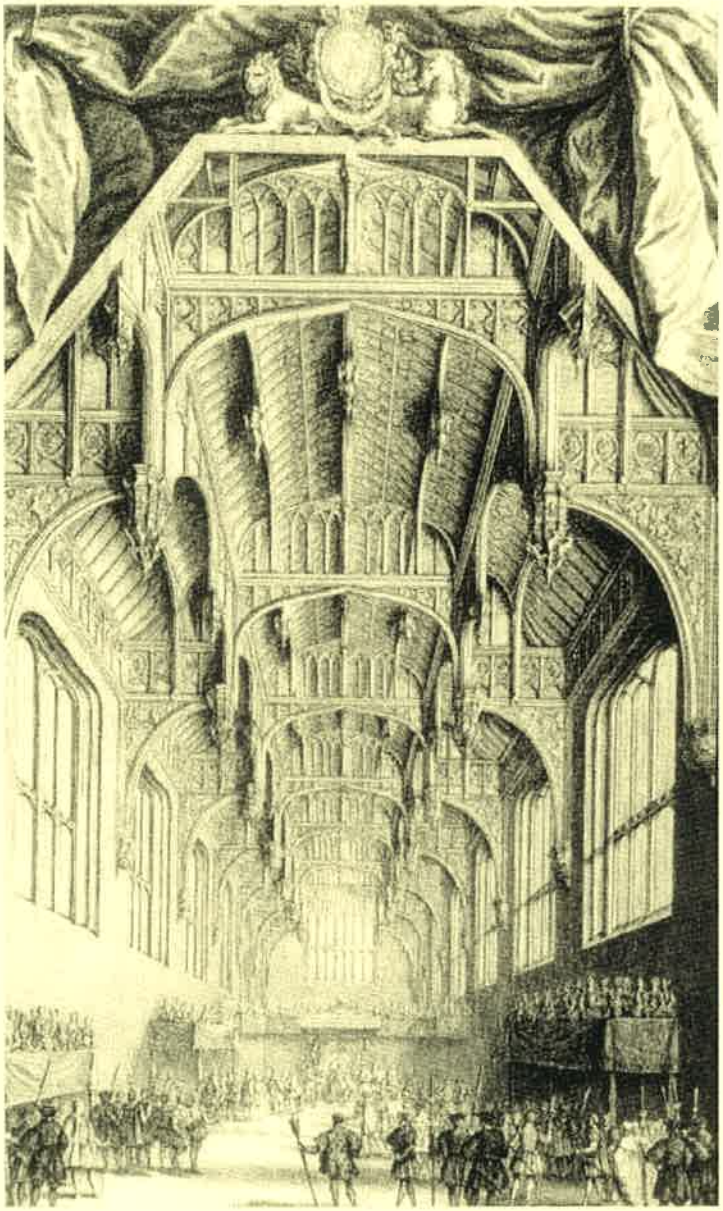
HISTORIC ROYAL PALACES

HAMPTON COURT PALACE

GREAT HALL ROOF

BUILDING RECORDING AND INVESTIGATION



OXFORD ARCHAEOLOGICAL UNIT
MAY 2000

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Summary

The hammer-beam roof of the great hall is one of the most celebrated features of Hampton Court. A project to renovate the roof's leadwork allowed the archaeological survey and recording of a small area of the roof structure with the specific objective of locating evidence of a former louvre, known to have existed until the late 17th century, and which allowed the release of smoke from a central fireplace within the hall. Evidence relating to the former louvre was identified and recorded including a secondary ridge piece which was inserted when the louvre was filled and mortices within the face of an existing truss which would have supported the louvre structure. The origins and significance of the roof are discussed, and the documentary sources for its construction and repair are described.

1 INTRODUCTION

1.1 Background

1.1.1 The Oxford Archaeological Unit (OAU) was commissioned by Historic Royal Palaces to undertake a programme of building investigation and recording during renovation works on the Great Hall roof at Hampton Court Palace (NGR: TQ157684, Figure 1). The renovation consisted of the installation of smoke sensors within the roof space and the insertion of a canvas layer coated in lime between the inner oak boards and the outer lead surface. This lime-coated alkaline layer is designed to combat the acid in the lead from corroding the oak boards and the work allowed some limited visual access into the roof space.

1.2 Aims and objectives

1.2.1 The overall aim of the project was to utilise the opportunity offered by the renovation of the roof to increase knowledge of the roof's form and structure. A more specific objective of the exercise was to identify and record evidence of the roof's former louvre which allowed the release of smoke from the central fireplace within the Great Hall and which is known to have existed from building accounts and contemporary illustrations.

1.2.2 The illustrations (Figure 2) show that the louvre was an upstanding structure which projected above the Great Hall roof line but they do not provide detailed information about the louvre's form or location. The investigation was therefore intended to confirm within which bay the louvre was located, whether it was hexagonal or octagonal in plan, and to provide further detail of

the structure's construction and form. Work was therefore targeted at the areas considered most likely to have supported the structure. Another specific objective was to record carpenter's marks revealed to allow their comparison with those in other parts of the Palace (though this was less succesful).

1.3 Methodology

1.3.1 Following the removal of the lead covering a limited number of oak boards were lifted from selected points on the upper section of roof to determine which areas should be opened further to provide the most useful information on the roof below (Figure 2). The areas initially opened, which were not exposed further, were on the southern upper slope of the mansard roof. Measured from the eastern edge of the roof the areas were between 1.8 and 2.2 m, between 7.3 and 7.6 m, between 11.76 and 12.15 m, and between 16.35 and 16.83 m. A single board was also opened on the northern upper slope between 10.15 and 10.25 m from the east.

1.3.2 The area containing the clearest evidence of the louvre, either side of Truss 4 (from the east) was then opened further to allow the measured drawing of each face of the truss, showing the contrasting features on either side (Figure 13). The enlarged opening was between 13.87 and 15.10 m (from the east) on the southern slope and between 14.15 and 14.55 m on the northern slope. Each face of the truss was drawn in elevation using hand survey techniques at a scale of 1:10, together with further details at 1:1, on polyester drafting film. Descriptive notes and sketches were also taken. The recording work was undertaken on 16 and 17 April 1998.

2 HISTORICAL BACKGROUND

2.1 Works on the Great Hall Roof

2.1.1 *The original build*

The rebuilding of Wolsey's hall by Henry VIII is well documented, and was the first phase of a rebuilding of the hall, chapel and royal lodgings from 1529 to 1537.[1] The demolition of the old hall roof began at the end of 1530; carpenters were paid for making a scaffold 'to take downe the Rouff of the olde Hall', and payments were made to tilers for taking down and sorting the tiles of the old Hall, and carpenters for assisting in taking down the old Hall and 'the timber of the Rouff of the same'.[2] After this the scaffold was removed, and the foundations of the new Hall were begun, including 6400 paving tiles.

Work continued in January 1532 with carpenters working on a scaffold to take down the old hall and its roof, tilers taking down and sorting the slates, and

1 H.M. Colvin et al., *The History of the King's Works Vol. IV 1485-1660* (1982), 132-4; original works accounts for 1529 to 1539 are preserved in Miscellaneous Books of the Exchequer, PRO E36/235 to 245 (Heath transcripts at HRP, Hampton Court have largely been used here).

2 PRO E36/241, pp.107-8.

carpenters taking down and sorting the timber. By March bricklayers were at work on the foundations, for which brick and stone were being unloaded, and carpenters had begun to work on the floor. In May/June and July/August a 'great scaffold' was being prepared for the new hall, and by August/September the walls had reached the height of the lower window transoms. In October/ November John Budde of Chislehurst provided 6400 tile 'to pave the Kyngs new Hall' and the height of the upper window transoms had been reached.

The roof is likely to have been designed by James Needham, the King's Master Carpenter from March 1531, when Humphrey Coke died,[3] but it is very probable that he had already discussed it with Coke. Needham occurs in the all the Hampton Court accounts as Master Carpenter until his appointment as Surveyor of the King's Works in October 1532, and at some point between then and the following Michaelmas he spent three weeks at Hampton Court 'in drawing of platts and makyng of molds for the new hall',[4] so he was clearly directly involved in the details of the work. The roof was certainly in hand: in March 1533 John Gwylders supplied 14 pins of iron 'servyng to joyne the Ruffs together(?) of the new Hall', and 'storopys' for the great wheel 'that conveyeth the tymber up in the Haull'. This implies that the roof was being raised and assembled, as does a further reference in March/April to 'brodds servyng for the pendantts for the new Hall', and again to 'doggs of Irne for the Rouff of the new Hall' in April/May. The work was progressing in some haste, and the carpenters, joiners and labourers were working in May 'in theyre owne tymys.... for the hastye Expedicyon of the same'; though reference to the drink perhaps implies a single occasion of rearing. Also in May the brick-layers were paid for hewing the brickwork to take the 'reprece posts in the hall', which may be associated with fitting the roof timbers in place.

Preparation was being made for the final decorative finish in June with payments to the carver Thomas Johnson of London for making '29 of the Kyngs bests to stand uppon the new batilments of the Kyngs new Hall and uppon the femerell of the said hall at 16s 8d the piece'. Another London carver, Richard Rydge was paid £4 3s 4d each for '16 pendantes standyng under the hammer beams' at the same time. That these were being put in place is suggested by another payment to John Gwylders 'for stays for the beasts on the battylments' in June/July, while in the same account Thomas Osley 'stapuller' was paid for 16 fother, 12 hundredweight and 3 quarters of lead 'to cover the Kynges new Hall', and other lead was used for pipes and gutters. John Wryght of South Mimms (evidently a mason) supplied 13 'beasts and badgs in the corbell tabyll uppon the Kyngs new Hall (i.e. the 14 external bays less one bay window) in July/August, and in the next account he was providing freestone for the gable ends of the hall; meanwhile the ironwork for

3 John Harvey, *English Mediaeval Architects* (revised edn, 1984), 210.

4 Colvin et al., *History of the King's Works Vol. III 1485-1660 (Pt.I)* (1975), 12-13, quoting Bodleian MS Rawlinson D 775, ff.220v-221v (this account is in a booklet of Tower works for May 1533, but includes Needham's expenses by land and water for over 175 days, and his fees for the full accounting year of Michaelmas 1532/33; the trip 'by the space of 22 days within the tyme of thys accompt' occurs near the top of the list).

the 'great bay wyndow in the south side of the Kynges new Hall' was supplied.

Either because it happened later, or since the craftsmen's accounts were only processed towards the end, the internal decorative finish of the roof and ceiling is mentioned from September/October when John Clement of Nutfield was paid for 'fyne selynge bourd for the Upper Rouff of the Kyngs new Hall', and Richard Rydge for 28 pendants 'standynge in the Crosse Mowntyn above the hamer beams' (i.e. the two pendants in the arcade of each bay on each side). Again in October/ November 'fyne selyng bourd' was obtained 'for the Vought in the Kyngs new hall'; this had to be finished with overtime 'fenesshyng of the Haull Vought in their owne and drynkyng tymes'. So the ceiling was described as a 'vault', as if it were the vault of a stone building. In November/December panelling was acquired and a number of craftsmen were paid for decorative work on the ceiling: Richard Rydge made 28 heads 'standing uppon the fote of the arches of the syde of the hammer beams in the new Hall', and 20 pendants 'standyng in the upper purloyns'.[5] Thomas Johnson of London, carver, made 26 spandrels 'to stand uppon the Repryse under the hamer beame' (presumably the grotesque carving), and Michell Joyner made 250 badges of the King and Queen 'standyng upon the Caters within the said Hall' (possibly the frieze of decorated quatrefoils).[6] As was usual in the short days of the winter months candles were provided for the carpenters 'workyng uppon the Vaught', and a cloth 'tilt' was put up to 'kepe the wether from dryving in' through the unglazed windows (and over the vault of the bay window, which was not completed until the following March).

