting common afters 9 and 10 which was affected by decay. High timber moisture content was detected along the length of the wall plate. Historic insect attack was also observed on the rafters. Severe decay was observed in the roofing battens
		2	✓✓	-	
		3	✓✓	27	
		4	××	-	
		5	✓✓	-	
		6	✓✓	-	
		7	✓✓	-	
		8	✓✓	25	
		9	✓✓		
		10	××	45	
	Purlin (east)		✓✓	12	The purlin comprised a pair of timber joists which were in good condition.
	(west)		✓✓	12	
(higher)	Common rafter	1	✓✓	-	The common rafters comprised a mixture of older and more recently installed timbers. Extensive decay was observed in the roofing battens. Common rafter Nos. 1 to 9 appeared to comprise new timbers whereas Nos. 10 to 15, characterised by a darker surface, appeared to be original members.
		2	✓✓	-	
		3	✓✓	-	
		4	✓✓	-	
		5	✓✓	-	
		6	✓✓	-	
		7	✓✓	-	
		8	✓✓	-	
		9	✓✓	-	

Table 1: Detailed condition survey findings.

Location	Component	Reference	Condition	Moisture content (%)	Comments
Front elevation	Common rafter	10	✓✓	-	
		11	✓✓	-	
		12	✓✓	-	
		13	✓✓	-	
		14	✓✓	-	
		15	✓✓	-	
Front	Beam		✓✓	24	The beam was in good condition. However, it must be noted that the bearing detail at the rear elevation (Denmark Place) was inadequate. In addition, the beam was deformed and this deformation was a consequence of significant slope of grain and drying in service. The excessive slope of grain prevented a strength grade from being assigned.
Rear			✓✓	12	

In isolation, a large proportion of the common rafters were in good condition at their bases. However, with particular reference to the rear elevation and upper front elevation, a number of common rafters had been strengthened by the addition of new rafters/sections of timber alongside.

When establishing which timbers to re-use, we recommend that any timber identified in Table 1 characterised by decay or distortion should not be re-used on account of weaker timber strength.

The effect of notching should be considered by the structural engineer prior to considering re-use of the common rafters if they are free from decay. Ladder access and limited visibility prevented Exova BM TRADA from fully quantifying the extent of notching on the common rafters. This may be quantified once the roof coverings have been removed and the reinforcing timbers removed. However, based on our observation s we would advise against the re-use of notched common rafters on the basis that the depth of the notch will most probably affect the visual strength grade or reduce the effective cross section.

In addition, the older timbers, particularly those with a woolly surface, may be contaminated after exposure to atmospheric pollutants when the smithy was in use. We recommend that the possible impact on health of surface contamination is considered before selecting these timbers for re-use.

It should be borne in mind that we have not examined the top surface of the common rafters. When we consider the poor state of the roofing battens, it is likely that the top faces of the common rafters have been exposed to periodic wetting and this may have caused localised decay around fixings. Removal of the roof coverings may reveal significant ‘socketing’ which is localised decay around fixings caused by water tracking down the shank of the fixing. Significant ‘socketing’ may prevent re-use of the common rafters as structural timbers.

It should also be borne in mind that deconstructing the roof to separate the original structural timbers from recent additions may cause significant damage to the rafters. Furthermore, deconstruction can also lead to the release of movement stresses which could cause distortion of the timbers which may affect their potential for re-use.

6.3 Indicative visual strength grading.

The common rafters were of variable quality. Based on our observations we would consider it reasonable to assign an indicative visual strength grade of GS to all common rafters apart from those considered to be affected by decay and/or significant notching.

GS grade may also be assigned to the pair of joists forming the purlin along the front elevation of the smithy.

We are of the opinion that the timber was not of sufficient high consistent quality to be assigned to SS grade.

The beam spanning from front to back across the smithy cannot be assigned an indicative strength grade due to the severe slope of grain that was observed.

6.4 Species identification and strength class

Two specimens of timber were removed from the common rafters of the smithy. These specimens were considered by Exova BM TRADA to be typical of the timber used in the construction of the roof. The gross characteristics of the specimens of timber removed from the building were consistent with a softwood. Closer examination indicated that they belonged to a pine (*Pinus* spp.). Identification within the genus *Pinus* is generally not possible beyond classification into one of the following seven groups: *Sylvestris, Khaysa, Taeda, Ponderosa, Sula, Parrya* and *Strobus*. Microscopic examination of the samples indicated that they were consistent with the *Sylvestris* group of pines which includes Scots pine, Corsican pine, Canadian red pine and European redwood.

It is not possible to differentiate between species within the *Sylvestris* group on the basis of a timber sample alone (i.e. without leaves or cones etc). However, the gross characteristics of the samples and slow rate of growth indicates that they comprise European redwood, a species most commonly imported to the UK and Ireland for structural use.

GS grade European redwood may be assigned to Strength Class C16 as defined in BS EN 1912: 2012 2012 +A4.

7 Discussion

Timber and timber based products are inherently durable materials, resistant to most biological degradation provided they remain dry. However, prolonged wetting greatly enhances the risk of decay by wood destroying fungi and insects, particularly fungi.

