DUNSTER CASTLE
ROOF REPAIRS

archaeological watching brief

2006-2008

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SUMMARY

Dunster Castle Roof Repairs 2006-2008
NGR: SS 9917 4347
Archaeological Watching Brief
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Removal of lead sheeting and two phases of counterboarding from the roof of Dunster Castle during the Autumn and Winter of 2006 prior to repairs undertaken in 2008, revealed a minimum of six separate roof structures representing c.five phases of roof construction between the 17th and the 20th century. The most significant of these are a flat roof, possibly of three sub-phases, dated to c. AD1611; their conversion into king post trusses in c. AD1728; and the insertion of wrought iron 'I' beams in c. 1865-72 probably under the supervision of the architect Anthony Salvin.

ACKNOWLEDGEMENTS

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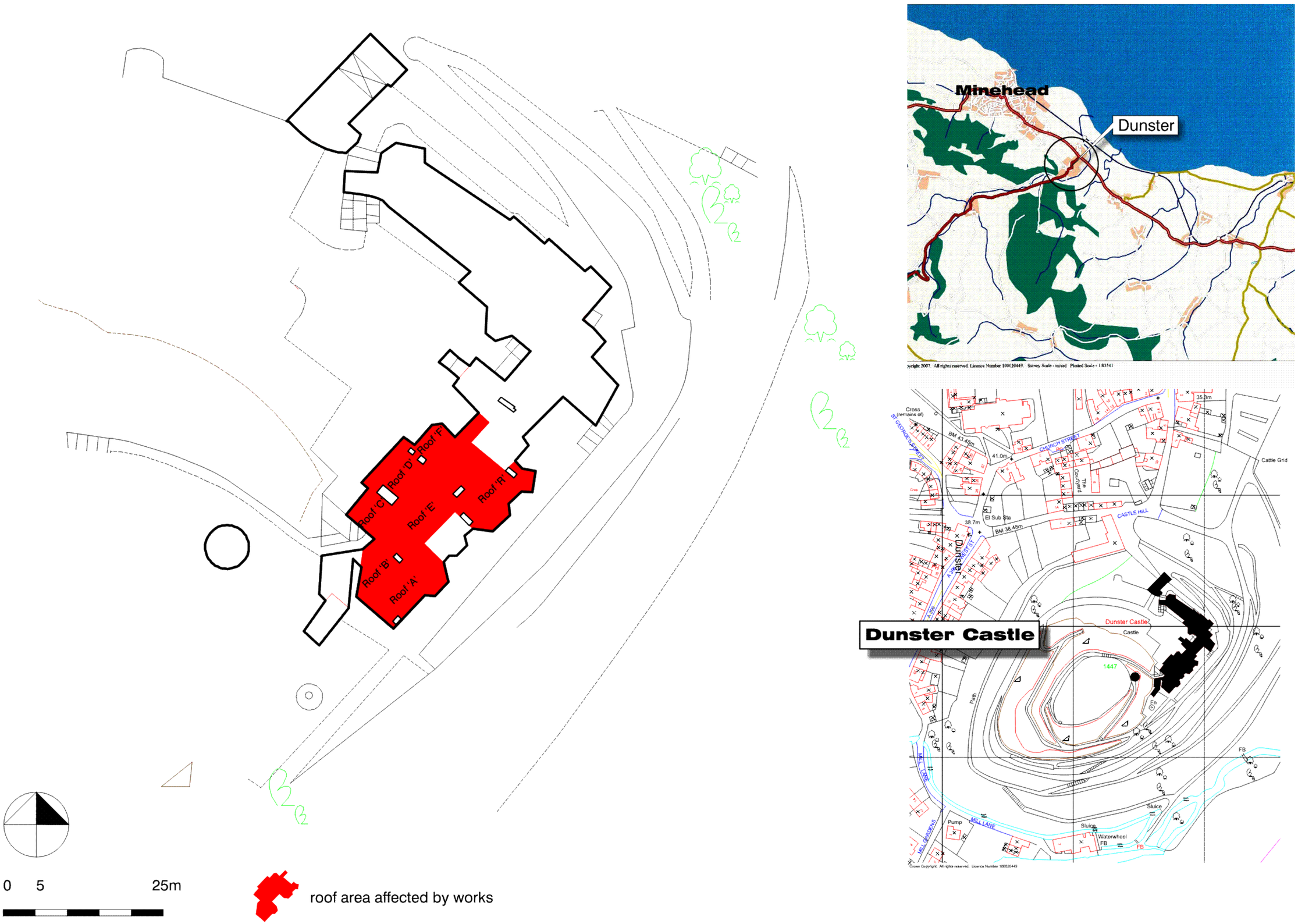

Figure 1. The site and its situation

Dunster Castle
Dunster, Exmoor, Somerset

Roof Repairs 2006 - 2008

Archaeological Watching Brief

1 INTRODUCTIONS

1.1 The Project

1.1.1 This document presents the results of an archaeological watching brief maintained during major repair of the roof structure over the south-western wing of Dunster Castle in Somerset between 2006 and 2008. The watching brief has been commissioned by the owners, The National Trust, in accordance with conditions attached to Listed Building Consent granted by *Exmoor National Park* and grant aid supplied by *English Heritage*. This report is subsequent to a draft assessment of the roof's archaeological potential and historical significance prepared by the author in November 2006 after preliminary opening-up, for inclusion within a conservation management plan prepared by *TFT Cultural Heritage* – the lead consultants to the project.

1.1.2 The work has been undertaken by Michael Heaton BTech PgDip GradDip MIFA IHBC in accordance with a 'brief' prepared by *TFT Cultural Heritage* and a 'written scheme of investigations' prepared by the author (Ref. 3363-1), submitted to and approved by *Exmoor National Park* and *English Heritage* in June 2006, and the published guidelines of English *Heritage* (2006), the *Institute for Archaeologist* (1999), the *Association of Local Government Archaeological Officers* (1997) and Exmoor National Park (n.d.). The 'WSI' presents a detailed methodology and statement of contractual obligations that are not repeated here other than in summary, and brief geographical and historical introductions that are.

1.1.3 The following pages present a brief methodology; a brief definition of the site for the purposes of this study, and its locational and historical setting; text descriptions of the structure and fabric of the building, cross referenced to line drawings and digital photographs; and concludes with an archaeological analysis and interpretation of observations made. The report refers to the history and structure of the building as a whole, for the purposes of establishing the structural and historical context of observations made, but it is not intended to be an exhaustive history, archaeological assessment or structural appraisal of the whole building as defined by the *Institute of Field Archaeologists* or the *RICS*.

1.2 Method

1.2.1 <u>Data collection</u>

a. Background historical research was provided by *TFT Cultural Heritage* in the form of a draft conservation plan, a summary of which is presented below in Section 2.2. No additional research into the history of the building has been undertaken.

b. Repair works and associated archaeological observations were conducted in two phases: (1) Removal of roof coverings between August and November 2006, and (2) repair works proper between September 2007and September 2008, with minor ancillary works continuing into early 2009 that were not subject to observation.

Archaeological observations were maintained on an intermittent basis determined by the rate of exposure of historic fabric and its archaeological potential, the Stage 1 works receiving almost continuous attendance, but with fewer visits during Stage 2. As retention of all historically significant fabric was an explicit objective of the project, the time-consuming creation of dimensionally accurate measured detail drawings was restricted to those components likely to be affected by repair and those components essential for illustrating the assessment report and this report. Accordingly, of the 19 trusses, six were recorded in detail individually. All trusses were recorded in plan at 1:50, together with all other significant structural and cosmetic details, and the majority of roof components and details were recorded photographically. All but one of the trusses and all other structural members remain, *in situ*, substantially unaffected by the repair works.

c. Archaeological observations were recorded using a standard archaeological system of complementary, numerically indexed written, drawn and photographic records. All drawings were in A3 format on polyester drawing film and comprised a series of 1:50 plans transcribed from a measured survey of the roof outline, provided by *TFT Cultural Heritage,* onto which structural details were direct-plotted; and a series of details at 1:20, principally truss elevations and assembly details. Written records comprise A4 pro-formae record sheets for each numbered detail, cross-referenced to drawings and photographs. Photographs were taken in 35mm and digital formats, principally the latter. The confined working spaces within the roof space, the fragility of the underlying ceiling structures and the mass of timbers forming the roof structure constrained photographic opportunities considerably. Observation concentrated on identifying historic fabric within the wallheads, roof structure and roof coverings that might pertain to former roof structures.

d. No material samples were retained.

e. Dendrochronological survey was undertaken by Michael Worthington accompanied by the author, whose results are summarised here. Worthington's detailed report is held by *The National Trust*.

f. The roof structure was also inspected by Richard Fewtrell of *SFK Consulting Ltd*, whose observations are summarised here. Fewtrell's inspections were concerned principally with the structural engineering of the roof and its 19th and 20th century interventions and his report is held by *TFT Cultural Heritage.* .

1.2.2 <u>Report preparation</u>

a. Geographical and historical introductions are presented in Section 2 below, cross-referenced to Figure 1. The descriptive text is presented <u>in a deliberately abbreviated syntax</u> in Section 3, below, cross-referenced to a roof plan, truss elevations and a selection of digital photographs reproduced as Figures 2, 3 and 4.

b. For the purposes of this report, the trusses and the valley beams have been assigned secondary references (1-19, and 1-2 respectively) to assist ease of navigation through the report, and a 'site north' has been adopted for all locational descriptions, approximately square to the common longitudinal axes of the roof structures. Trusses have been numbered sequentially (T1-T19) from the south-west corner; valley beams have been numbered (VB1-VB2) from south to north. The National Trust's roof nomenclature has been adopted, i.e. Roofs 'A'-'F' and 'R', the arrangement of which is illustrated on Figure 1. All are numerical references have been assigned west to east, but are not necessarily annotated on the drawings.

c. The report concludes with an archaeological interpretation of the observations and an assessment of their significance, cross-referenced to a suggested chronological development of the roof structure illustrated by Figure 5. .

d. The terms ‘archaeology’ and ‘archaeological’ in this report refer to the material evidence of past cultural activity and its environmental consequences, irrespective of whether that evidence is contained within subsoils or built-structures. For the purposes of this report, therefore, evidence of modification of a building is potentially archaeological evidence.