In January 1534 work began on the great louvre or 'femerell' of the hall, which seems to have been hexagonal: it had six 'Rochemounds' and six 'hawsys' cut for it, and then six lintels with 18 lights 'for the fyrst store', six lintels with six lights 'for the second storey of the sayd femerell', and the light 'servyng for the Typpe of the femerell' cut in February/March. Presumably these were all of timber, as were the four pendants cut by Richard Rydge 'hangyng uppon the femerell of the Kyngs new Haull'. The rooftop sculptures were finished with paint: six lions and four dragons, all topped with gilded vanes (presumably around the upper battlements) and then four lions and four greyhounds 'servyng for the femerell', surmounted by 'a great lyone crowned baryng a great vane servyng for the toppe of the femerell'. The painter John Hethe was also paid for painting the 172 badges and 28 heads in the hall vault and the 'Kyngs bests and the quenys of antyk work standyng in the spanderells'. These are presumably the work of Thomas Johnson referred to above, but he was not the only worker in that style, for in August/September Robert Skynoyk of London 'mowlder of antykeworke' (probably a German called Schenk) was paid for 'mowldyng of antyk work for the Haull; crest moldyd work wyth the Kyngys armys and the quenys standyng in the Kyngs Haull above the Evys pece'.[7] In March/April the 'second vowghte' of the

5 The totals here of 16 main pendants, 28 heads behind them, 28 pendants above them and 20 pendants in the upper layers (actually 14 in the upper tier, and 7 on the ridge) accounts for all such decoration in the roof bar one.

6 Through at 7 bays x 2 sides x 14 badges the frieze total would be 196.

7 PRO E36/242 p.208 (see *King's Works IV*, 133).

femerell was finished with 6 lintels 'wrought wyth bowtells in the nyght tymes', and it was covered with lead. Yet more decoration of the louvre was undertaken in April/May, when Richard Rydge cut and carved 'a Rose Crownyd standyng in the Crowne vowght of the femerell', six trails 'standyng in the first Courbe of the femerell', and likewise in the second; John May cut another six trails for each of the third and fourth levels, and three others cut six hollow bowtells for each of the three storeys, with '6 holow leyntells wrought with boutells for the crowne vowght'. On the outside the vanes on the freestone beasts 'standyng at the ends uppon the Haull' were painted and gilded.

Clearly the upper roof of the hall was intended to be accessible, for in May/June work was done on the door 'at the vyce fote goyng up to the batylments of the Haull', and also at the top; in June/July carvings (two greyhounds and a leopard ('lybbert') were made for the top of the stair (vyce). The louvre was then finally completed when the painter John Heath painted the inside blue ('byssyng of 236 fote bourde') and green ('layng 6 lattys wyth grene') and gilded the 'great Rose crownyd'.

Interior fitting out remained to be done. In July/August the bricklayers and carpenters built the partition wall in the basement between the cellar and buttery (and this carried the vault that supports the open hearth in the hall). In September/October 1534 some 2000 tiles from Chertsey used for paving the hall floor, and the hearth was paved with 36 foot of Reigate stone (i.e. six foot square). The hall was glazed in the next account, and the detailed list includes 'the lover uppon the Haull in the nether story ys 12 lyghts, every lyght conteynyng 7 foots 4 ynches; the upper story of the forsaid lover in the said femerell ys 18 pecys of harnys conteynyng 6 foots.' Work continuing into 1535 included the screen, set up in June/July, with carving by Richard Rydge of 32 of the King's and Queen's badges.

This summary of work on the hall concentrates on the roof, but the very detailed records could this period have much more to say on craftsmen, and the source and transport of materials (stone, brick, and ironwork). The accounts have not been searched for timber procurement, but Baines reported the sources as Dorking, Holmwood, Leatherhead, Banstead, Berewood, and St John's Wood.[8]

2.1.2 *The restructuring of the rooftop*

Later expenditure on maintenance is recorded in much less detail, the chief source being the declared accounts of the audit office. For example, in 1617-18 they record 'work in the lanthorne and postes rounde about the rayles on the topp of the Hall; grafting on new in their places; wyer worke for the Lanthorne over the Hall'.[9] The roof with its prominent parapet and louvre appears in all early views of Hampton Court, especially the series of drawings

8 *The Builder* 23 December 1927, 973.

9 PRO E351/3252 (accounts run from Michaelmas to Michaelmas).

by Wyngaerde in 1557-9,[10] which give the only clear indication of the shape of the louvre (Figure 3a-c). Abram Booth's view of 1629/30 gives perhaps the clearest view of the three-decker louvre surrounded by battlements (Figure 3d), with all the upright posts and vanes (and the decorated heads of the corner turrets).[11] Other early 17th-century views such as the Pepys Library drawing,[12] the Dartford Collection view,[13] and the Hollar view with a sundial,[14] do not add any significant detail. However, the drawing in Vienna by Willem Schellinks, who visited Hampton Court in 1662, shows neither the louvre nor battlements (Figure 4a), though it does delineate a fine example of a state coach passing on front of the palace.[15] It would seem that the series of repairs recorded in 1663,[16] shortly after the Restoration, must have included the removal of the external roof timbers, leaving the roof with the slightly surprising profile that it has today. Whether the works were done sooner, or Schellinks made a later visit is not clear. Later views of the palace show the roof as now, with only the stone battlements at the ends,[17] and this is how it is shown on the Kip and Knyff birdseye view of c.1705 from *Britannia Illustrata* (Figure 4b).

2.1.3 *Later History*

The hall was used for theatrical performances on several occasions (in James I's reign Shakespeare was involved in masques performed there), and the hall was actually converted to a theatre in 1718 by King George I to rival his son's separate court at Richmond, and it remained until 1798.[18] George II entertained the Duke of Lorraine in the hall in 1731, and the ceiling was apparently repainted in 1764 (see below), but the palace itself was scarcely used after the king's in 1760, apart from a short period of use as a substitute parish church in 1829-31 while St Mary's at Hampton was rebuilt.[19] Despite the hall's late gothic and renaissance features, details of the Hall roof were illustrated by A.W.N. Pugin, *Specimens of Gothic Architecture* Vol. II (1821). It continued to be maintained: repairs had been recommended by Soane in c.1820, but not completed; in 1840, two years after the state apartments were

10 Montserrat Galera I Monegal, *Antoon van den Wijngaerde, pintor de civtats I de fets d'armes a l'Europa del Cinc-cents* (Inst. Cartografia de Catalunya 1998). The originals are all in the Ashmolean Museum, Oxford.

11 University of Utrecht, MS 1198, f.143v.

12 Magdalene College, Cambridge: Pepys Library 2972, 209B (a line drawing, not to be confused with the later drawing commissioned by Pepys in the 1660s, Pepys Library 2972, 210-11).

13 A long pen and ink drawing with somewhat stylised architectural details (photo with HRP).

14 A distant view with a sundial in the foreground, British Museum L.B. 8(a).

15 For the background to this, and the detailed account in his diary of the visit, see M. Exwood and H.L. Lehmann (eds), *The Journal of William Shellinks' travels in England 1661-3,* Camden 5th Series Vol. I (1993), 79, 86-92. The drawings, in the Van der Hem *Atlas* in the National Library in Vienna are described in P.H Hulton, *Drawings of England in the Seventeenth Century by William Schellinks...,* Walpole Society 35, 1959.

16 Colvin et al., *History of the King's Works Vol. V 1660-1782*, 153 (Works Accounts for 1663-4, PRO WORK 5/4).

17 E.g. two anonymous paintings of Hampton Court in the Royal Collection of 'c.1640' (view across the river with a coach on a ferry) and 'c.1663-70' (garden view along the canal).

18 Colvin et al., *History of the King's Works Vol. V 1660-1782*, 180.

19 Information from HRP; J.M. Crook and M.H. Port, *History of the King's Works Vol. VI 1782-1851*, (1973), 333.

opened to the public, the Great Hall was opened, and in 1841 the window glass was restored by Thomas Willement.[20]

2.1.4 *Modern repairs and restoration*

A major campaign of roof repairs was carried out in the 1920s, presumably following on from Baines' survey and repairs to the hammerbeam roof of Westminster Hall.[21] The project commenced in December 1921 with the decision to inspect the roof. The initial report by Sir Frank Baines, dated June 1922, found extensive damage from rot and death watch beetle, and led to a fuller investigation which resulted in a second report from Baines in April 1923. This recommended repairs to the roof, suggesting a steel frame like that used in Westminster Hall, since the 'roof can be retained with a minimum of renewal in the way of new oak', and 'that all the decorative members will remain intact'; it would also strengthen the roof effectively and was easily inserted. The suggestion was made that the femerell could be re-erected (roundly rejected by Peers as 'a piece of needless restoration'). The cost of work was estimated at £35,000. The question of paint treatment had also been raised, and Baines reported in November 1923 on a paint survey that revealed only varnish on the moulded timbers and successive layers of white and blue oil paint on the ceiling panels, over a 'dull blue water paint or distemper' that was thought to be the original colour. It was subsequently proved by the Government chemist to contains the pigment azurite; while the later coats were found to be a white oil undercoat to blue oil containing Prussian Blue. While the azurite may therefore be the 'byssing' applied by Heath the painter, the Prussian Blue (then thought to post-date 1724) was reported by Baines to include a signature with the date 1764 (Baines to Robertson 2 August 1923). After discussion, and site visits with Peers it was decided to leave all the gilt that was found and darken the panels after removing varnish, though this also involved replacing some deal panels with oak.

The progress of work is not covered by the file, though Treasury asked anxiously about expenditure in June 1926, and a memo from Baines in August promised that the roof (but not the floor) would be finished within a year. In fact it was completed by April 1927, the scaffold was removed in June and the cost had been about £36,000. The last stage of work was on the floor, found to be in poor condition when examined, and in need of repair, though this was undertaken at the same time that the cellars were cleared for opening to the public. The records made for the roof repairs were extensive, and over a hundred drawings showing both removed and replaced timberwork have been deposited in the PRO, while some copies remain in the English Heritage plans room (Figure 8).[22] During the repair work to the floor was in 1928, the central hearth was located and recorded (Figure 7). A valuable series of photographs was also taken before and during works, showing details of the decorated parts

20 Ibid, 332-4.

21 The Office of Works file on the Great Hall is PRO WORK 19/583, and the drawings are WORK 34/1605 to 1708 (dated 1922-23).

22 Drawings consulted while still in English Heritage plans room, Keysign House, with original numbers 25R/4 to 50 (new nos. 2521-60) in File 40; see also Files 41 and 43.

of the roof (Figs 5-6).[23] The works were reported by Sir Frank Baines in a lecture, who described the precarious state of the roof and the extensive effects of death-watch beetle attack, and outlined the method of steel trussing employed to prevent collapse.[24]

2.2 Hammer Beam Roofs

The roof at Hampton Court is one of the last of the great medieval roofs, and must be seen in the context of the development of the hammerbeam:

> *The elaboration of the hammer-beam roof exploited so brilliantly at Westminster Hall had essentially three heirs in the late fifteenth and early sixteenth centuries: the angel roofs developed in parish church architecture; the hammer-beam roofs of royal great halls and those emulating them; and the timber roofs of the chapels and halls of late medieval colleges, principally at Oxford'.*[25]

After the great roof of Westminster Hall of the 1390s (itself built almost a century after the first use of hammerbeams), the next major hammerbeam construction was over Edward IV's hall at **Eltham Palace** (1479-80), presumably designed by Edmund Gravely, the king's chief carpenter.[26] Again it is filled with tracery, and its soffit forms a series of four-centered tudor arches, while the posts above the hammers have pendants descending below the hammers, providing a vertical emphasis rather than the horizontal effect of the flying angels in Westminster, and reflecting the contemporary usage of masonry (e.g. the vault of the Divinity School in Oxford). The design is bold and open, with heavily moulded timbers drawing attention to the wallplates and arches. In structural terms the pendant posts, being tenoned to the hammers, do not function as the Westminster design, and the roof is of the 'false hammerbeam' type.

An important precursor of Eltham is the hall of the London merchant Sir John Crosby, formerly at **Crosby Place** in Bishopsgate.[27] This is not a hammerbeam roof, but a coved ceiling with pendants formed on the soffit of a scissors truss. The proliferation of arches between the pendants, running longitudinally as well as transversely, the general application of carved decoration, and the richly decorated wallplate were to set a new standard for elaborate roof carpentry. The name of the carpenter responsible is unknown. Courtenay draws attention to the successors of Eltham: the hall roof of Sir Nicholas Carew's mansion at **Beddington** in Surrey (c.1500); the lost roof of **Richmond Palace** (1501); and the main body of the **Savoy Hospital** in

23 Copies of Office of Works photographs at HRP collection, Hampton Court Palace.

24 Reported in *The Builder*, 23 December 1927, 971-3, and *The Journal of the London Society*, pp.5-9 (Lecture delivered 16 December 1927); I owe these references to the report of Alan Baxter and Associates 'Hampton Court Palace Great Hall Roof' (May 1997).