Timber and timber based products become vulnerable to fungal decay if the moisture content exceeds the decay threshold, which is nominally 20%. The moisture content of internal building timbers should not reach this level unless poor design, poor construction or neglect and dereliction have led to moisture ingress. The two most common types of wood rotting fungi are wet rot type fungi and dry rot. No dry rot was observed. Wet rot fungi require the moisture content of the timber to exceed the decay threshold (20%) for prolonged periods in order to degrade the timber. The optimum moisture content that supports wet rot attack is approximately 40% to 60%. However, these fungi are limited to the areas of timber where high moisture content levels are present.

Insect attack was present in the smithy appeared to be minor and historic. This limited attack appeared to be consistent with that of *Anobium punctatum* more widely known as common furniture beetle for woodworm.

8 Conclusions

Based on our survey findings, Exova BM TRADA concludes the following:

1. Our condition survey findings have been based upon accessing the lower level of the roof. The ridge was subject to a visual examination only.

2. The condition of the roof timbers was variable and there was evidence to show that new timbers had been installed alongside older timbers which had been affected by either decay and/or notching.

3. Decay of the common rafters was limited although decay of the roofing battens was extensive. Removal of the roof coverings may reveal extensive decay in the top faces of the common rafters coincident with fixings. Such decay associated with the fixings may be referred to as 'socketing.'

4. The woolly appearance of a number of the common rafters was consistent with chemical attack. Chemical attack may be the result of long term exposure to atmospheric pollutants during the active life of the smithy. We recommend that the potential impact of pollutants is considered by the client of these timbers to be re-used.

5. Timber wall plates were generally in good condition although extensive wetting was detected along the front elevation. Localised decay was detected along the front elevation as marked on the floorplan in the Appendix.

6. Two specimens of timber removed from the common rafters were identified as comprising European redwood.

7. Unless specifically referred to in Section 6 above, all common rafters, not affected by decay and notching and the purlin may be assigned to GS grade.

8. We also recommend that the structural engineer takes into consideration the effect of notching on the common rafters. In our opinion, notched common rafters may not be re-used on the basis of the size of the notch affecting the visual strength grade. It should also be noted that the full extent of notching on original common rafters may only be quantified once the roof covering and additional strengthening timbers have been removed,

9. With reference to BS EN 1912 GS grade European redwood may be assigned to Strength Class C16.

10. The principal beam spanning across the smithy was characterised by significant slope of grain and cannot be assigned to a timber strength class. Furthermore, the bearing of the beam at the rear elevation (Denmark Place) is inadequate and has been subject to ad-hoc repair. This must be checked by a structural engineer (Refer to Photograph 35 in report reference TCS/F15420-2).

11. The building is in a poor state of repair although the condition of the majority of the common rafters supporting roof may be described as free from decay and high timber moisture content associated with water ingress and in comparatively good condition. However, there are a number of rafters characterised by significant decay in their bases which have been identified in Table 1. Moreover, a number of rafters in good condition have been locally reinforced by the addition of lengths of timber alongside them.

12. High timber moisture content was detected along the length of the wall plate along the front elevation and the front bearing end of the principal beam that spanned the smithy. In addition, localised wetting was detected along the rear elevation.

13. It is our opinion that re-use of the common rafters may present significant challenges particularly if the top faces has been affected by 'socketing'. Whilst recognising the historic importance of the grade II* listed structure, we are of the opinion that it may be impracticable to re-use the original common rafters. However, they could be incorporated into a refurbished roof provided that additional support is introduced so the common rafters do not carry the full load of the roof. This assumes that any surface contamination that may be present is not a risk to health. We recommend that the Client undertakes a risk assessment to investigate of the any potential hazards to health associated with the build-up of contaminants on the surface of the roof timbers.

14. It should also be borne in mind that deconstructing the roof to separate the original structural timbers from recent additions may cause significant damage to the original timbers. Furthermore, deconstruction can also lead to the release of movement stresses which could cause distortion of the timbers which may affect their potential for re-use. Deconstruction of the roof may also exposure extensive notching would, on the balance of probability, affect the strength and potential for re-use of the common rafters. As already stated, the presence of extensive socketing on the top edges would preclude the re-use of these timbers in a structural capacity due to localised weakening and the uncertainty of achieving robust fixing of roof coverings to the original timbers.

15. Despite the low levels of decay in the roof timbers, the combination of decay, notching, strengthening works, exposure to atmospheric pollutants and the risks of damage during deconstruction and the likelihood of 'socketing' of the timber present significant challenges for the re-use of these timbers. It is our opinion that it is unlikely that these timbers could be re-used successfully.

9 Authorisation

	Issued by:	Under the authority of:
Signature:		
Name:	Dr John Williams	Philip O'Leary
Title:	**Senior Technical Consultant** **Timber Technology Investigations**	**Head of Section** **Timber Technology Investigations**

APPENDIX

Marked up floorplans of the smithy, No. 23 Denmark Place.