1.2.3 Archive

a. The archive consists of two A1 format 1:100 outline roof plans, 17 A3 format drawings at 1:50 and 1:20 on polyester film and 159 photographs in digital and 35mm format.

b. The archive will be deposited with *The National Trust* (Wessex Region) at Warminster in due course.

1.3 Caveats

1.3.1 This report has been prepared with reasonable skill and care, following the guidances of the professional bodies cited above and based on information publicly available at the time of writing. Archaeological or historical discoveries made in the area after the date of writing, or changes in research strategies affecting the perceived significance of such discoveries, may affect the currency of the report.

1.3.2 No person other than the Client named in paragraph 1.1.1 to whom this report is addressed shall rely on it in any respect and no duty of care will be owed by the author to any such third party.

1.3.3 The executive summary and conclusions contain overviews of the key findings and conclusions. However, no reliance should be placed on any part of the executive summary until the whole of the report has been read: other sections of the report, particularly the methodological statements contain information that may affect interpretation of the executive summary.

1.3.4 The drawings are included for illustrative purposes only. Whilst every care has been taken to ensure metric accuracy, they should not be used for the specification or control of building works without checking all dimensions and positions on-site.

2 THE SITE

2.1 Situation and site **Figure 1**

2.1.1 The village of Dunster is situated 1km upstream of the mouth of the River Avill on the north Somerset coast, c. 3km south east of Minehead. The village occupies a narrow and steeply inclined valley between promontories of the Brendon Hills, which rise from c. 20mOD in the village to c. 200mm at the summits of Gallax Hill and Grabbist Hill 500m to the south and north-west respectively. To the north, the ground falls imperceptibly across the (probably reclaimed) margins of the Bristol Channel to the shore, c. 1km to the north. The geological base is dominated by an outcrop of Hangman Grits – a local Old Red Sandstone – surrounded by wider expanses of the Triassic conglomerates that underlie much of the Bristol Channel and its margins. To the south, within the Brendon Hills, are extensive exposures of Ilfracombe Slates and Pilton Shales.

2.1.2 The castle is situated at the south east corner of the village on an outcrop of the Hangman Grits, from where it overlooks the village and the River Avill from an elevation of c. 60mOD, centred on NGR SS 9917 4347. The outcrop has been landscaped to create a series of terraces beneath a conical summit, with the more expansive terraces occupying the north-east end, on which are sited the main domestic buildings of the castle. These are ranged in an 'L'-shape around the outer edge of the terrace, along SW-NE axes, looking outwards to the south-east and the north-east.

2.1.3 The repairs affected the roofs of the outer half of the south-western range, referred to as Roofs 'A'-'F' and 'R' by *The National Trust,* together with the wall heads, parapets and associated elements such as lintels. The failure of repeated piece meal repairs to halt long term water ingress, especially over rooms containing fragile fixtures and fittings, necessitated a comprehensive evaluation of the roof structure and its coverings. Initial inspection demonstrated extensive failure of the lead sheeting at the ridges, but the principal defects appeared to be insufficient upstands, inadequate falls along the valleys and insufficient discharge points through the parapets. Ancillary inspection of the roofs' structural competence revealed serious inadequacies in the structural members and their bearings. The subsequent repair programme left all structural members *in situ* except the upper parts of one truss - No.19 – which were removed to create a new valley across the east end of Roof 'F'. Investigation (see below) demonstrated the affected timbers to be of less importance than the rest of the roof. Elsewhere, upstands and falls were adjusted by the raising of eaves and the re-positioning of valley boards. No historically significant fabric was materially affected.

2.2 Historical background

2.2.1 Dunster Castle was founded in the years immediately following the Norman Conquest as a motte and bailey fort on the summit of the outcrop now enclosed by the castle and was rebuilt and extended in stonework in the late 12th and 13th centuries. Thereafter, it experienced the vicissitudes in political and architectural fortunes common to most medieval castles, being modified and extended continuously during the ensuing centuries, but is one of the few to have been in the ownership of one family – the Luttrell's - for most of that period (Maxwell-Lyte 1882).

2.2.2 From the early 17th century, the Luttrell family began the piecemeal conversion of the medieval military installation into the Baroque and, eventually, neo-Gothic mansion that stands today. The south-western range was essentially created in 1617 around a spine of massive medieval masonry; augmented by the 'Thornhill' chapel in 1722 (dem. 1868); and then again in c. 1867-8 when the interior was re-organised, the Thornhill chapel replaced by the current Drawing Room tower, and the whole north-western range added under supervision of the architect Anthony Salvin. Development

of the house has been accompanied by creation of the gardens with their belvederes and terraces, the stables and, between the castle and the town, the courtyard buildings. (Musgrave 1968)

2.2.3 The nature of these refurbishments is hinted at by brief archives sources and, for the 1867-8 works, plan drawings and elevational views prepared before and afterwards (Gibbs 1936), but detailed sources have not been identified (TFT Cultural Heritage, 2006) and it appears that Salvin's records were destroyed by his family at his death. Specifically, the extent to which the pre-existent and successive roof structures were affected is not known.

2.3 Status

2.3.1 Dunster Castle is a Grade 1 Listed Building.

2.3.2 It is owned by *The National Trust*

3 DESCRIPTION

3.1 Layout Figure 2

3.1.1 Eight separate structures are comprised within Roofs A-F and R; Roof 'A' comprising a pitched roof and a mono-pitch apron along its south side that is not distinguished by the National Trust's nomenclature. For the purposes of this report, the mono-pitch is referred to as Roof 'A1'. Roof 'D' surmounts the masonry turret situated between Roofs 'C' and 'F', shown blank on Figure 2 for reasons explained below.

3.1.2 All eight structures share a common W-E orientation (relative to site north), but with a slight divergence towards the east.

3.2 Coverings

3.2.1 Milled 3mm thick lead sheet in uniform 700m wide bays laid in single sheets across the full span of each pitch, which, in the case of Roof 'E', extended to 3250mm. Bays and ridge defined by c. 75mm diameter softwood rolls, some with cam-shaped bases, with rebates at junctions to take overlaps, to which the sheets are fixed by copper nails. Upstands against masonry and over valley eaves, the former covered by flashings set into chased/mechanically cut rebates in masonry covered by multiple phases of cementitious haunchings. Fleece slip membrane covering Bays 4-8 of Roof 'E' and adjoining eaves of Roof 'F'.

3.2.2 Most lead sheets open-cracked at the rolls, with multiple welded and tingled repairs (**Plate 1**). Merchants labels on underside of flashings around base of chimney in south-west corner of Roof 'E', dated 1998. Similarly un-corroded sheets forming most of the valleys, all of the covering of Roof 'D' and the upstands at the east ends of Roofs' E' and 'F', suggest that most of the peripheral lead sheeting has been replaced relatively recently.

3.2.3 Lead covering of Roof 'D' supported by *in situ* Portland cement concrete dome, not described further here.

3.2.4 All other sheeting supported by softwood counterboarding of four forms: Roof 'R' covered by circular-sawn 220mm x 15mm circular-sawn softwood boards laid diagonally; the interior of Roofs 'A', 'C', 'E' and 'F' covered by 280mm x 15mm planed 'whitewood' boarding laid parallel with the ridge; the verge margins of most roofs including all those abutting masonry, and the mono-pitches 'A1' and 'B' covered by 150mm-175mm x 25mm band-sawn and tanalised cedar ? boarding laid parallel with the ridges (**Plate 2**); whilst the eaves margins of most roofs are repaired locally with planed whitewood boarding of varying dimensions. All boarding rebated at the eaves to take lead sheet valley overlaps, fixed with oval wire brads and separated from a lower layer of counterboarding by tapered firring blocks.

3.2.5 A lower layer of counterboarding survived across Bays 2 and 3 of Roof 'A', the interior of Roof 'C' and most of Roofs 'E' and 'F' (Archive references: 10-15, 18-23, 27-33, 41-44) (**Plate 3**). Extensively patch-repaired and, in places, almost completely decayed, it consisted of three forms of board: mixed width c. 145mm-260mm) 21mm thick pit-sawn softwood boards in lengths of c. 2.60m (mainly but not always determined by truss spacings) fixed by large cut brads; narrow (c. 130mm) pit-sawn and adzed 25mm thick oak boards in lengths of c. 2.6m – 3.5m (as above), bearing large, countersunk empty nail holes between the rafters, fixed by large cut brads and occasional large hand-wrought clout nails; and broad (c. 260mm) 25mm thick pit-sawn Elm boards fixed by large cut brads, generally forming short repairs at the verge abutments of Roofs 'A' , 'E' and 'F'.

3.3 Structure Figures 2 and 3

3.3.1 *Mono pitches*

a. The mono-pitches 'A1' (**Plate 4**) and 'B' are formed of 80mmx100mm band-sawn tanalised softwood rafters supported on a stud frame of similar scantling rising off an *in-situ* cast concrete ring beam that encloses the north, west and south sides of Roofs 'A' and 'B'. Roof 'B' is supported at mid span by a 'built up' 130mm x 180mm softwood purlin and at the valley by a 130mm x 300mm RSJ, whilst Roof 'A1' is supported mid span by a 75mm x 145mm softwood purlin and, at the valley, by a 'built up' 110mm x 230 softwood purlin.

b. The valleys of these two structures, i.e. those defining the south and north edge of Roof 'A', are of similar construction; that on the south edge of Roof 'B' being carried by 'noggins' resting on the lower web of the RSJ, that on the northern edge of Roof 'A1' being carried by an extension of the stud frame.

c. The mono-pitch aprons along the south side of Roof 'R' are of two constructions, both utilising mechanically-cut softwood rafters: an 'original' form, at the west end, in which the common rafters are housed into the second of four courses of hand made stock brickwork (**Plate 5**); and an applied form in which the rafters are supported by a mural plate nailed to the rubble masonry behind (**Plate 6**).