25 Lynn Courtenay, *English Royal Carpentry in the Late Middle Ages, the Hammer-Beam Roof* (unpublished D.Phil thesis, University of Wisconsin – Madison, 1979), 168. I am indebted to Dr. Courtenay for much of the following.

26 Courtenay, 172ff.

27 Courtenay, 175ff.

London (1515-19).[28] Two of them had hammerbeams and all had rich decoration and pendants. The Savoy was presumably designed by Humphrey Coke the master carpenter (and subsequently the king's chief carpenter), and demonstrates a return to the more sound relationship between hammer and post that had been dispensed with at Eltham. The decoration of the Savoy was also rather more austere, with quatrefoil decoration rather than extensive tracery, but there was an elaborate timber lantern at the crossing of the cruciform hospital, mounted by beasts supporting a crown. Coke was also employed in Oxford for Bishop Fox's new foundation at **Corpus Christi College** (1512-14), where a similar design to Eltham was employed over a much smaller space and (apart from the pendants) the mouldings make up for a lack of other decoration. From Corpus, Coke naturally progressed to Wolsey's new foundation of Cardinal College (now **Christ Church**), to design the roof of the palatial hall (and also for the lost chapel) in the 1520s. At Christ Church the Eltham model is transformed (a la Crosby) by the transverse/longitudinal series of arches running across each other to form a network of arches with pendants (in the Oxford context these had been presaged by the late 15th-century stone vaults of the Divinity School and St Frideswide's choir). The cardinal's megalomania was expressed in the continuous frieze of badges at wallplate level (and heraldic detail elsewhere), a feature that was to be repeated at Hampton Court.[29] Courtenay observes also the continuing use of 15th-century decorative features (tudor arch, pendant and quatrefoil panels) with a revival of earlier motifs such as open tracery in the spandrels and the oculus + dagger design typical of the late 14th century.[30]

At Hampton Court the general design of the Christ Church hall is repeated (over a room - 40 by 106 feet - of almost identical dimensions), but with the added depth of an earlier medieval style of steep pitch with resultant deep four-centred arches, rather than the low pitch and flat tudor arches of the Oxford hall. Nevertheless, the apex of the roof is reduced to a very low pitch, giving an almost flat area of leads between the 'battlements'. The increased depth allows for larger spandrels below the 'tiebeams', and much more space above them for full-sized traceried windows between the collars. As at Christ Church there is a frieze with badges on the walls and running out over the hammer beams, but many more pendants, and instead of one row of longitudinal arches on each side there are no less than three tiers of arches with pendants (the lower one actually in the form of a hammerbeam arcade running down the hall). Thus there is a proliferation of carving, and much of this (especially in the hammerbeam spandrels) is in full Italianate Rennaisance style: the 'antik work' of the accounts (Figure 6). Not only this, but the whole roof is ceiled (it was often referred to as the 'vault' in the accounts), so the roof is closed off by traceried panels, rising in three curved coves from above the hammerbeam level (and all painted blue). Externally, the hall had a broken profile, like a mansard roof, with freestone battlements along the upper gables, that continued along the sides of the angle, with timber battlements adorned with painted and gilded lions and greyhounds, and the three-storey louvre rising in the middle. No other English roof had ever been finished like this,

28 Courtenay, 180ff.
29 R.C.H.M. *Inventory of Oxford* (1939), 34, pl.81.
30 Courtenay, thesis, 195.

though the onion-shaped domes on the turrets were becoming common enough.

Uniting in one roof the historic gothic forms with current tudor ones and the latest in Italianate decoration, combining the use of the steep gothic roof on a grand scale with the intimacy of a domestic panelled ceiling, and looking forward to the rooftop pavilions and walks of Elizabethan great houses, the roof at Hampton Court is an extraordinary creature of its times, and a defining moment in royal carpentry and architectural design.

3 INVESTIGATIONS AND OBSERVATIONS

3.1 General Description of Roof

The hammerbeam roof in the Great Hall is one of Hampton Court Palace's most celebrated features. The roof, which has a mansard profile, consists of eight hammerbeam trusses of which the two outer ones are adjacent to the end walls of the hall. Each truss has a pair of hammerbeams projecting into the building from the top of the external walls supported by arched braces. The hammer beams support hammer posts which themselves support a lower collar. Above and behind the decorative arch-braces the collar is supported by a system of bracing back to the hammer post and down through the hammerbeam to the lower wall-post (Figure 5); this is reminiscent of the arch in the Westminster Great Hall roof, but is here obscured by the decorative covering. The lower collar is tenoned into a pair of large principal rafters which form the lower, steeper-sloped section of the roof and support an upper collar. A king-post resting on the lower collar projects above the upper collar and supports a thick section ridge piece and a pair of low-pitched upper rafters. Each lower principal rafter supports two purlins and a wall-plate/purlin at the junction between upper and lower principal rafters. There is a single (secondary) purlin supporting each of the upper slopes.

Most of the principal structural elements of the roof are visible from below although they are partially obscured by rich decoration. The boarded ceiling is formed by three arches which hide the upper and lower principal rafters behind, and most of the common rafters. A substantial reinforcing steel frame was inserted in the 1920s and (probably at the same time) many of the original common rafters were removed to be replaced by common purlins covered by oak boards and a lead lining.

3.2 Truss 4, Phase 1: The primary roof

The current recording project only allowed a limited visual inspection of the upper section of each truss and only the detailed recording of the upper section of Truss 4. It is believed that the upstanding louvre was located in the bay to the east of this truss (Bay 3) and each face was examined and recorded to identify structural differences providing evidence of the louvre. The following is therefore a detailed description of the upper section of Truss 4.

Although the roof has undergone substantial alterations since its original construction most of the main primary elements of the upper section of Truss 4 remain *in situ* together with indirect evidence of the louvre. All the visible primary elements of the roof are of oak. The upper section of the truss consists of an upper collar (36 x 32 cm) spanning between two wall-plates/purlins and two shallow-pitched primary upper principal-rafters (30 x 22 cm) tenoned with two pegs into the head of a wide king-post (Figures 8-11, 17, 19).

The base of the head of the king-post is 62 cm wide by 34 cm deep by 33 cm tall and has two vertical projections. The outer faces of the projections are sloped and house the principal rafters while the inner faces are squared and form a wide slot supporting the large primary ridge piece (30 cm^2). In a roof of this type and age it would be usual for a large ridge piece to be tenoned into each face of the king-post, rather than sitting in a slot, but in Truss 4 the ridge piece is cantilevered over the king-post a short distance (c45 cm) to the east where it terminates with an edge-halved end which supports a secondary ridge piece (Figure 14, see Phase 2 below). This detail of cantilevered primary ridge-piece and inserted secondary ridge piece are clear pieces of evidence confirming that the former louvre was located in Bay 3. The upstanding structure over the smoke-bay would have required substantial support and this would have been partially provided by the king-post and the cantilevered ridge-piece. It may be that in each of the other trusses the ridge-piece is tenoned into the king-post, except for the one on the other side of the louvre (Truss 3).

The primary ridge-piece to the west of the truss has a slightly cambered upper face and continuous sloped shoulders cut at the two upper corners with deeper individual mortices which would have housed primary common rafters at the same height as the principal rafter. The mortices are 10 cm wide by 4 cm deep and are at 41 cm centres. The primary rafters are no longer in situ having been superseded by the common purlins inserted in the 1920s which directly support the boards currently covering the roof (Figures 13 & 16). The secondary ridge-piece has several differences to the primary: it is smaller (22 cm^2), it has a squared upper face, and the outer edges of the mortices which formerly housed the heads of common rafters are flush with the face of the ridge-piece, rather than being set within a shoulder.

The east face of the base of the king-post is covered with a grey paint, clearly terminating at the base of the two vertical projections. A small sample of the paint was taken to allow its future analysis.

The other main piece of evidence confirming the location of the former louvre is the contrast in mortice holes on each face of the truss. The west face of the truss represents the standard, non-louvred roof structure which originally had a single purlin to each pitch supporting the common rafters. These purlins are no longer in situ but some evidence of them survives in mortice holes in principal rafters. Unfortunately 1920s oak infilling has obscured the possible mortices in the west face of Truss 4 but a photograph was taken within the

roof space, from the opening at Truss 4 towards the west face of the northern principal rafter of Truss 3 (Figure 18). Although the image is hazy a thin inclined mortice is visible which would formerly have housed a primary purlin supporting the primary common rafters. This is assumed to be a typical detail present on each truss unaffected by the louvre.

On the east side of Truss 4 the existence of the louvre would presumably have removed the need for conventional purlins at the angle of the roof slope and the mortices reflect this. On the east face of the northern principal rafter there is a rectangular, horizontally-set mortice contrasting with the inclined angle of the former rafters (Figure 9). The mortice is 26 cm wide x 4 cm deep. The height of the recess is obscured by a piece of 1920s oak placed over the mortice to support secondary purlins immediately beneath the roof-covering boards. There is no mortice hole visible on the east face of the southern principal rafter (again on the side of the louvre) but there is a large piece of 1920s oak which may obscure such a feature. Also on this side, directly beneath the oak covering piece is a mortice within the primary upper-collar largely obscured by a 1920s steel member covering the upper-collar. This mortice, which is 4.5 cm deep x 22.5 cm wide (with unknown depth) extends vertically to the upper ridge of the collar and would therefore be suitable for supporting an upstanding structure, rising above the collar and alongside the principal-rafter.

The two horizontally-set mortices would presumably have housed the ends of two beams spanning Bay 3 which would have supported the northern and southern edges of the upstanding louvre. The beams would have been about three metres apart while the eastern and western edges of the louvre (supported by the ridge piece cantilevered over Trusses 3 and 4) would have been about four metres apart. If the louvre had been an octagonal-plan structure it would have had flat faces towards the north, south, east and west and the east-west span would therefore have been the same as the north-south. It therefore appears that the structure would have been six-sided with flat faces towards the north and south and corner edges to the east and west supported by the cantilevered ridge-piece. This evidence is supported by the references in the building accounts to the louvre having six windows.

Another feature which may relate to the former louvre is a mortice in the upper surface of the primary ridge piece. The mortice is 34 cm long x 4 cm wide x 11 cm deep and its central axis is roughly at the west edge of the king-post.

At the lower edge of the south slope, at the junction between upper and lower principal rafters, is a primary purlin which acts similarly to the wall plate of a standard pitched roof. The member is cut from a 33 cm x 25 cm section timber, with a deep chamfer to the lower, outer corner into which are tenoned the primary (?) rafters of the lower, steeper slope of the mansard roof. It was not possible accurately to measure their section or angle of pitch. A shallow angled shoulder is also cut into the inner, upper edge of the purlin/wall plate into which the base of the original rafters would have sat. From the mortices it appears that the former rafters would have been square sectioned measuring 12 cm x 12 cm and would have been pegged from above.

The two edges to the underside of the upper-collar were found to have double-curved, ogee mouldings with square stops c 8 cm from each post. Each moulding is 5 cm wide with a 3 cm deep inner lip creating a recessed central section to the tie-beam. Although at this point the underside of the collar is not visible from within the hall the moulding detail is presumably a continuation of the detail to the central section of the collar which is visible within the hall. Within the hall the collar supports the upper edge of a tracery panel. Also primary are two timber posts, supporting the lower end of the principal-rafters. It was not possible accurately to determine the dimensions of these posts.

3.3 Phase 2

As described above, Phase 2 is the insertion of the secondary ridge-piece, which was scarfed onto the larger primary ridge-piece to the east of the truss, when the louvre opening was filled (Figures 9, 11 &14).

3.4 Phase 3

Some renovation work has been undertaken on the roof, which is clearly secondary (and later than the infilling of the louvre) but appears, from the age of the timbers and other evidence, to pre-date the known work in the 1920s.

The main members of Phase 3 are the single purlin to each pitch, either side of Truss 4, centrally located between the outer purlin (wall-plate) and the king-post. Each purlin is tenoned into the principal rafter at the same angle as the rafter and measures c 19 (w) cm x 14 (h) cm in section. They strongly appear to be machine cut.

We can be certain that the purlins pre-date the 1920s work because due to the re-orientation of the roof from a common rafter to common purlin (more detail below) they no longer support rafters holding the covering boards. The purlins would have supported the mid-point of inclined rafters spanning between the purlin/wall-plate and the ridge-piece. This is most obvious when analysing the west face of the south half of Truss 4. A line drawn between the shoulder cut in the purlin/wall-plate and the mortice within the ridge-piece passes directly across the upper, sloped face of the Phase 3 purlin. A line similarly drawn on the other side of the truss, however, would cut directly through the purlin. There were no mortice holes apparent within the purlin so the rafters were not tenoned which suggests that the rafters in this section must have been of a different depth or were cut to accommodate the purlin.

The upper side of the arched ceiling, formed by ribbed arched panels, is visible and appears to be secondary. An upper covering may have been added to the remaining primary underside. At the highest point of the arch there is a circular-sawn ceiling ridge-piece (22 cm x 6 cm), beneath the main ridge-piece, bolted to the panelling beneath.

3.5 Phase 4

A large amount of strengthening work including the insertion of a substantial steel frame around the existing timbers was undertaken on the Great Hall roof in the 1920s, as described above. The engineer's survey drawings survive, dated 1923, which provide a useful record of the reinforcement work undertaken.

The main element of Phase 4 is the large steel frame which is remarkably unobtrusive being invisible from beneath in the Great Hall. The steel used is c.2 cm thick and the members are bolted together. The parts of the steel frame visible from above naturally echo the primary structure. Two steel plates (30 cm tall) sandwich the existing upper-collar and are supported to either side by angled steel posts. Additional struts, at a sharper angle than the posts, strengthen the junction between post and beam. Right-angled steel brackets are bolted to the steel posts and to the rear of the purlin/wall-plate, providing reinforcement to these members.

As previously described, the roof was originally a common rafter roof, consisting of inclined rafters (the upper surface of which was flush with the existing principal rafter) supported by the Phase 3 purlins. The work in the 1920s converted this to a common purlin roof with the insertion of oak butt purlins (12 x 6 cm) supported by a secondary oak rafter set on top of the principal rafter and by a intermediate supporting rafter at the centre of each bay. The two rafters on the south slope (primary and secondary) are secured by four timber pegs. The purlins have edge-halved scarfes which slot within recess in the secondary rafter. There is a curious contrast in the distance between principal rafter and oak boarding between each pitch and consequently in the thickness of the secondary rafter. To the north pitch the rafter tapers from 8 cm deep adjacent at the ridge to 2 cm at the wall-plate, whereas on the south pitch, the rafter remains constant at 8 cm deep for its full length. The rafters meet at a secondary oak ridge-piece (8.5 cm wide x 12.5 cm high) set on top of the primary ridge-piece. The purlins support oak boards 10 cm wide x 2.75 cm deep.

The re-orientation of the roof, from common rafter to common purlin, also enables us to date the clearly secondary northern purlin/wall-plate on the east side of Truss 4 to this phase. This member (39 x 24 cm) is circular-sawn and, similarly to the primary purlin it replaced, has a chamfered lower edge into which the rafters of the lower roof are tenoned. Unlike the primary purlins this one does not have a shoulder cut to accommodate the rafter bases and can therefore apparently only fit into a common purlin roof.

It is interesting to note that a similar pattern can be seen in the roof of the Great Watching Chamber, where two main phases of restoration can be identified and again the original common rafter roof was re-aligned to a

common purlin. The re-alignment at the Great Watching Chamber took place substantially earlier, however, probably in the early nineteenth century.[31]

Oak ashlaring members (14 cm deep) which support vertical oak boards, have been added to either side, supported by the upper-purlin/wall-plate. Several patching-up oak members have been added to the structure, apparently of early twentieth century date and presumably of the same phase as the steel-work. For example such members have been inserted beneath the Phase 3 purlins. The difference in height of these purlins, mentioned above, results in the tapered oak pieces being of different dimensions on either side of the truss. To the east of the truss the members, which are bolted to the principal rafter, are 45 cm long and 18 and 10 cm tall at either end. The corresponding members to the west of the truss, which are not bolted to the principal rafter due to the lower level of purlin, are 44 cm long and 11 cm and 1 cm tall.

4 CONCLUSIONS

4.1 The principal objective of the project was to determine conclusively the location of the former louvre together with gaining an indication of its form. The location of the louvre was positively shown to have been in Bay 3 by several pieces of evidence.

4.2 The clearest piece of evidence was the secondary ridge-piece inserted within Bay 3 and scarfed onto the primary ridge-piece. That this section of ridge-piece was secondary was apparent from its smaller section, different profile and different rafter mortices from those in the primary ridge-piece. The cantilevered primary ridge-piece, supported in a slot rather than tenoned into the head of the king-post also provides evidence of the former louvre as do the contrast in mortices on either side of Truss 4. The mortices to the east of the truss suggest horizontally-set purlins which would have supported the louvre in contrast with the conventional angled purlins found on other trusses.

4.3 The building accounts and early views also substantiate the hexagonal shape of the louvre. While the internal decoration of the Great Hall is well known, the building accounts confirm the indications of the early view of the hall that the exterior was equally decorated. The surviving battlements on the upper part of the roof are but a fragment of the extensive timber battlements with painted and gilded figures that ranged along either side of the louvre, while that was also decorated and painted on the exterior.

4.4 Comparison between Hampton Court and other late medieval great roofs shows that while it forms part of a steady progression in design and decoration it quite surpasses them in the range of its decorative elements, and the combination of Gothic, Tudor and Italianate motifs.

Jonathan Gill and Julian Munby, Oxford Archaeological Unit, May 2000.

31 *Hampton Court Palace: Great Watching Chamber Roof; Archaeological and photographic record in advance of repair,* unpublished OAU report for HRP (1997).

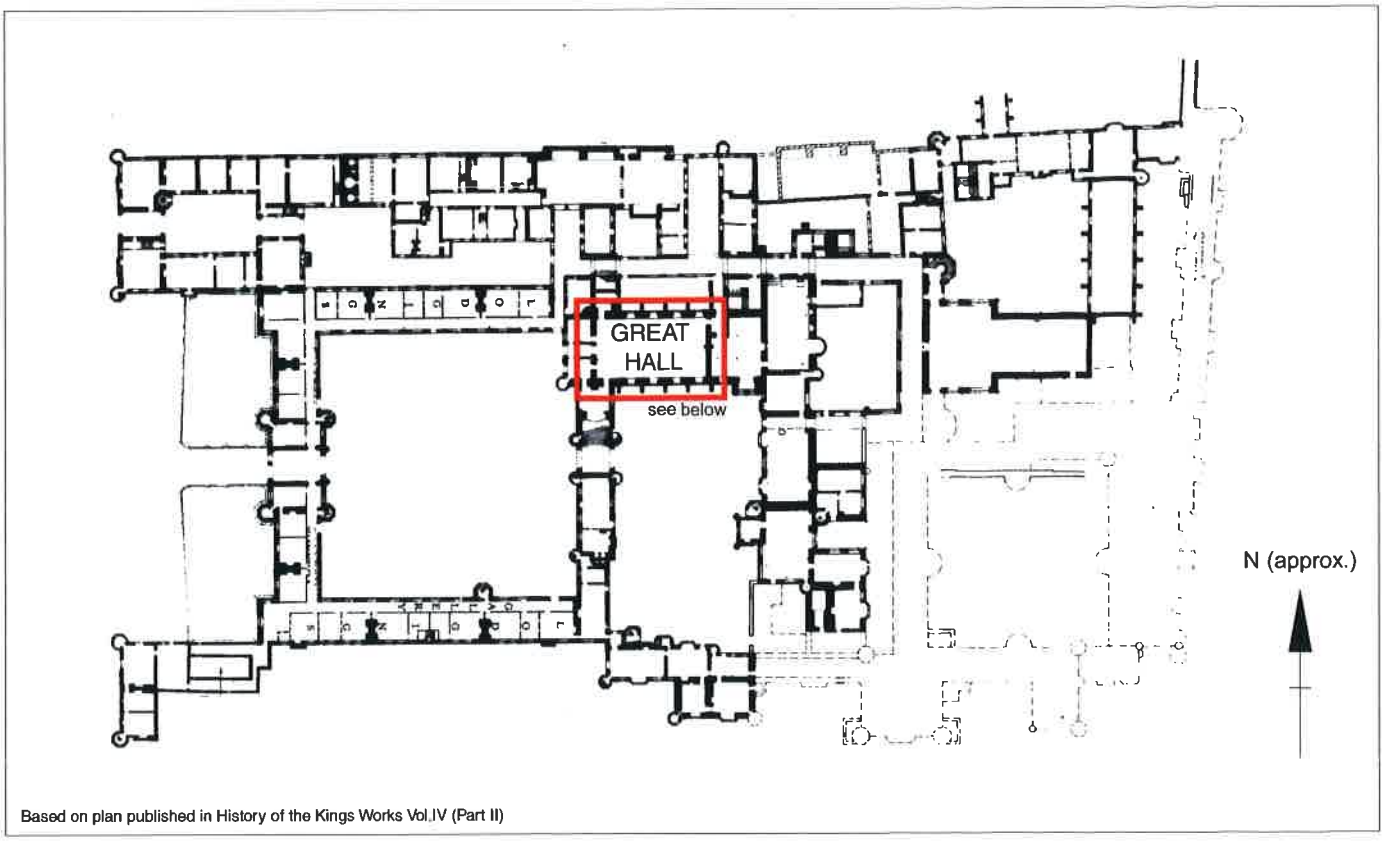


Figure 1: Location plan

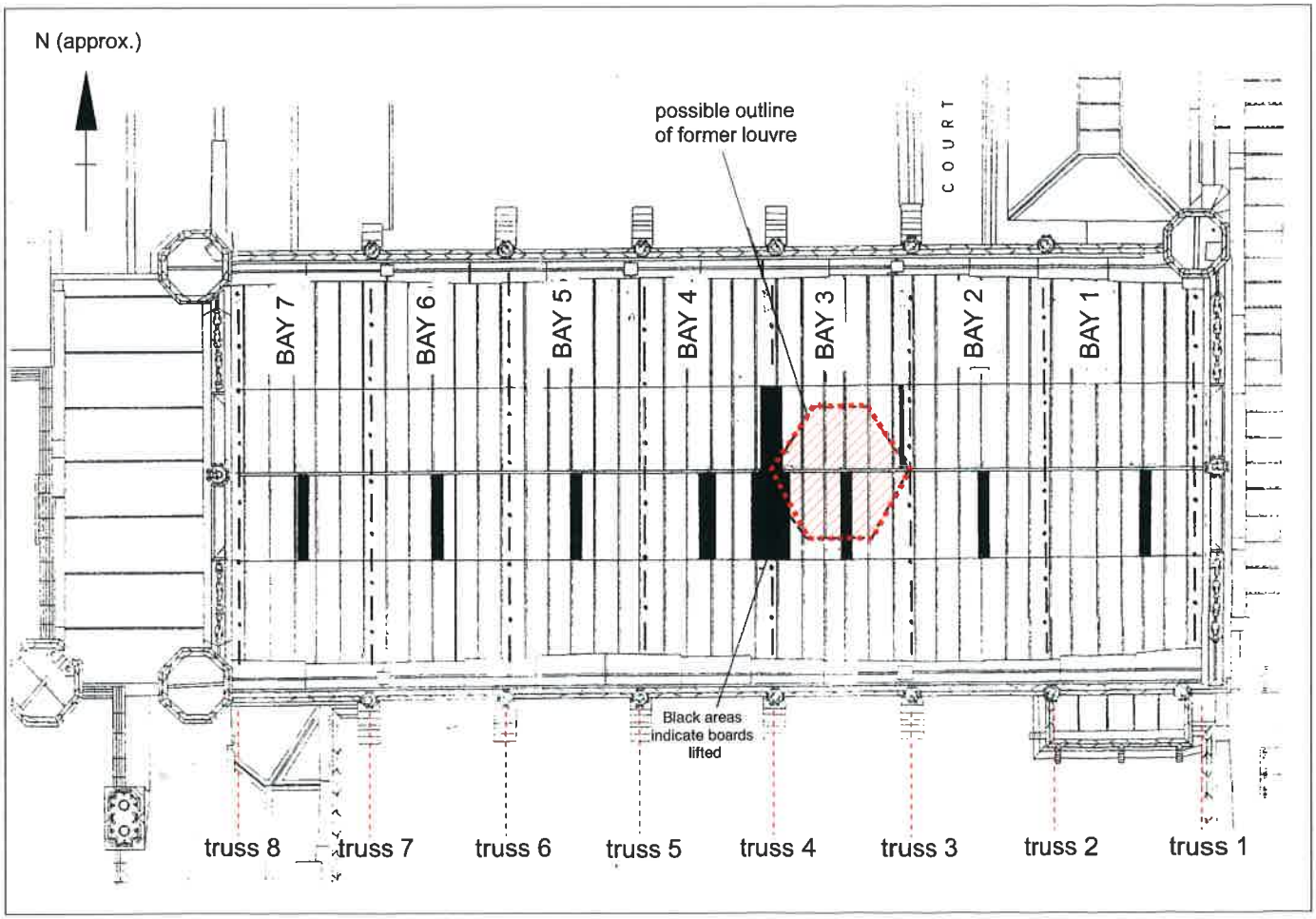
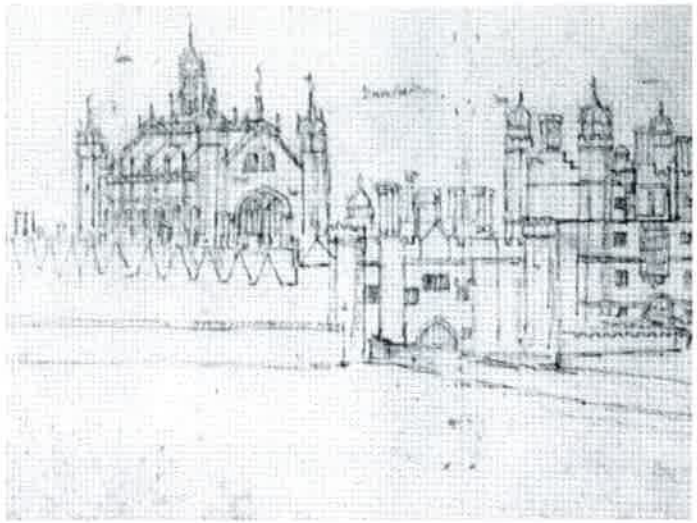
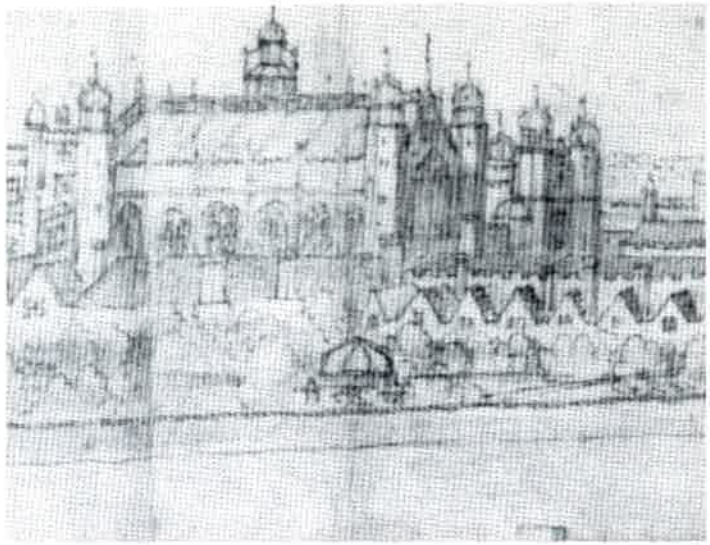