3.3.2 *Pitched roofs*

a. Roofs 'A', 'C', 'E' and 'F' are of shallow pitched form varying from 11° ('C') to 20° ('E') and all share a similar – though not identical – form of structure, illustrated on Figure 3. Roof 'R' appears to be of later, collar-tied form and is described at the end of this section. In addition to common rafters, butt-purlins and a chamfered ridge purlin dovetailed into a yoke, all four structures consist of a tie beam supporting a later, shallow-pitched king post and principal rafter assembly. Truss 1, at the west end of Roof 'A' is modern replacement formed of band-sawn oak and is not described further.

b. Where visible, the tie beams are boxed-heart oaks, generally 330mm-350mm square and spanning the full width of each roof. Those of Roofs 'C', 'F' and 'E' are axe-finished on all visible faces, those of Roof 'A' (Trusses 2-4) are pit-sawn. All are straight, nominally, except those of Roof 'E', which are cambered by about 180mm at the centre, giving a pitch of c. 5° (**Plate 7**). All bear joist mortices in their exposed faces but, where visible, not in faces abutting masonry. In the case of Roof 'E', the mortices are aligned with the camber of the beam. In the case of Trusses 13 and 14 (west face) and 5-8 (and possibly 9-12), the outermost mortices retain their 60mm x 350mm joists. The mortices vary slightly in detail between the axed and sawn beams: the former (Roofs 'C', 'E' and 'F') being of short tusk tenon form with diminished shoulders and slightly spurred soffits, those of Roof 'A' being of short soffit tenon form with a separate but equally short diminished shoulder. All retain or bear evidence of draw pegs.

c. The beam end bearings vary. The north ends of those of Roofs 'C', 'D' and 'E' bear on discontinuous oak wall plates, whilst their south ends bear on Valley Beam 2 or, in the case of Truss 19, a dragon beam **(Plate 14)** spiked to the north face of Valley Beam 2 and a recently installed RSJ; the north ends of the beams of Roof 'E' bear on Valley Beam 2, except for Trusses 11 and 12, which bear on the lower flange of a pair of 134mm x 470mm wrought iron 'I' beams **(Plate 17)** that also support the masonry walls above them (see below: Engineers Report); the south ends of the beams of Roof 'E' bear directly on the window lintels or on, or in, the masonry of the wall head, which at Trusses 6 and 8 is a free-sanding pier of rubble masonry. At the interior valleys, the beams bear on or, in the case of Trusses 2 and 3 are tenoned

into, equally massive valley beams. The southernmost and slightest of these at c. 200mm x 340mm, Valley Beam 1 (archive reference 50) spans c. 7500mm between the obtuse angle at the western end of the roof and the western end of an internal masonry wallhead that forms the north-eastern edge of Roof 'A'. It appears to be a single timber, quartered rather than boxed, to which the tie beams are fixed by modern steel brackets and, possibly, tenons. Valley Beam 2, between Roof 'E' and Roofs 'C' and 'F' also appears to be a single 14500mm long 350mm x 350mm beam that bears on a masonry corbel at its east end and on the wallhead offset at its west end. All the tie beams of the three adjoining roofs bear on this beam.

d. The beams support king posts (**Plate 7**) and principal rafters of a similar form, but with minor variations. All are of pit-sawn oak, have shoulders and (except Truss 13) a joggle at the ridge into which the principals are tenoned. The trusses of Roof 'E', alone, have raking struts rising off the shoulders of the post to the principals and Trusses 9-11 have longitudinal struts rising off the top of the beam to the ridge purlin, to which they are half-lapped. The negligible pitch of the lateral struts (10°) makes it unlikely that they serve any structural function. The ridge purlins are all dovetailed into yokes spiked to the faces of the king post joggles. All the king posts, except those of Trusses 1, 13 and 19, are fixed to the beams by wrought iron straps secured by hand-wrought spikes and, to the posts, by forelock bolts. In the case of Truss 16, at the west end of Roof 'F', the strap covers and has been bent into one of the empty joist sockets.

e. The principal rafters of Roof 'A' are spiked onto the tie beams without, apparently, any form of tenon or key into the beam (**Plate 8**). The spikes are substantial hand-wrought iron items, and that at the south end of Truss 4 at the east end of Roof 'A', is loose. In all other cases except Trusses 10, 11 and 12, the principal rafters are spiked onto substantial horizontal timbers - referred to here as 'sprockets' – that are in turn spiked to the tie beams. (**Plate 9**, showing south end of Truss 6). Where principals are missing, shallow rebates are visible in the tops of the sprockets that would have restrained the outward thrust of the principals. The sprockets are of various forms and that at the south end of Truss 6, at least, is a re-used timber with a redundant forelock bolt in its west face. In the majority of cases, the sprocket outer ends correspond with those of the tie beams: those of Trusses 6, 8 and 9 in the western half of Roof 'E', and the principals carried by them, oversail the beam ends by up to 500mm. In all cases, the sprocket outer ends appear to support the valley sides.

f. The principal at the northern end of Truss 11 is strapped to the sprocket by two overlapping hand-wrought iron straps spiked to the timbers. The southern ends of Trusses 10, 11 and 12, at the east end of Roof 'E' are obscured, so the method of fixing between the principals and the beams has not been identified. However, the trusses appear to be set into the wall face, bearing on, and contained by, brickwork levelling courses that may be holding the assembly together.

g. Roof 'R' appears to be of collar-tied form. The upper surfaces of four unevenly spaced trusses are visible. All are of 120mm wide mechanically sawn softwood with square-headed iron bolts approximately 1/3 up their pitch in the positions where collars would be expected. All are wallfast at their north ends, Trusses R1 and R2 appear to be supported by a valley beam at their south ends and Trusses R3 and R4 are wallfast at their south ends.

3.3.3 *Valleys*

a. Four valley forms have been identified. In all cases of sprocketted trusses, the sprockets support the valley fascia. In all cases, the parapet openings at the lower ends of the valleys appear to have been inserted into pre-existing masonry, all being un-closed and without lintels or sills.

b. The southern valley of Roof 'A', the valley between Roofs 'A' and 'B', and the southern valley of Bays 3-5 of Roof 'E' are formed of tanalised band-sawn softwood boards carried on short sprockets/noggins (**Plate 10**, showing west end of 'A'/'B' valley). Along the southern edge of Roofs A and Bays 3-5 of Roof 'E', these are raised above the wallhead by similarly tanalised band-sawn softwood stud frames; between roofs 'A' and 'B' they are supported by the eaves RSJ. All are of 20th century construction.

c. The valley along the northern edge of Roofs 'C' and 'F' and that between the east end of Roof 'A' and the west end of Roof 'E', are also of band-sawn tanalised boards carried on short sprockets/noggins, but these are raised off the wallheads by brickwork piers that vary in height to create the fall (**Plate 11**, showing north end of Truss 16). The majority of the bricks are hand-made stocks (225x108x65) bonded in white sand/lime mortar, examples of which bear the impressed date '1870', but the upper courses of the southern of these two valleys (between 'A' and 'E') have been replaced or augmented with machine-made bricks in a grey cementitious (OPC ?) mortar.

d. The main internal valley, between Roof 'E' and Roofs 'C' and 'F' appears to retain approximately three phases of boarding and is carried, in part, by the valley beam itself. This is most complete towards the eastern and higher end (**Plate 12**): Here, a single 30mm oak board is supported c. 260mm above the top of the adjacent tie beam by a prop rising off the supporting dragon beam (see Figure 3). The lowest valley board is covered by an elm board of similar dimensions, in turn covered by plastic sheeting, counterbattens and the present valley boards. As the valley falls to the west, it is carried on the tie beam and then cut into the tie beam until, at the west end, the valley boards rest directly on the masonry of the wallhead offset.

e. The fourth form is present at the easternmost and highest end of most of the valleys, specifically both of those of Roof 'E' and Roof 'R'. The wide 'V'-shaped valleys here, all of planed or band-sawn softwood, rest directly on the upper edge of the rafters. All the valleys of Roof 'R' appear to be of this form.

3.3.4 *Ceilings*

a. Where visible, all ceiling are of riven chestnut lath and lime plaster construction suspended beneath mixed hardwood joists fixed to mural grounds and supported mid-span by binders housed into the beams. Where visible, nails appear to be small, hand-wrought iron tacks. The ceiling beneath Roof 'A', Bays 4-8 of Roof 'E' and Roof 'R' were of double-skinned construction, all others appear to be single-skinned.

b. Beneath Bays 4-8 of Roof 'E', the ceiling rests slightly above the upper edge of the tie beams, the upper skin apparently enveloping the beams. The extra height is supported at both eaves by a stud frame rising, apparently, from the floor below, which is formed of band-sawn softwood studs and wire nails.