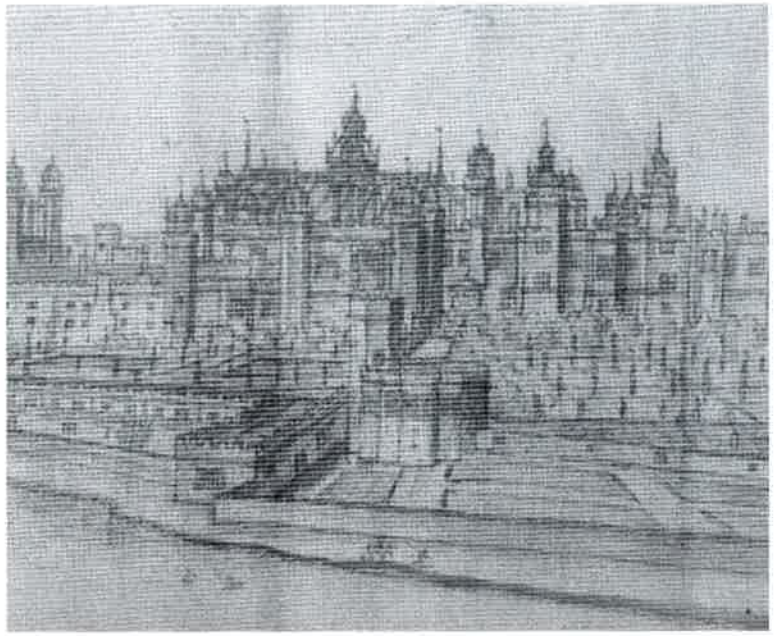
Figure 2: Plan of Hall Roof showing location of work



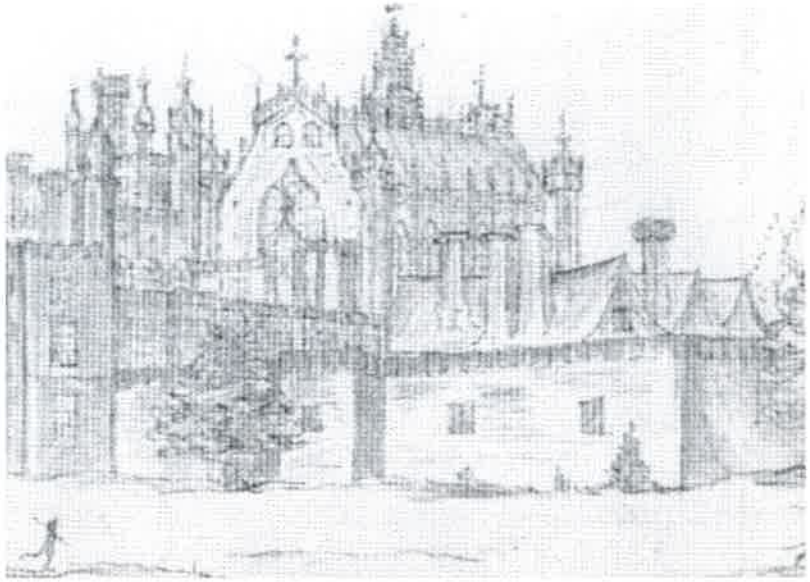
(a)



(b)

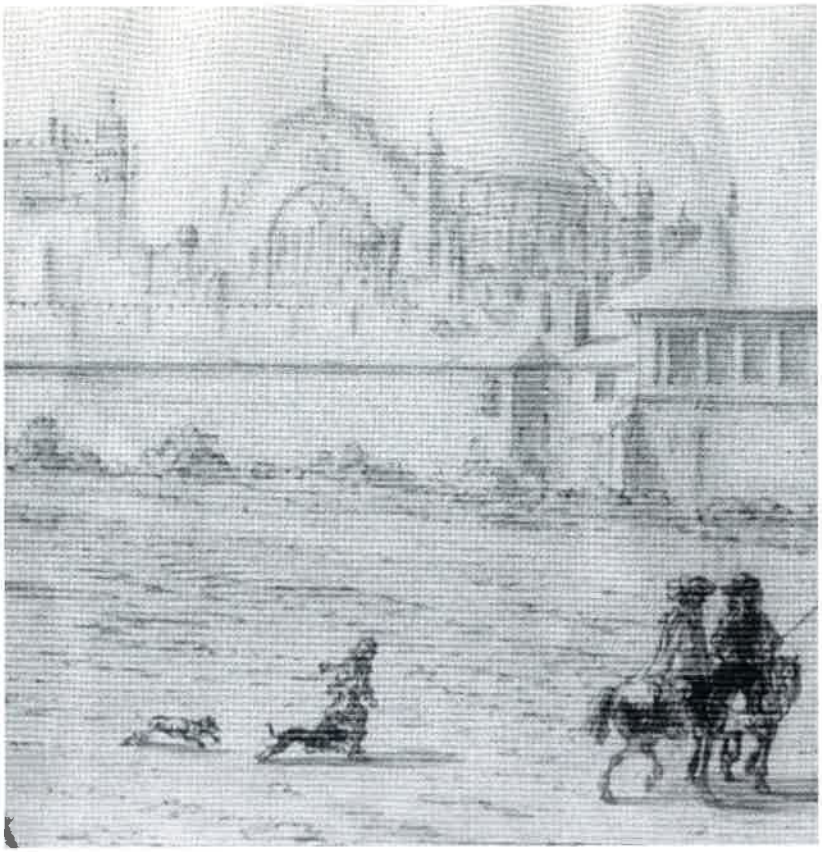


(c)

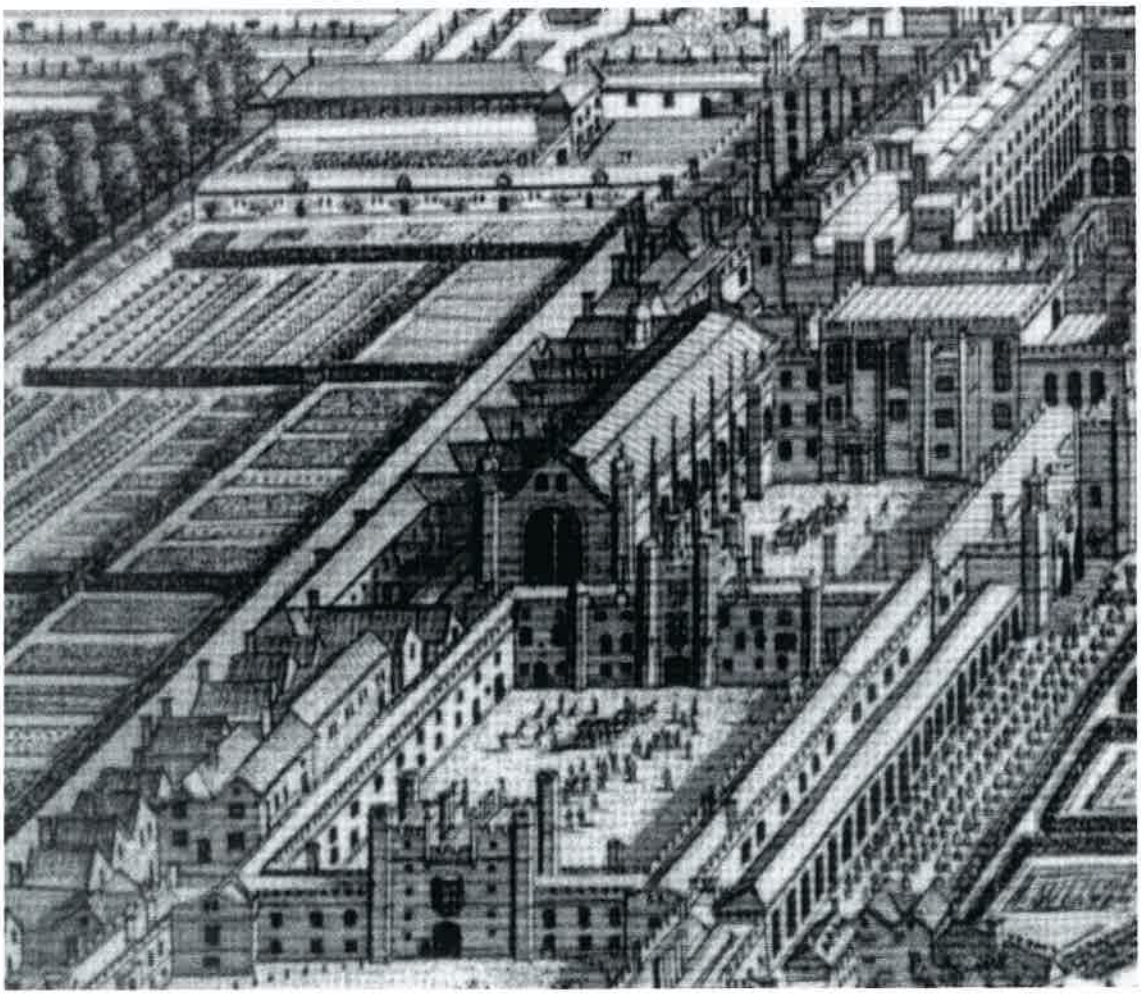


(d)

Figure 3: (a) - (c); Wyngaerde view of Hampton Court Palace (Ashmolean Museum) (d); View by Abram Booth



(a)



(b)

Figure 4: (a) View of Great Hall by Willem Schellinks *c.*1662
(b) View of Great Hall by Kiff and Knyff *c.*1705