3.3.5 *Repairs*

a. Several of the beams and their connections with valley beams have been braced by steel brackets and, or timber splints and one Truss – No. 19 at the east end of Roof 'F' - is splinted and supported entirely by braces off adjacent elements.

b. Steel brackets (**Plate 13**) connect the north ends of Trusses 1 and 2 to Valley Beam 1 and the south end of Truss 9 to the window lintels on which it bears. These are of uncorroded 20mm thick plate fixed by hexagonal machine-cut bolts, are fresh painted and appear to be of relatively recent installation.

c. Tanalised timber splints support the south end of Truss 3 and span between it and Truss 4 as an additional purlin. The most numerous and structural repairs affect Truss 19 (**Plate 14** and Figure 3): The beam - heavily decayed mid span – is splinted above and on its west face by c. 150mm thick oak beams spiked to it, the uppermost of which supports the king post. The north end, decayed to the extent that it does not bear on masonry, is supported by a salvaged 200mm x 90mm softwood beam/joist strapped to its upper side, which bears on Truss 18 and the adjacent wallhead offset. The principal/beam connection here is also braced by a pierced cast iron plate spiked to its west face. The east end bears, just, on a short dragon beam spanning between Valley Beam 2 and the adjacent wall face and is supported by two RSJs: one, 100mm x 205mm and galvanised, spans between Truss 18 and the eastern gable wall face with the beam suspended beneath it in a 20mm steel bracket; whilst the other – 80mm x 150mm - appears to run across the tops of the studs of the wall linings of the rooms below.

d. Un-treated splints support the king post and ridge purlin of Truss 13 at the west end of Roof 'C' (**Plate 15**). This king post of this, the smallest and least complete of the trusses, lacks a joggle, the principals being tenoned into the edge of the post just above the shoulder. It has either lost its joggle to decay, or it didn't have one originally. The yokes differ from all others by bearing on the beam and in its simple rectangular form; that on the east face being a band-sawn timber, that on the west being pit-sawn. The form of the yokes may have been constrained by the diminutive proportions of the truss (king post is c. 600mm high), but equally they may allude to a different construction fro the rest of the pitched roof.

3.4 Relic details

3.4.1 The roof and its supporting masonry retain several features not obviously related to the present structure: consisting of empty sockets in the masonry, empty dowel holes in the counterboarding, a pulley and associated ropeways, redundant carpentry suggested of triangulated bracing and, most significantly, mural lead flashing.

3.4.2 The latter (archive refs: 17 and 26) is the more easily described and interpreted (**Plate 16**, showing NW corner of Roof 'B'). It consisted of the hacked-off edge of a flashing of cast lead sheet c. 4-6mm thick, protruding from between the courses of the parapet masonry around the entire perimeter of the roof and its internal masonry surfaces, except the chimney at the south-west corner of Roof 'E', approximately 600mm above the wall head offset. For most of its circuit it has been cut-off close to the wall face, but in places it survived as a downward fold of c. 100mm depth. The flashing appears to be more-or-less level, except at the east end of Roof 'F' (Figure 3) where it follows a consistent inclination southwards of approximately 5° towards the ridge of the adjoining Roof 'E'. Along the northern edge of Roof 'B', the flashing (archive ref. 17) appears to have been dressed onto a protruding table course 150mm below the top of the flashing.

3.4.3 Possible evidence of alternative connections between the roof, ceilings and the wall heads survives at the edges of Roofs 'A' and 'B'. The concrete ring beam across the west end of Roof 'A' has five 200mm wide x 300mm deep sockets cast into its upper surface, only one of which is occupied by a ceiling binder, whilst there is no evidence that binders or joists have been removed from the present double-skinned ceiling. Along the northern edge of Roof 'B', below the flashing table course (above), there appears to be a number of ill-defined voids of c. 100mm x 100mm in the inner face of the parapet just above the wall head offset. These are ambiguous, localised and shallow and, in fact, may merely be missing stones. At the east end of Roof 'A', behind Truss 4, is a possible relic wall plate, c. 60mm thick, running along the inner face of the parapet wall immediately above the wall head offset. It is heavily decayed and localised – no other examples were identified anywhere else – and is not

exposed in the outer face of the wall. It may have been a temporary fixture left *in situ* or a stabilising 'binder' timber set into the wall face, though these are more commonly found in brick masonry.

3.4.4 Similarly ambiguous is a cut-off horizontal brace protruding from a mortice in the east face of the south end of Truss 18. This short piece of 80mm x 100mm pit-sawn oak is set at an angle of approximately 60° to the truss, 1000mm from its south end and 350mm from its overlap with Valley Beam 2. It appears to correspond, in alignment, with an axed step in the upper face of the valley beam and the north end of Truss 11. Possibly coincidental, is the exact coincidence of the intersection of the brace and valley beam with that of the dragon beam and valley beam.

3.4.5 Several of the counterboards - but not the lead sheeting – were pierced by oval holes. The eaves boards of lower layer of counterboards immediately either side of the south end of Truss 17 were each pierced by a slightly elliptical 35mm x 40mm hole that appeared to have been deliberately cut with a knife/chisel. Neither affected the structural timbers or corresponded with details in the ceiling below. In the south west corner of the northern half of the central bay of Roof 'A', both layers of counterboard were pierced by a 40mm diameter round hole situated immediately above an elm pulley block and base, bolted to a board fixed to the ceiling joists below. The orientation of the pulley corresponded with wear marks on the ceiling joists and plaster pricking coat consistent with repeated rope friction. Marks on the upper counterboards around the hole suggest it was surrounded by a rectangular supporting structure or plate.

3.5 Structural walls

3.5.1 The enclosing walls are approximately 860mm thick with a c. 400mm thick coped parapet rising c. 2200mm above the upper surface of the internal 460mm wide offset. All valley openings, except those of Roof 'R', appear to have been formed after the parapets were built, leaving irregular holes without lintels or sills and with core fabric exposed in the sides of the openings. The openings of Roof 'R' appear to be original to the wall fabric. Window openings are spanned by massive lintels of quartered pit-sawn oak generally c. 300mm x 150mm section, laid with the waney edge to the outside.

3.5.2 Around the south and west sides of Roof 'A' and the west and north sides of Roof 'B', the internal offset supports – or is re-inforced by – an *in situ* cast concrete ring beam that varies in width from 250mm along the south side of Roof 'A', 360mm along the west side of Roof 'B' and 600mm across the apsidal projection at the south east corner of Roof 'A'. Neither internal re-inforcement nor the method of connection to the wall head offset was visible. On Figure 2 the ring beam is shaded mid grey.

3.5.3 A more massive wall construction runs along the south side of Roof 'E', inside the parapet wall. Here, the unfinished top of a rubble wall extends to a thickness of c. 1300mm inside the parapet, i.e. a total thickness of c. 1700mm and runs the full length of Roof 'E' to the chimney at its south west corner (see below). It is pierced by two very rough openings spanned by timber lintels that appear to bear mid span on piers of masonry. It is assumed that these are window openings and that they correspond with openings in the external skin of the wall. However, it is pertinent to observe that the westernmost of these extends into the interior space between Roofs 'A' and 'E'. Here, adjacent to Roof 'A', the inner masonry appears to be faced on its south side by a thinner - c. 500mm – skin capped with hand-made stock brickwork that corresponds with the outer – facing – skin of the rest of the wall.

3.5.4 Brickwork was identified in the masonry of the walls at the east end of Roofs 'E and 'F', in the chimney at the south west end of Roof 'E' and around the inner face of Roof 'R' below the roof line. The brickwork of the walls of Roof 'R' (**Plate 5**) is integral to

the walls' construction and consists of hand made stock bricks in a coarse and poorly mixed pale grey ash/sand/lime mortar. In all other cases the brickwork is at or immediately beneath the level of the tie beams and or valleys, are of machine-made bricks (this needs to be checked) in cementitious mortars and are associated with RSJs. The latter appear to support all three walls enclosing the east end of Roof 'E' and the beams ends of Trusses 10 - 12, with courses of brickwork laid on them between the truss ends.

3.6 Dendrochronology

3.6.1 Michael Worthington's full report is held by The National Trust.

3.6.2 Samples recovered from the structural timbers of Roofs 'C' and 'F' yielded consistent dates for the tie beams and wall plates of c. AD1611 and for the king posts and principal rafters of c. AD1728.

3.6.3 The position of the samples is indicated on Figure 2. The distribution of samples is not ideal. It was caused by confusion between *English Heritage* and *The National Trust* as to the meaning of the former's offer of providing a dendrochronological survey. By the time the confusion was identified, most of the structural timbers had been re-covered.

3.7 Metalwork

3.7.1 Richard Fewtrell's full report is held by The National Trust and TFT Cultural Heritage.

3.7.2 The majority of the structural metalwork is recently installed mild steel of metric dimensions.

3.7.3 The paired 'I' beams supporting the north ends of Trusses 11 and 12 of Roof 'E' and, apparently, the masonry of the turrets at the east end of that roof, are made of wrought iron. Each is c. 134mm x 470mm and c. 19mm thick, with slightly tapered flanges and with a well-defined 1mm thickening on each face of the top and bottom of the web. The profiles are illustrated on Figure 4 and a photograph is presented on Plate 17.

4 CONCLUSIONS

4.1 Chronology, form and function Figure 5

4.1.1 Accepting that differences in construction technology, structure and fabric allude to separate building episodes, a minimum of five phases of roof structure plus minor repair and refurbishment episodes are represented. The principal phases are, in approximate chronological order:

4.1.2 A slightly cambered 'flat' roof construction over the Gallery and the East Room, represented now by the cambered tie beams of Roof 'E'. It comprised axe-trimmed beams, cambered to provide a shallow pitch of c. 4°, with deep joists tenoned into their faces supporting - we assume – counterboards and a waterproof membrane, probably cast lead sheeting. The beams bore directly on the inner offsets of the outer masonry walls and - possibly – the valley beams. (But see below). This structure is restricted, now, to Roof 'E'. It is possible that the same construction extended over the King Charles Bedroom and the Red Room/Terrace Room extension in the positions occupied now by Roofs 'F'/'C' and 'A', but the existing roof structures there are of slightly different and possibly later construction (see below). Assuming the roof was covered with lead sheeting, and there is no evidence for another form of covering, it must have extended to the eaves and, either lapped over the eaves in a traditional overhang detail, or lapped against the inside face of a parapet. The latter and more plausible interpretation is supported by the relic lead flashing that survives around most of the walls' circuit, suggesting an upstand of nearly 600mm. That extraordinary upstand and the absence of original valley openings in the parapets, suggests that rainwater was left to pond on the roof. An alternative overhanging eaves detail is suggested by the possible relic wallplate present in the east wall of Roof 'A'. This is an ambiguous detail and the interpretation offered above is far from conclusive, not least because: a) it does not survive anywhere else, and: b) every graphic depiction of the castle since the early 18th century shows it with crennelated parapets around its entire circuit.

4.1.3 A 'true' flat roof construction over the King Charles bedroom, represented now by the flat tie beams of Roof 'F'. This was of essentially identical construction to Roof 'E' (4.1.2), with only slight variation in the form of the joist/beam connection, and may therefore be broadly contemporaneous, the difference in pitch possibly being an architectural expression of room hierarchy rather than of technological development. However, it may equally represent a different understanding of the properties and performance of lead sheeting, which in turn may have been chronological. In either event, it retained the high upstand of the lead sheeting at the parapets and, apparently, no opening in the parapet for ponded water. It was contemporaneous with the chimney stack at the west end of the King Charles Bedroom, as there are no joist sockets in the occluding faces of the beams either side of the stack. The absence of joist sockets in those faces also demonstrates that the tie beams are not re-used floor beams. Dendrochronology suggests the beams were felled c. AD1611, broadly contemporary with the AD1617 refurbishment of the medieval castle.

4.1.4 A 'true' flat roof construction over the Red Room and Terrace Room, represented now by the flat tie beams of Roof 'A'. These are distinguished from those of Roofs 'E' and 'F' by being pit-sawn and having sockets for soffit-tenoned connections rather than tusk tenons, suggesting a later date. Nonetheless, it appears to have been covered in the same manner as Roofs 'E' and 'F' (4.1.2) and (4.1.3) with the same 600mm upstand at the parapet, so all three are likely to have been chronologically close.

4.1.5 A king post pitched roof over all three rooms that survives as the present structure of Roofs 'E', 'C', 'F' and most of Roof 'A'. The form and carpentry details of these structures are sufficiently similar to be of a single construction episode. There can be no doubt that the addition of king posts post-dated the 'flat' roof forms: the wrought

iron straps of the king posts overlap the empty joist sockets of at least one tie beam (Truss 13), whilst the massive sprockets would have been unnecessary had the trusses been assembled in a single operation. All the timbers are pit-sawn or are salvaged axe-trimmed timbers and the principal members are fixed using hand-wrought forelock bolts and large hand-wrought iron spikes. The roof was covered with a mixture of salvaged oak and newly cut softwood counterboarding, all pit-sawn and fixed by large cut brads, supporting cast lead sheeting fixed by large hand-wrought clout nails. The pitches drained into valleys corresponding with the present valley layout, the structures of which were partly cut into the beams of the earlier 'flat' roofs and consisted of oak and, or elm boards resting on brick piers, timber chocks and the beams themselves. Openings through the parapets were formed for this roof structure. Raising of the roof pitch over Roof 'E' appears associated with a raised lath and plaster ceiling and wall lining in that room that raised the soffit of the ceiling above the joists of the 'flat' roof. The raised ceiling and 'flat' roof could not have co-existed. Dendrochronology suggests the king posts and principals were felled c. AD1728, broadly contemporary with the AD1722 refurbishment and exactly contemporary with 1729-dated rainwater hoppers on the north elevation (see cover illustration). That date is slightly earlier than the 'mid 18th century ' normally accepted for the adoption of cut nails and the 'early 19th century' date normally accepted for the adoption of king post trusses in provincial Britain (cf. Yeomans 1992; Holzer 2009).

4.1.6 The sprockets are, as far as the author is aware, unique to this roof structure. They would not have been necessary for the retro-assembly of the king post trusses on pre-existing beams – unless the designers didn't understand the function of trusses – because a simple notch in the upper face of the beam and a spike would have been sufficient (as is the case in Roof 'A'). Alternatively, an iron strap over the principal, in the manner widespread on the Continent in the 17th century and earlier (Holzer 2009) would also have sufficed. Similarly, they are not present on all trusses- the principals of Roof 'A' being spiked directly to the beams. It is likely, therefore, that they were incorporated within/added to the trusses to support the valley fascias, specifically the deep falls necessary along the east-west axis of the roofs. The bayed lead sheet covering required the ridge and eaves of the roofs to be at even levels along the line of the roofs, to prevent ingress of driven rainwater under the bay rolls. The eaves therefore had to be raised to allow sufficient fall along the valleys and the sprockets served to support the fascias and the principals. The lack of sprockets on Roof 'A' reflects the shorter distances travelled by the valleys.

4.1.7 In addition, major structural repairs were undertaken at the east end of Roofs 'E' and 'F' and around the south, west and north walls of Roofs 'A' and 'B' after all other structural alterations had been completed. The masonry structures at the east end of Roofs 'E' and 'F' are supported by wrought iron 'I' beams into which the beams of Trusses 11 and 12 at the eastern end of Roof 'E' are housed. The 'I' beams are set into rubble masonry that retains its relic lead flashing, suggesting the beams were inserted into pre-existing masonry to span an inserted opening below. They are inherently undatable (except, perhaps by highly refined C14 of the carbon inclusions), but their use of wrought iron as opposed to cast iron or steel and the slightly splayed flanges suggests they were installed before the 1880s and certainly before 1914 (Mende 2006). Possibly at the same time, the valleys along the north side of Roofs 'C', 'D' and 'F' and the south side of Roof 'E' were refurbished with brick piers lifting the valleys c. 300mm above the wall plates. The upper layer of softwood counterboarding was probably added in the same operation, otherwise there would have been no point in adjusting the valleys. This work is securely dated to 1870 on the basis of the dates impressed onto some of the bricks. That date is compatible with Salvin's campaigns of 1867-72. The upper layer of counterboarding is of a wholly different nature to the boarding it covered and was fixed with smaller, machine-made, cut brads. The planed finish and probably foreign source of the ?Fir boarding that makes up 90% of the roof area, suggests it is of mid to late 19th century date. The timbers are of similar form to those installed on Roof 'R' under Salvin's direction and appear to respect the layout of the turrets installed by Salvin. This

suggests that, if work to the rest of the roofs was undertaken under Salvin's direction, the upper counterboarding is probably it.

4.1.8 A softwood, collar-tied roof utilising square-headed bolts at the collar ends, with lath and plaster torching and mono-pitch aprons, was installed over the Drawing Room as Roof 'R' during the same construction episode as the rest of the Drawing Room. The double-skinned lath and plaster ceiling fixed to its soffit is of the same construction as all visible ceilings and wall linings beneath Roofs 'A'-'C' and 'E'-'F'. The supporting structure is attributable to Salvin and the bolted connections suggest this is a mid – late 19th century structure, possibly contemporaneous with the 'I' beam, valley and counterboarding refurbishments of 1870.

4.1.9 Later repairs involved complete replacement of Truss 1 with a wholly new timber structure; installation of two RSJs at the south end of Truss 19; and the installation of steel brackets at the north end of Truss 2 and the south end of Truss 9. A concrete ring beam was cast around the top of the inner wall head offset of Roofs 'A' and 'B', possibly associated with installation of an RSJ valley beam, upon which the mono-pitch roofs bear. These works are likely to have been of late 20th century data.

4.2 Significance

4.2.1 Leaving aside the significance derived from the roof's association with Dunster Castle and its historical associations, and accepting the chronologies posited above, the relative importance of the individual structures and their components derives primarily their chronology and construction technology, secondly from their quality of survival and thirdly, their possible associations with historical figures. The constricted distribution of the dendrochronological samples is disappointing, especially as there are clear differences between the three flat roofs, of which only the northernmost – Roof 'F' – is dated securely: The possibility of medieval survival is tantalising, but therefore not provable at the moment.

4.2.2 The flat roof in its three variants together with their *in situ* joists and associated *in situ* mural lead flashing, all probably of early 17th century construction, are probably the work of William Arnold but are not represented in any of the published sources available to the author. However, there appears to be three phases of 'flat' roof, only the northernmost of which has been dated dendrochronologically (AD1611) and one of which – Roof 'E' – bears partly on the medieval south wall. Of the walls identified by as being possibly medieval (cf. Gibbs, 1981) the south wall of Roof 'E' is the only one to rise through the full height of the present castle in its full thickness. It is not impossible, therefore, that the beams of Roof 'E' predate Arnold's work of 1617 as a survivor of the 'ruinous' structures described by Leland. The author has been unable to find published examples of 'flat' roofs similar to those of Phases 1, 2 or 3, but has received an anecdotal description of a similar roof structure at Godolphin House (Cornwall). Notwithstanding that, this appears to be unique to Britain (but may equally be a manifestation of the limitations of Architectural History). Flat roofs are a Mediterranean and near eastern roof form and, though advocated by Durer as early as 1517 (Pommer, 1983), were not adopted in Europe until concrete translated Mediterranean roof forms into a weathertight material suitable for Temperate and Atlantic climates in the 20th century. If this interpretation is correct, the flat roofs, their components and associations are of Exceptional Signficance to the study of construction technology and architectural history.

4.2.3 The king post trusses are only slightly less historically ambiguous. King Post trusses, of a form, have been used in Britain since the middle ages (Yeomans, 1992 p16), but in all pre-17th century examples the king post acts in compression, primarily as a support for the principal rafters (cf. Cordingley, 1961, Fig. 20) and is therefore not a truss in the correct sense of the word; i.e. a triangulated mechanism for transferring load through tension and compression. Trusses, in the correct sense of the word,

were not employed in Britain until the 17th century (Yeomans, 1992). These examples are trusses: the joggle of the king post puts it in tension and the iron straps recognise that. However, the extremely shallow pitch of the principals and their 'proxy' connection with the beams here suggests they were copied from published designs – such as Serlio's of 1588 and later versions - without a proper understanding of the mechanics of the truss, whilst the straps at the base of the posts would certainly open out under prolonged tension. The pitch, at least, is similar to that of examples published in the mid 17th century (cf. Yeomans, 1992; Holzer 2009) that formed the basis for the introduction of the trussed roof in the late 17th and 18th centuries, but the king post truss was not widely employed by vernacular craftsmen until the 19th century. Nonetheless, the dendrochronology of these examples suggests that king post trusses were being employed in the larger buildings by the middle of the18th century at least, possibly as an expression of the owners cultural leanings.