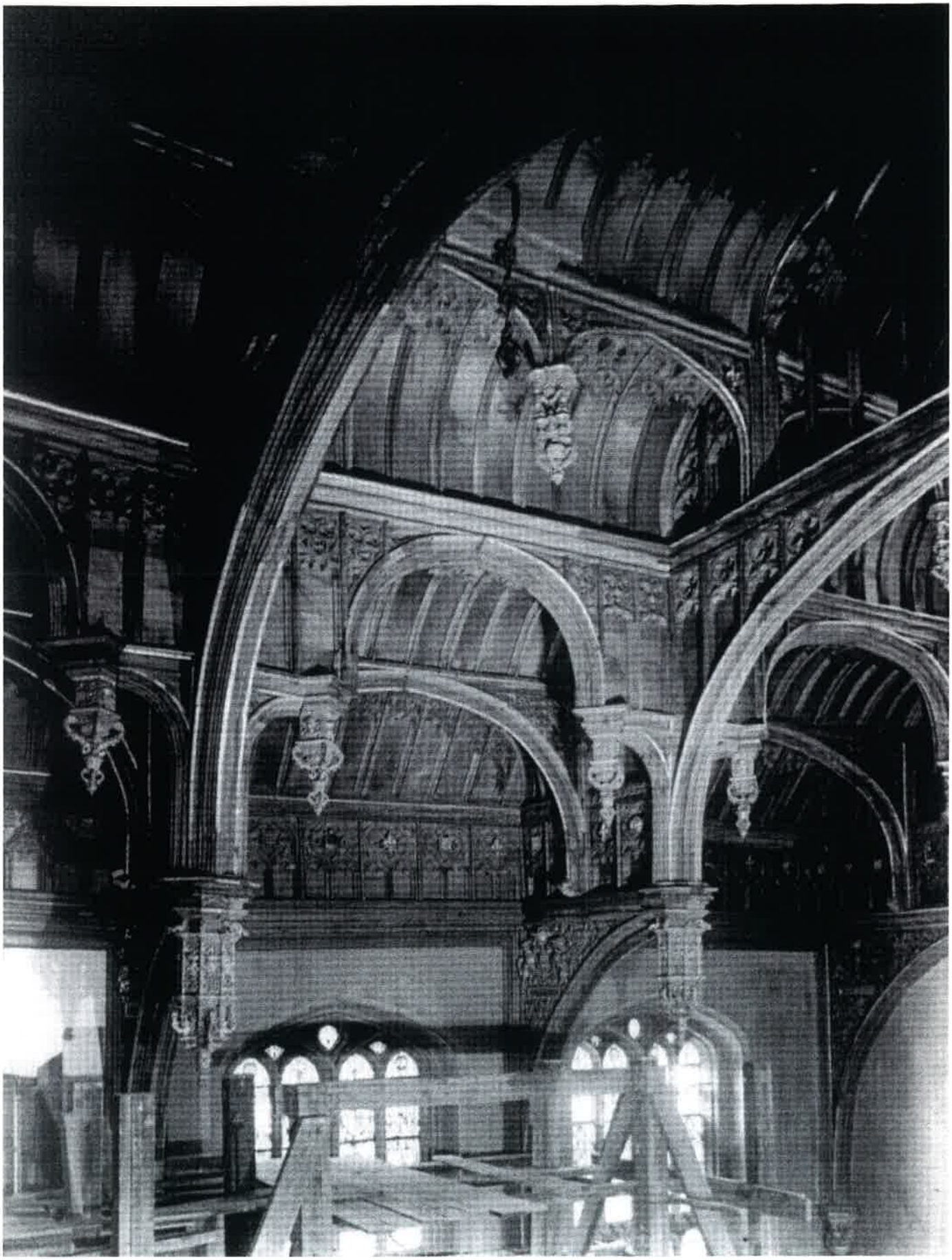


Figure 5: Great Hall Roof; general view (HM Office of Works, c.1926) [H1229]

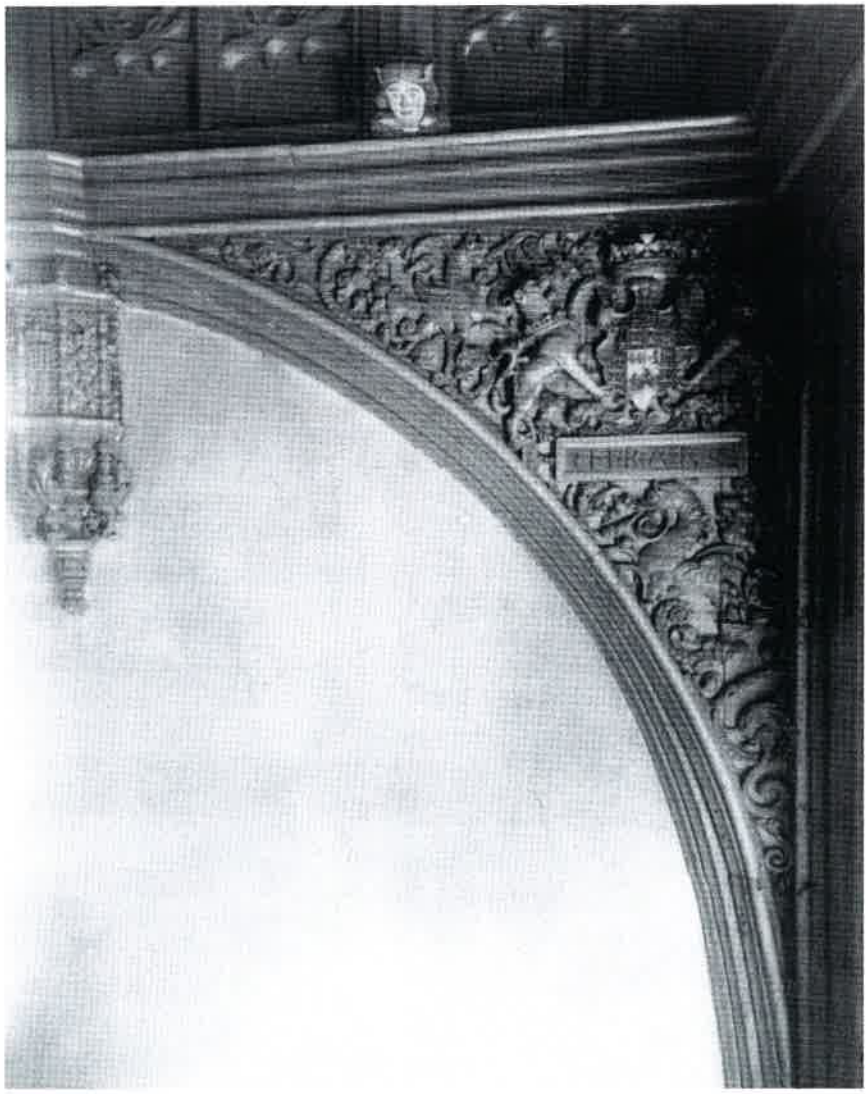


Figure 6: Carving in Hammer Spandrels (HM Office of Works, c.1926) [H1233 & 1359)

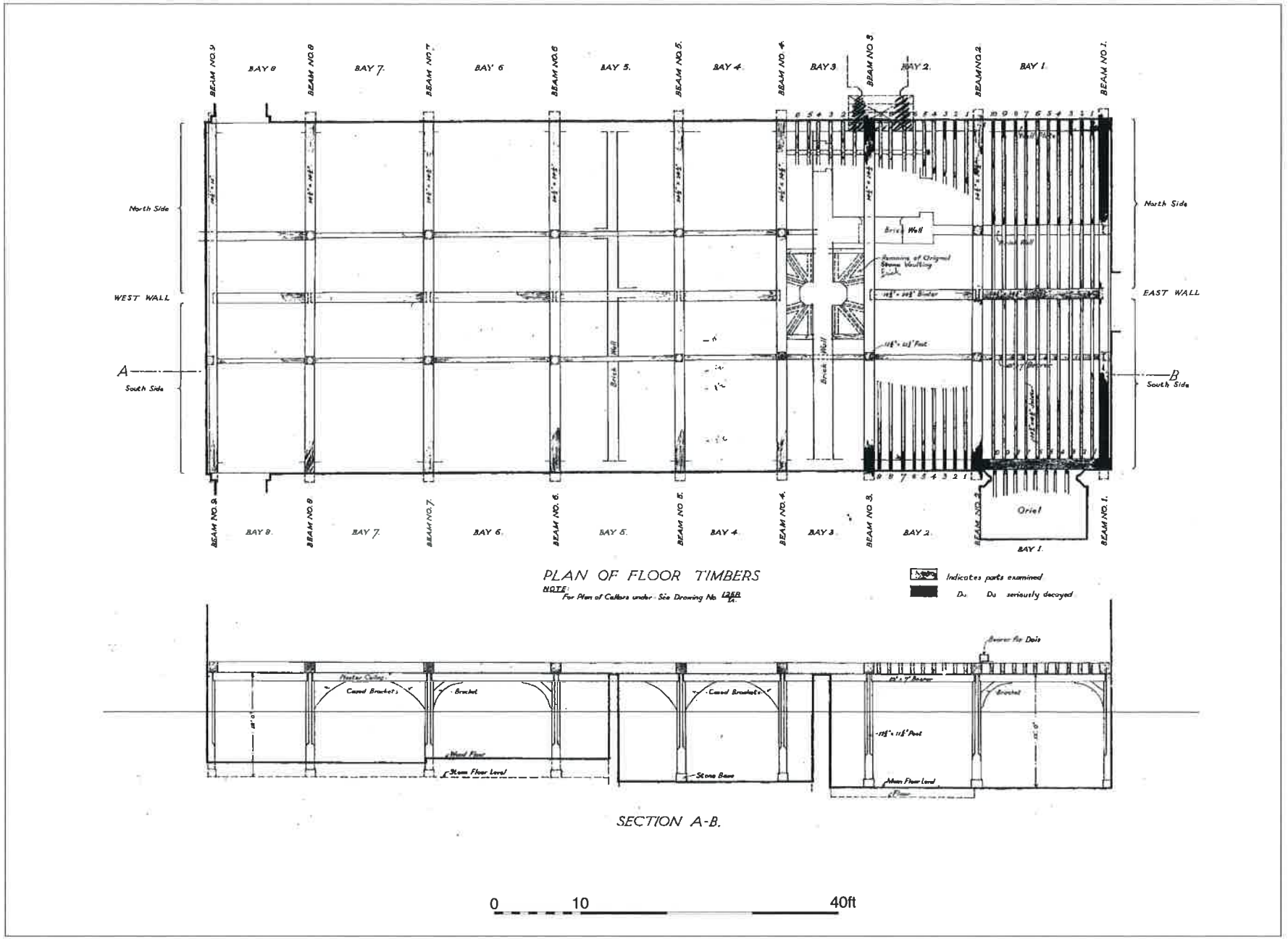


Figure 7: Construction of floor; Plan and Section indicating location of hearth (HM Office of Works, Sptember 1926) [125R/30A]