4.2.4 All three of the king post roofs are of similar construction and are therefore likely to share the c. AD1728 date suggested by dendrochronology. They are, as such, early examples of a form that in Britain was first employed in London and those towns associated with technological advances, such as Oxford and Cambridge. In addition, the examples here appear to demonstrate a stage in the development of the form, in that they were probably assembled in ignorance of the mechanics of the truss. The sprockets are significant in that regard and are also, apparently, unparalleled in published examples. The king post roofs, their individual structural components and the structures supporting the valley are, therefore, of Considerable Significance. However, their quality of survival is variable. The majority of the trusses appear to have survived complete and relatively unscathed: Truss 1 is a 20th century replacement of No Signficance; Trusses 13 and 15 are missing one of their principals and Truss 19 has lost much of its original technological detail and has been extensively repaired. The counterboarding has also been extensively modified, consists of largely salvaged timber and is unlikely to have been *in situ* as found, and many of the valley piers have been replaced or augmented with 20th century brickwork or timber noggins. These items are therefore necessarily of less significance.

4.2.5 The trusses appear to be associated with the raised ceiling over the Leather Gallery, in as much as the only obvious function they serve is to raise the outer members of the roof above the raised ceiling. This suggests that the leather hangings were installed c.1728 and not c.1710 as received architectural history would have it (cf. Gibbs 1936). Similarly, the dendrochronology provides better chronological resolution to the 'early 18th century' obsolescence Yeomans (1992 p169) suggests for forelock bolts.

4.2.6 The lower layer of counterboarding on the trusses was fixed with large cut brads of 18th – early 19th century form and so is almost certainly contemporaneous with the king post trusses, but has suffered extensive replacement and probably includes salvaged timber: Replacement is self-evident in the patchwork of repairs in different timbers (softwood and hardwoods) and this will have been recurrent throughout the 18th and 19th centuries until the upper layer was fixed (see below). Use of salvaged timber, or at least relocation of timbers, is evident in the many empty nail holes not corresponding with the present rafters or rafter intervals, particularly in the narrow (110mm x 20mm) oak boards. As many of the empty holes were formed by square-section nails and are countersunk, they are likely to have predated the cut brads used extensively across the pitched roof, which would not have been used before the early 18th century. It is not impossible, therefore, that the oak counter boards were salvaged from the 1617 roof. This raises the possibility that the 1617 roof was not covered directly by lead sheeting, as a membrane would have been necessary to prevent the tannins in the oak affecting the lead.

4.2.7 Salvin's work is represented by Roof 'R', the upper layer of counterboarding and the mural 'I' beams. Their significance derives, in part, from their association with Salvin - an architect described as 'dullish' by one *English Heritage* reviewer of Allibone's biography – but chiefly from their apparently innovative use here. Certainly the architectural forms are of no architectural significance, in that they possess no aesthetic quality; whilst the counterboarding and the structure of Roof 'R' appear to be wholly utilitarian. These details are of No Significance. The mural 'I' beams, however, are a different matter, assuming Fewtrell's identification of them as wrought iron, as opposed to cast iron or steel, is correct. Rolled wrought iron beams enjoyed a relatively short-lived currency in building construction, from c. 1840 to c. 1885, invariably as purpose-built components of one-off buildings such as the Palm House at Kew Gardens (c. 1846) or bridges (cf. Thorne, 2000). The nature of such structures reflects the predominantly engineering-lead impetus of historical study of wrought iron in the 19th century (Sutherland 2000), which has resulted in a dearth of published material on the use of wrought iron components in refurbishment of buildings such as Dunster Castle. Accordingly, the author is unaware of published parallels for the use rolled wrought iron beams in a 19th century refurbishment of a major house. Assuming we are correct in ascribing them to Salvin, he was using them within 20 years of their first – and highly speculative – adoption at Kew (Diestelkamp 1983) and for quite different purposes. The normal method of spanning an inserted opening in a structural wall such as this would have been a masonry arch, such as those formed in nave walls during the aisle extension of medieval churches. There use by Salvin to span an inserted opening in c. 1865-70 was innovative: he might have been architecturally 'dullish', but his appreciation of the structural potential of wrought iron appears to have been well ahead of its time. For that reason, the beams are of Considerable Significance.

4.2.8 The 20th century components of the roofs – the free-spanning RSJs, the cedar counterboard repairs, the concrete ring beam, the mono-pitch roofs A1 and B, and repairs executed in machine-made brickwork, cementitious mortar or mechanically-sawn softwoods, are of No Significance.