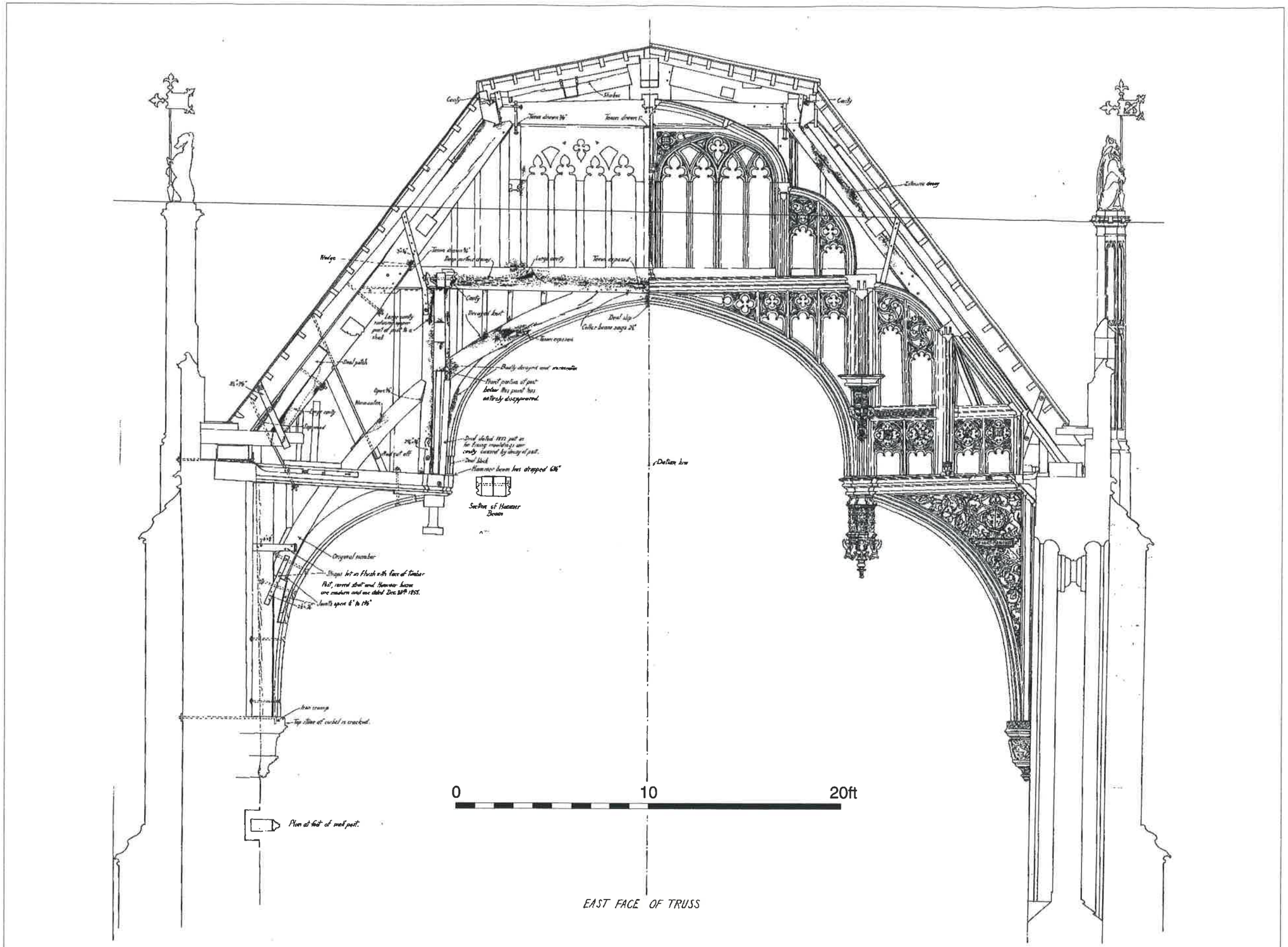


Figure 8: Roof truss 3 east face (HM Office of Works May 1922)