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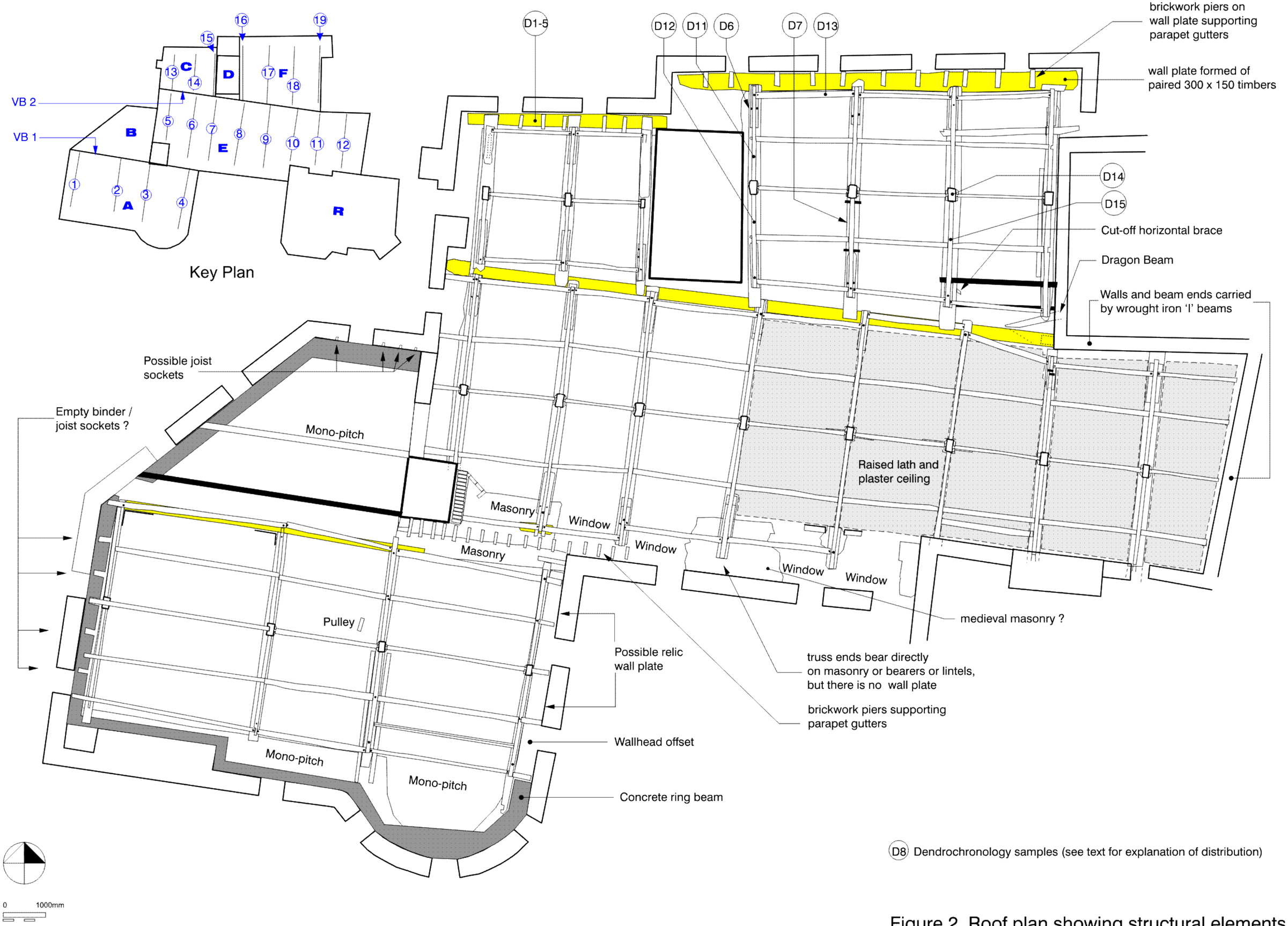
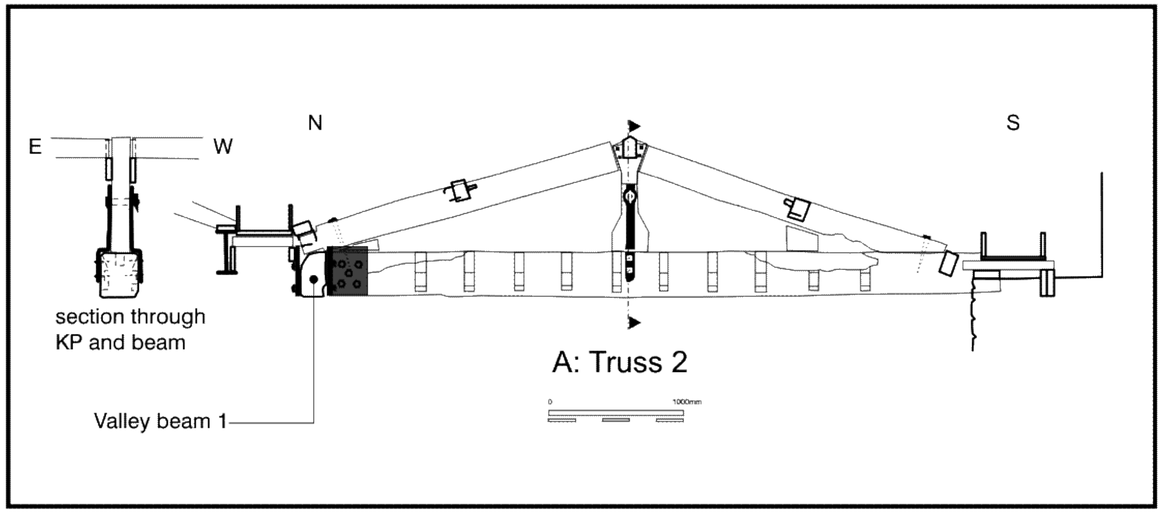
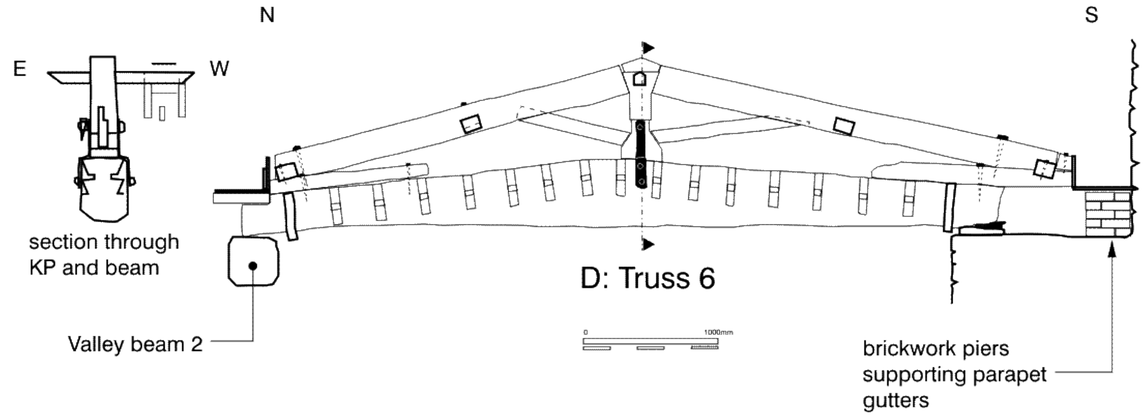
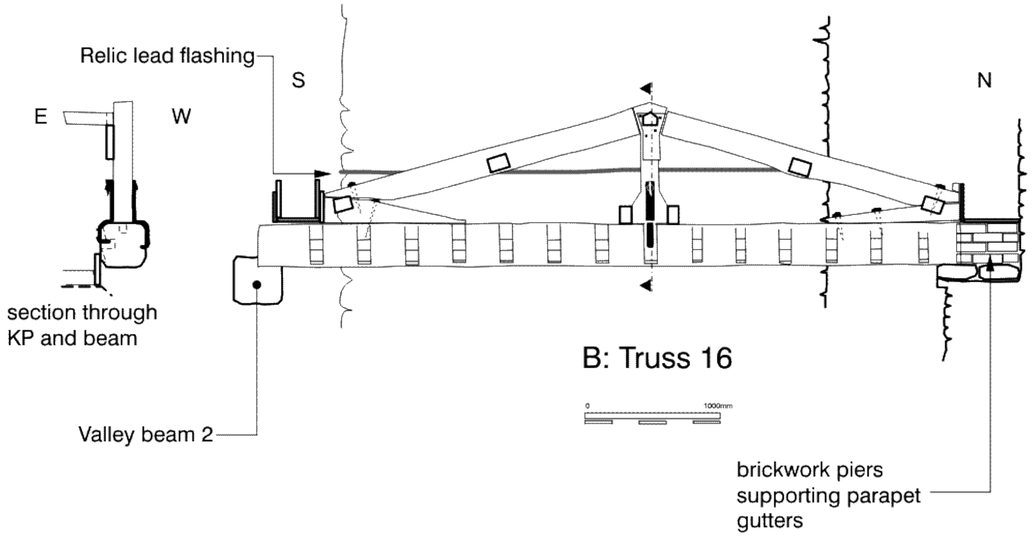
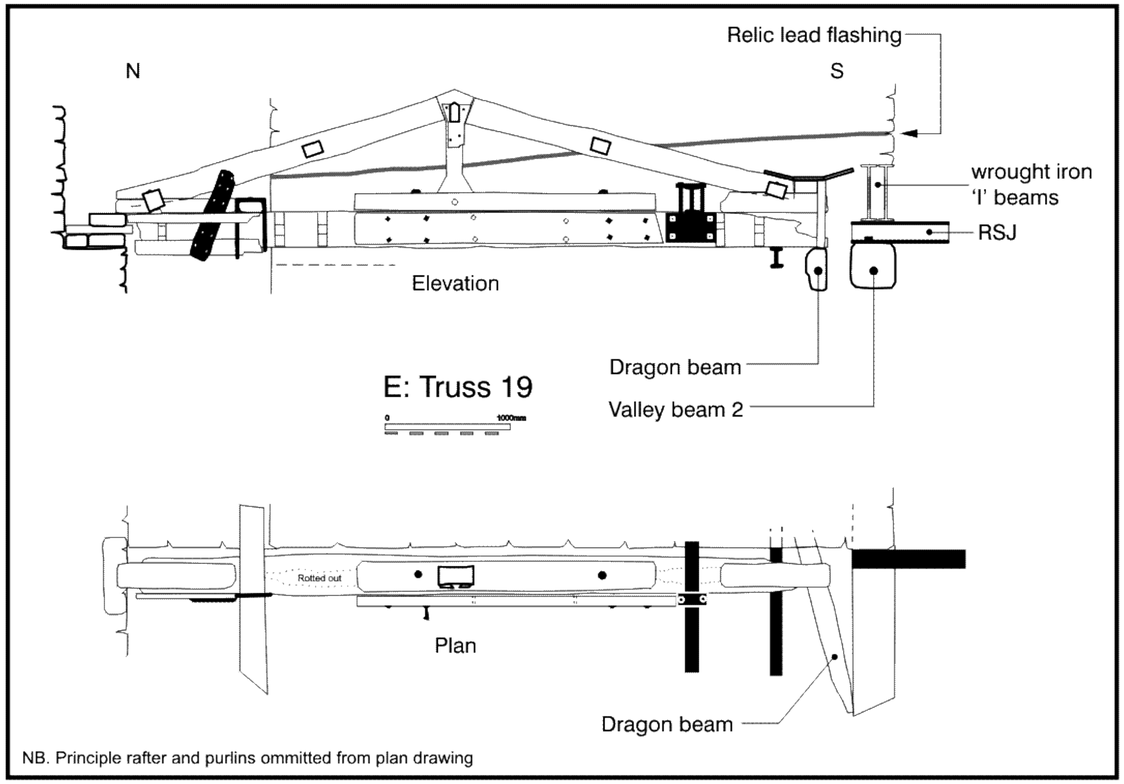