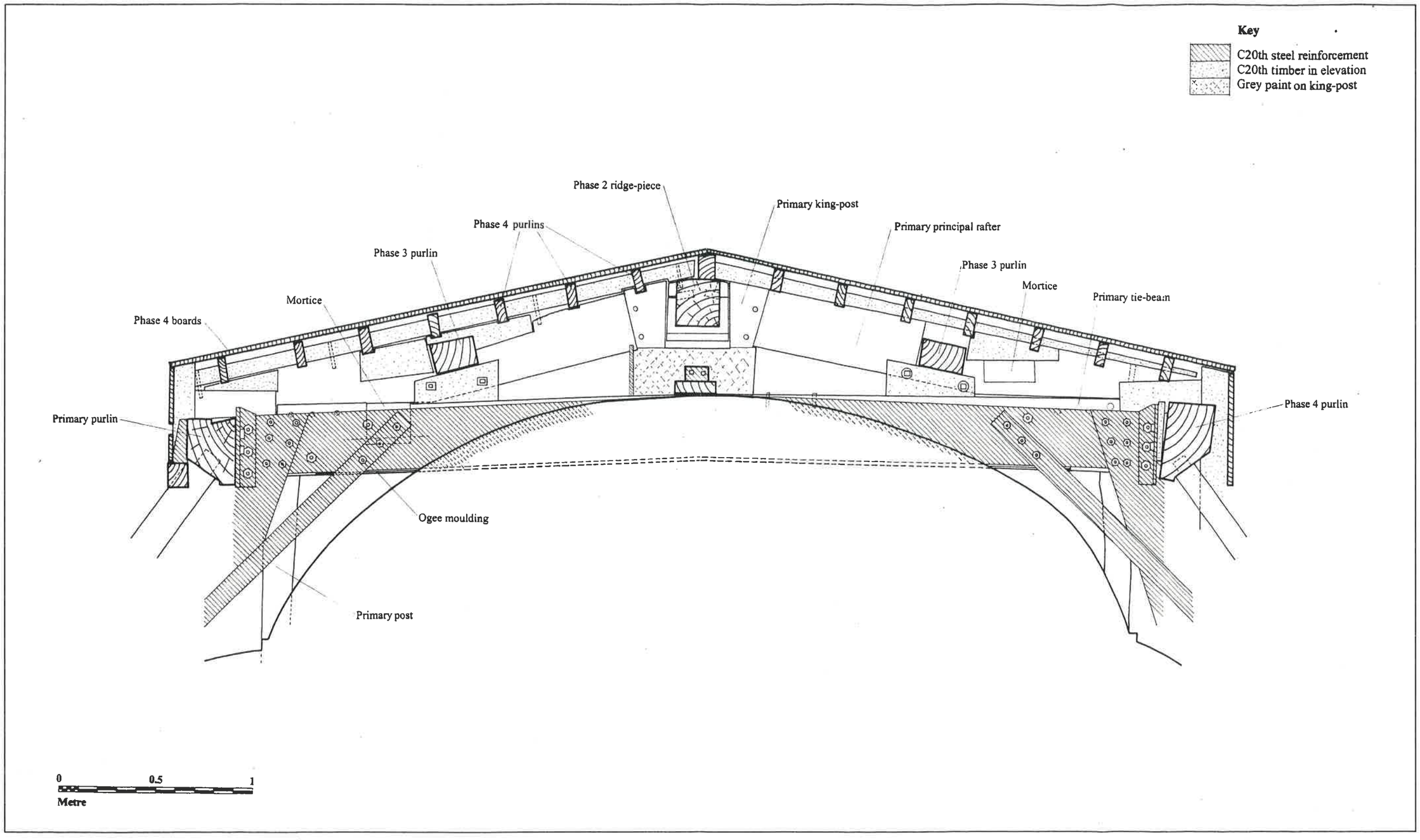


Figure 9: East face of truss 4

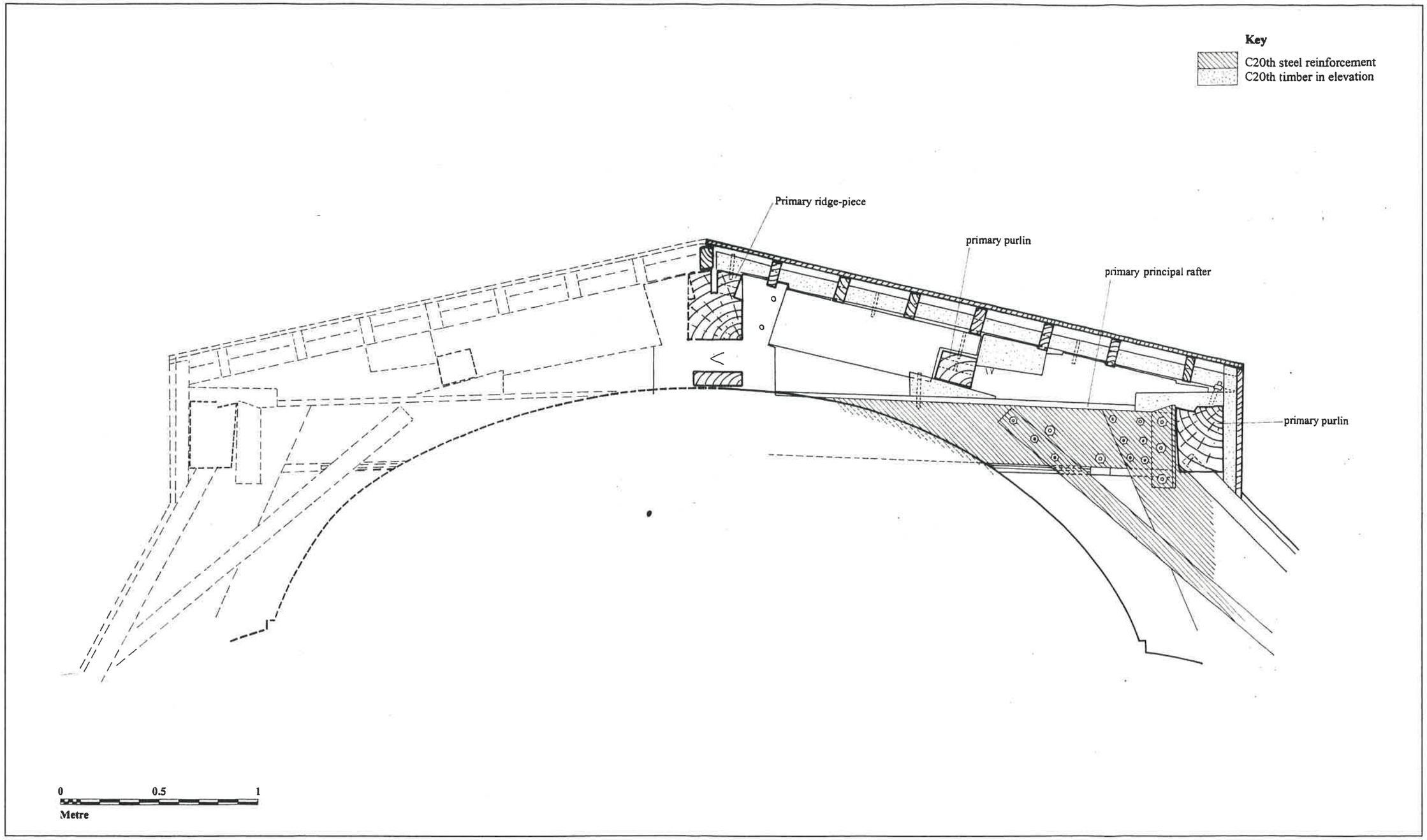


Figure 10: West face of truss 4

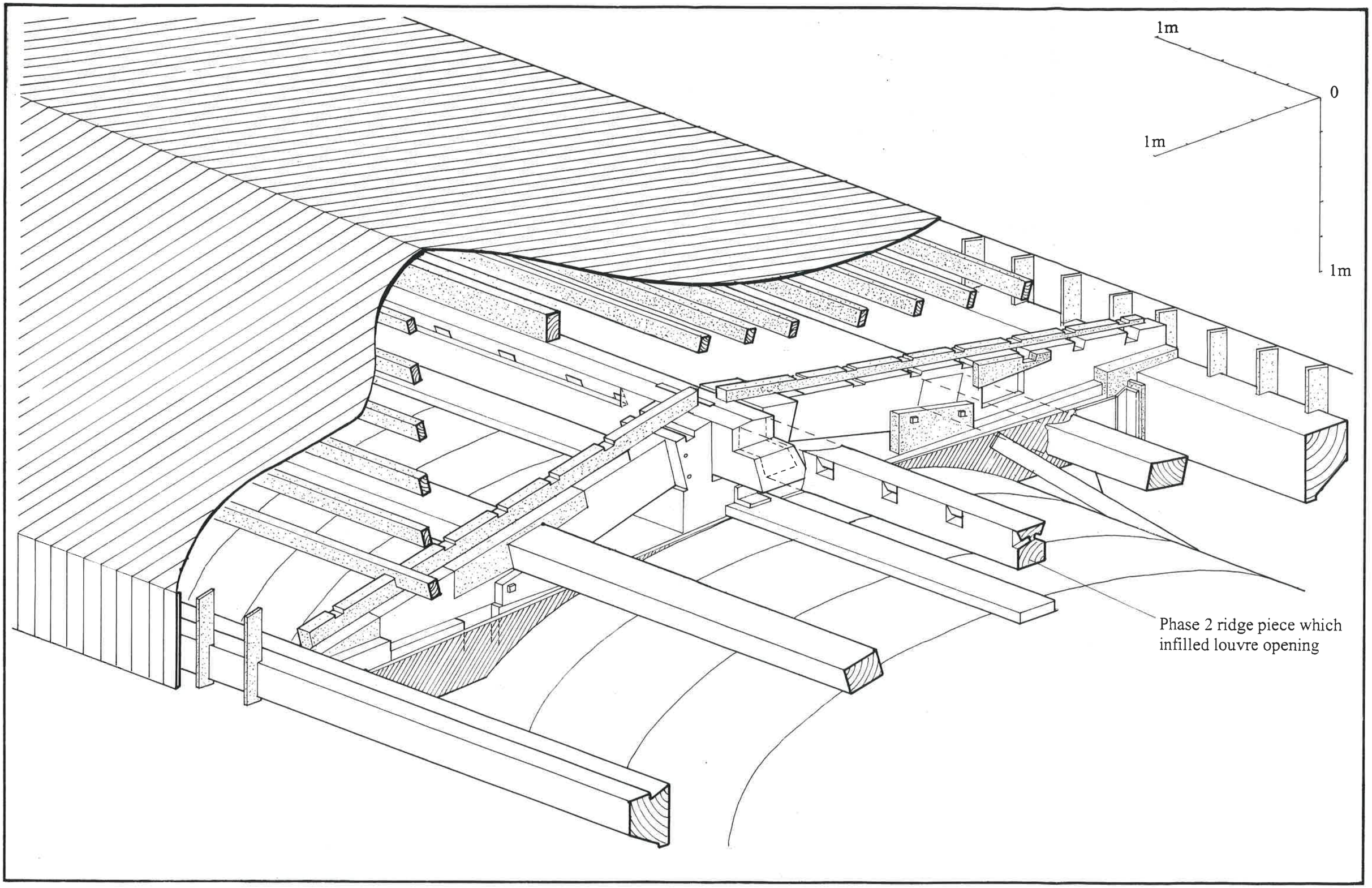


Figure 11: Isometric view of truss 4

Figure 12: General view of roof from south-west

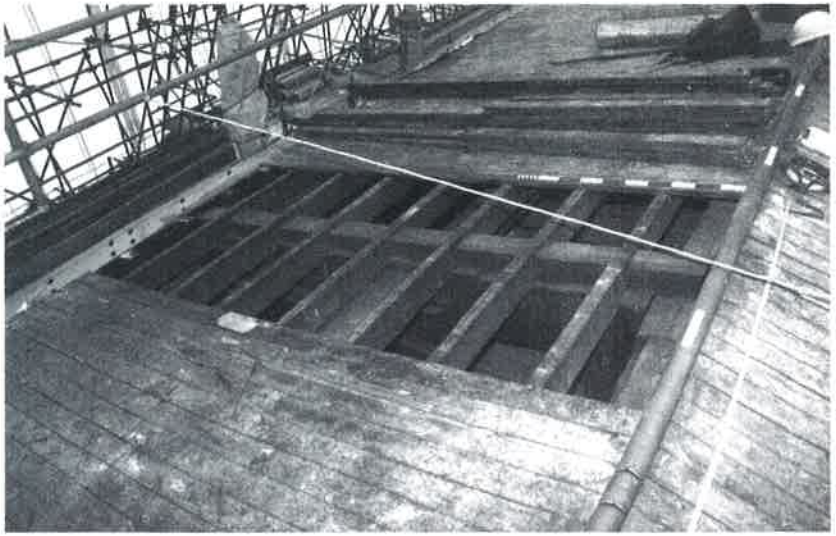


Figure 13: Area of boards lifted either side of Truss 4

Figure 14: Detail showing large primary ridge-piece supporting smaller secondary ridge-piece (added when the louvre was removed)

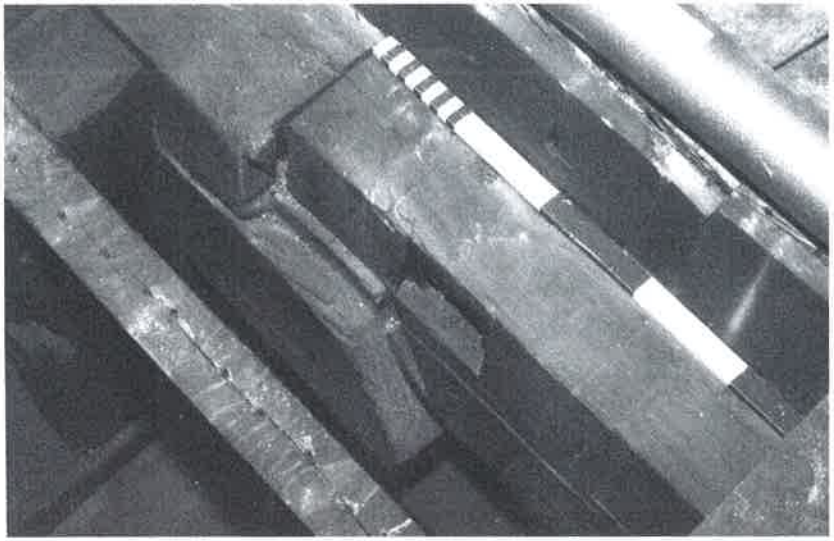
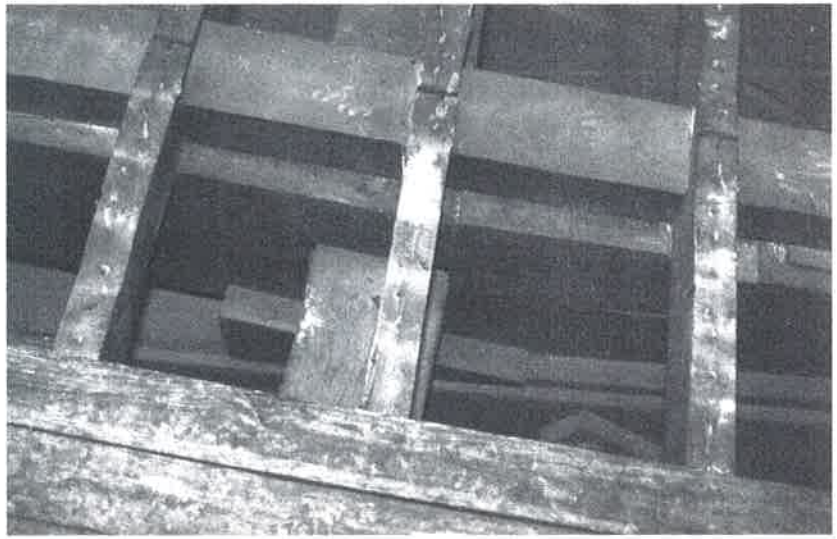


Figure 15: Detail of purlin adjoining west face of Truss 4



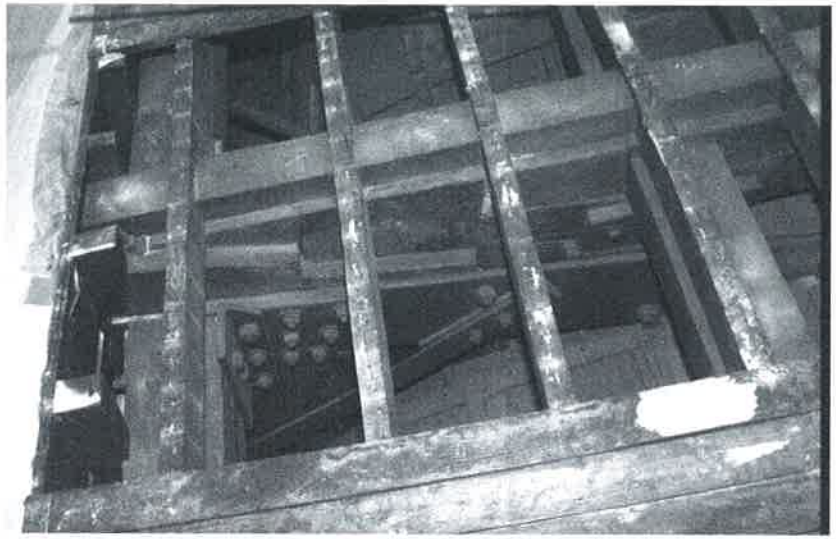


Figure 16: Detail showing mortice in primary principal rafter which is believed to relate to former louvre structure

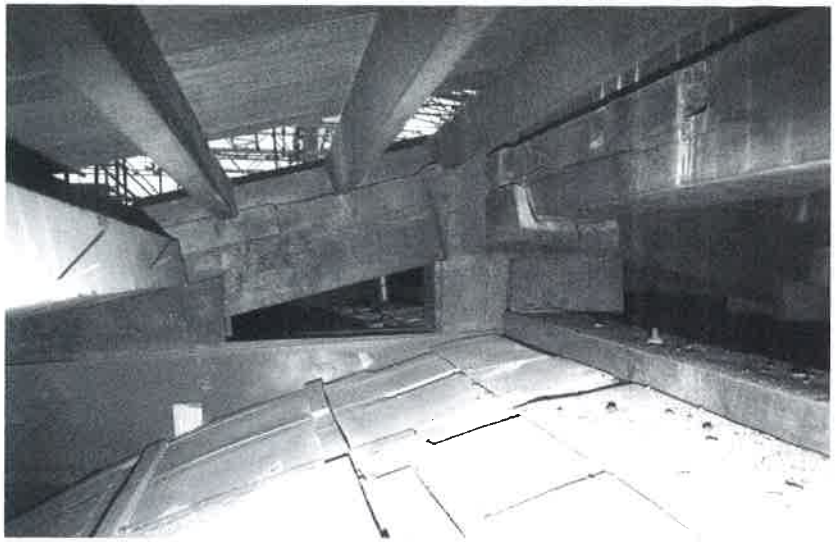


Figure 17: View towards Truss 4 from the east showing secondary scarfed ridge piece added when the louvre was removed

Figure 18: Detail on west face of Truss 3 showing mortice which housed primary purlin to left of current secondary purlin

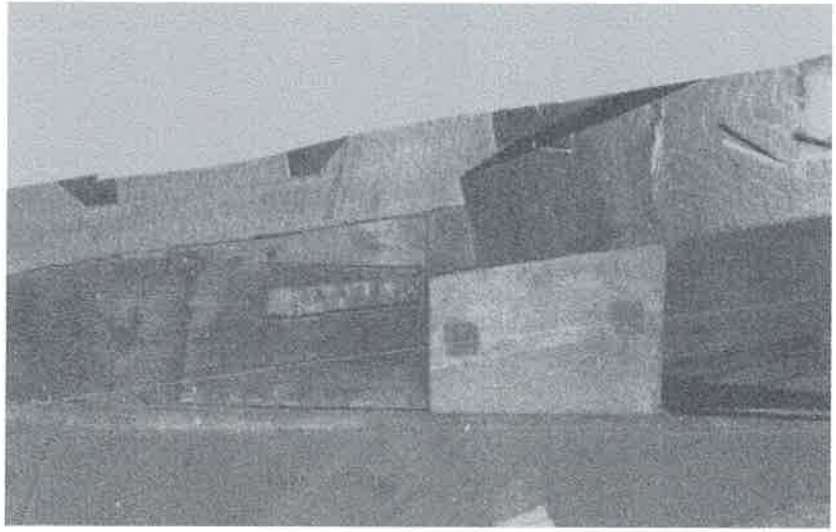
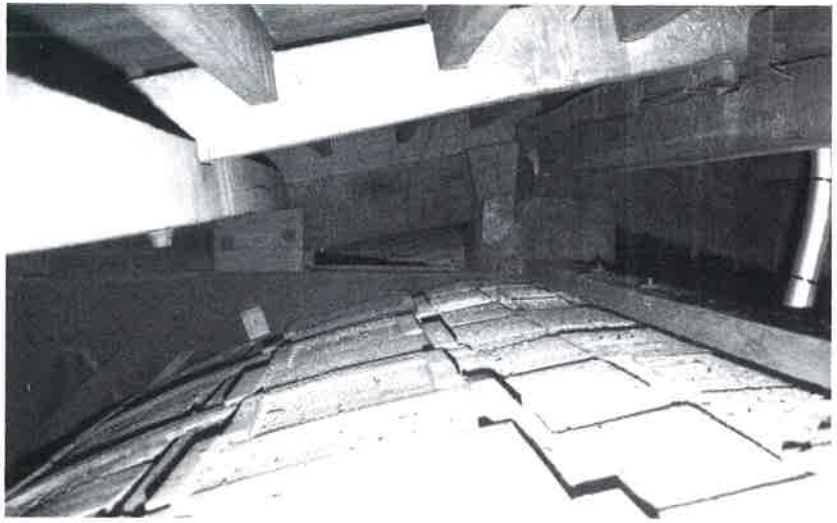


Figure 19: View towards Truss 4 from the west



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