Figure 2. Roof plan showing structural elements









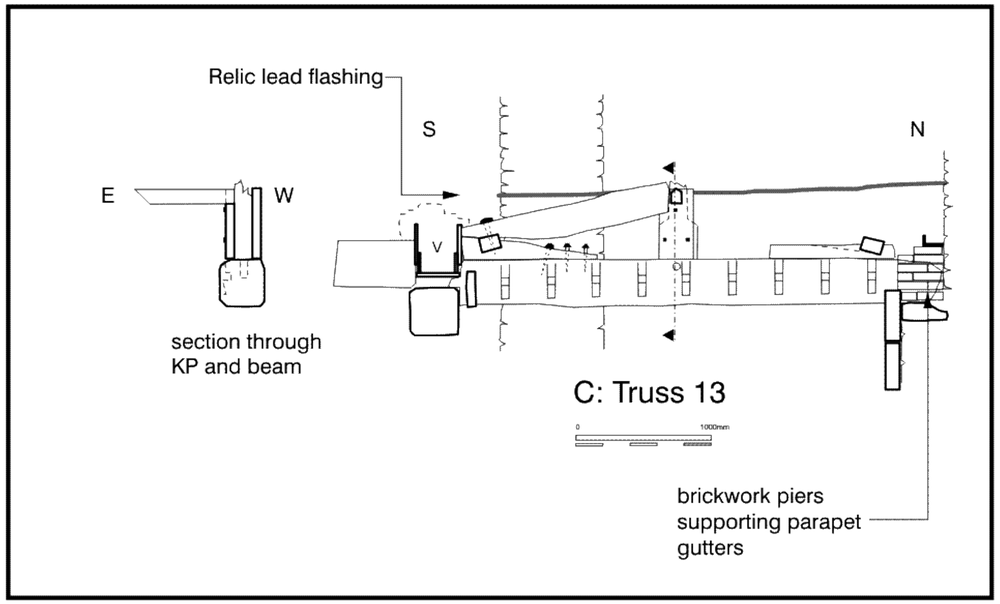


Figure 3. Example truss details

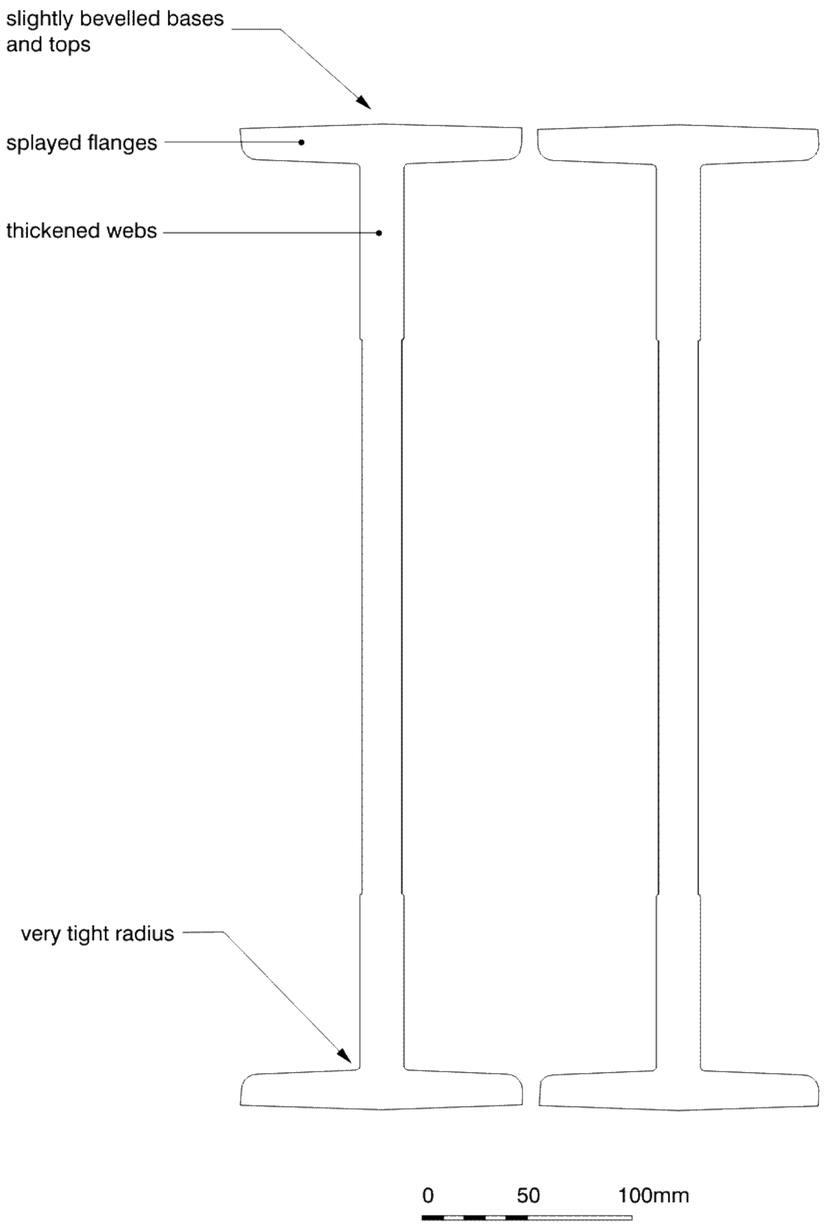


Figure 4. Profiles of wrought iron ‘I’ beams

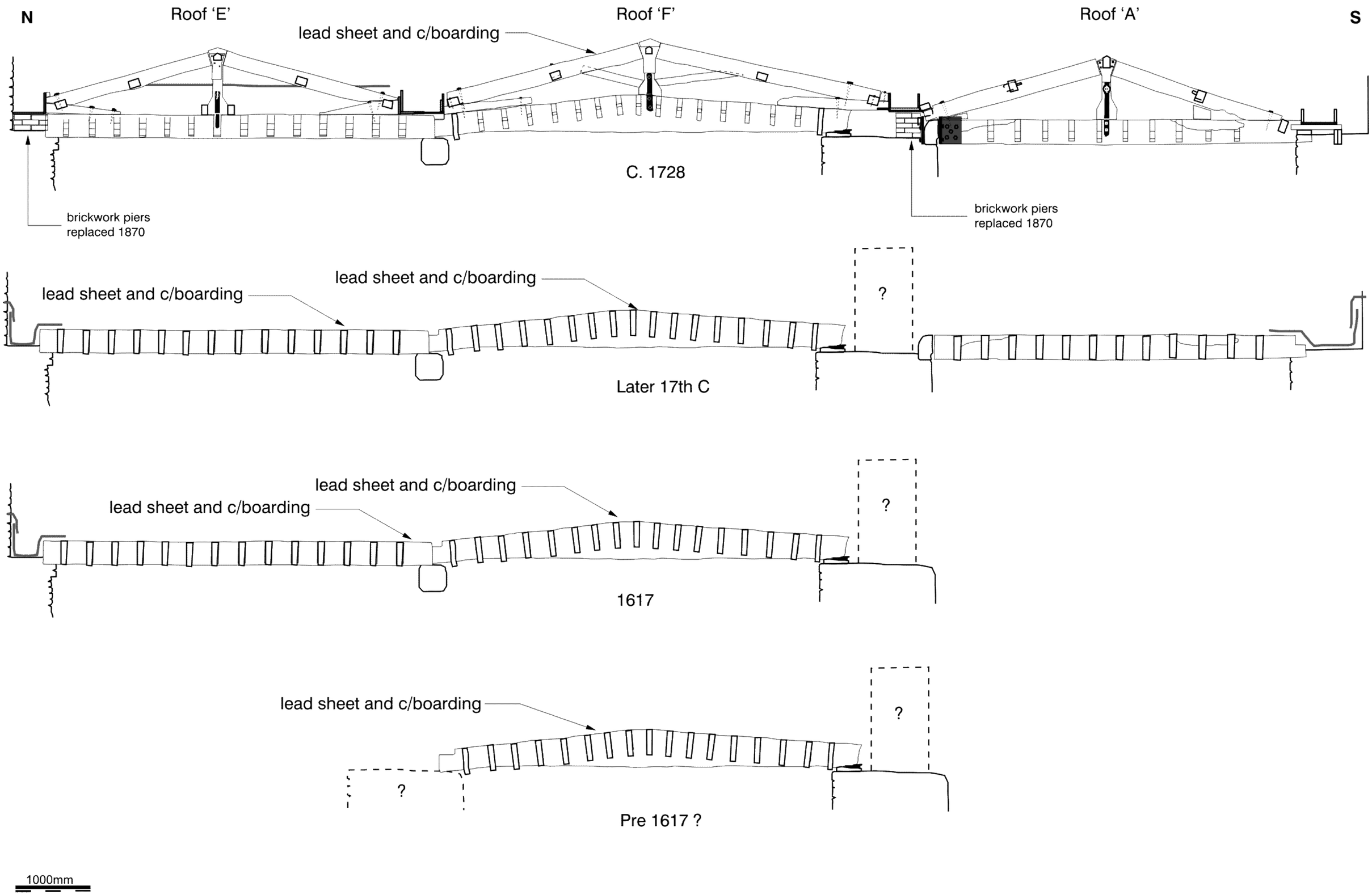


Figure 5. Suggested roof development

Plate 1. Example of failed lead sheeting at ridge

Plate 2. Example of the upper layer of counterboarding, probably of c. 1870

Plate 3. Example of the lower layer of counterboarding, on Roof 'E', with later firring pieces fixed to it.

Plate 4. Modern mono-pitch Roof 'A1'.

Plate 5. Primary structure of mono-pitch Roof 'R'.

Plate 6. Secondary form of mono-pitch Roof 'R'

Plate 7. Truss 6, from the north-west

Plate 8. Truss 2, from the north-east

Figure 6. Plates 1-8

Plate 9. Re-used timber with forelock bolt used as sprocket at south end of Truss 6

Plate 10. The west end of the valley between Roofs 'A' and 'B'.

Plate 11. Brickwork piers carrying valley at north end of Truss 16,

Plate 12. East end of valley between Roofs 'E' and 'F', showing middle of three phases of valley board with firring pieces on top.

Plate 13. Modern steel brackets connecting new trusses 1 and 2 to the pre-existing valley beam.

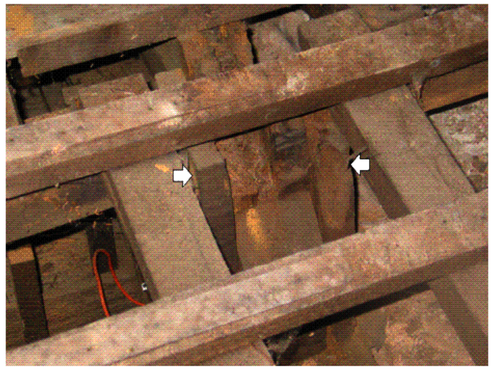


Plate 15. Splints supporting king post of Truss 13.

Plate 16. Relic lead flashing in wall face below Roof 'B'.

Plate 17. Wrought iron 'I' beams at south-east corner of Roof 'E', from the north-west.

Figure 7. Plates 9-13 and 15-17

Truss 19, from the north-west

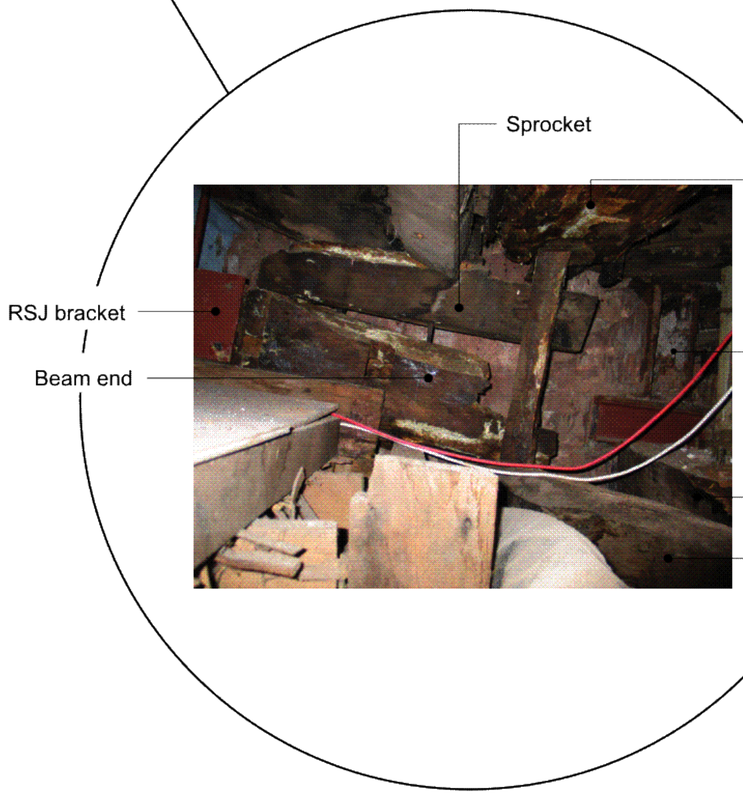


Figure 8. Plate 14