

Hammer-Beam: Tradition, Innovation and the Carpenter's Art in
Late Medieval England

ILLUSTRATIONS

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Fig. 1.1: Jan Van Eyck, *St Barbara* (1437), detail. Oil on panel



Fig. 1.2: Jean Fouquet, *The Building of a Cathedral* (c. 1465). Illumination on parchment.

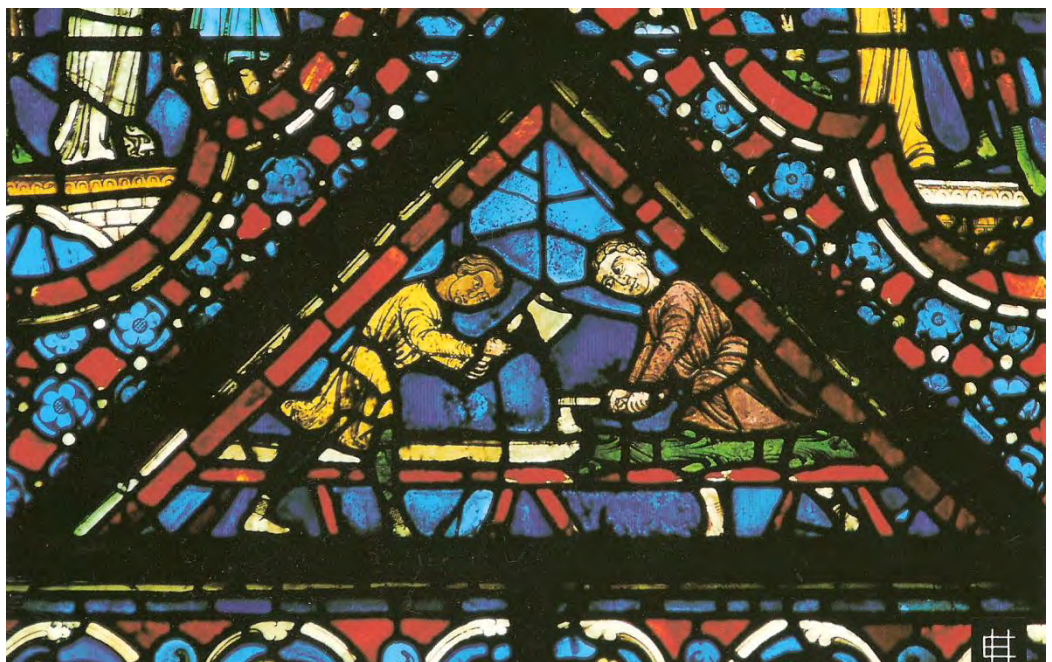


Fig. 1.3: Chartres Cathedral, nave, *The Story of Noah* (C13). Aisle window, stained glass.



Fig. 1.4: Fifteenth-century oak window frame, English.
(V & A collection)



Fig. 1.5: Exeter Cathedral, Bishop's Throne, 1317.



Fig. 1.6: Reconstruction of a medieval pile-driver, Chateau Mezerville, Aude, France.

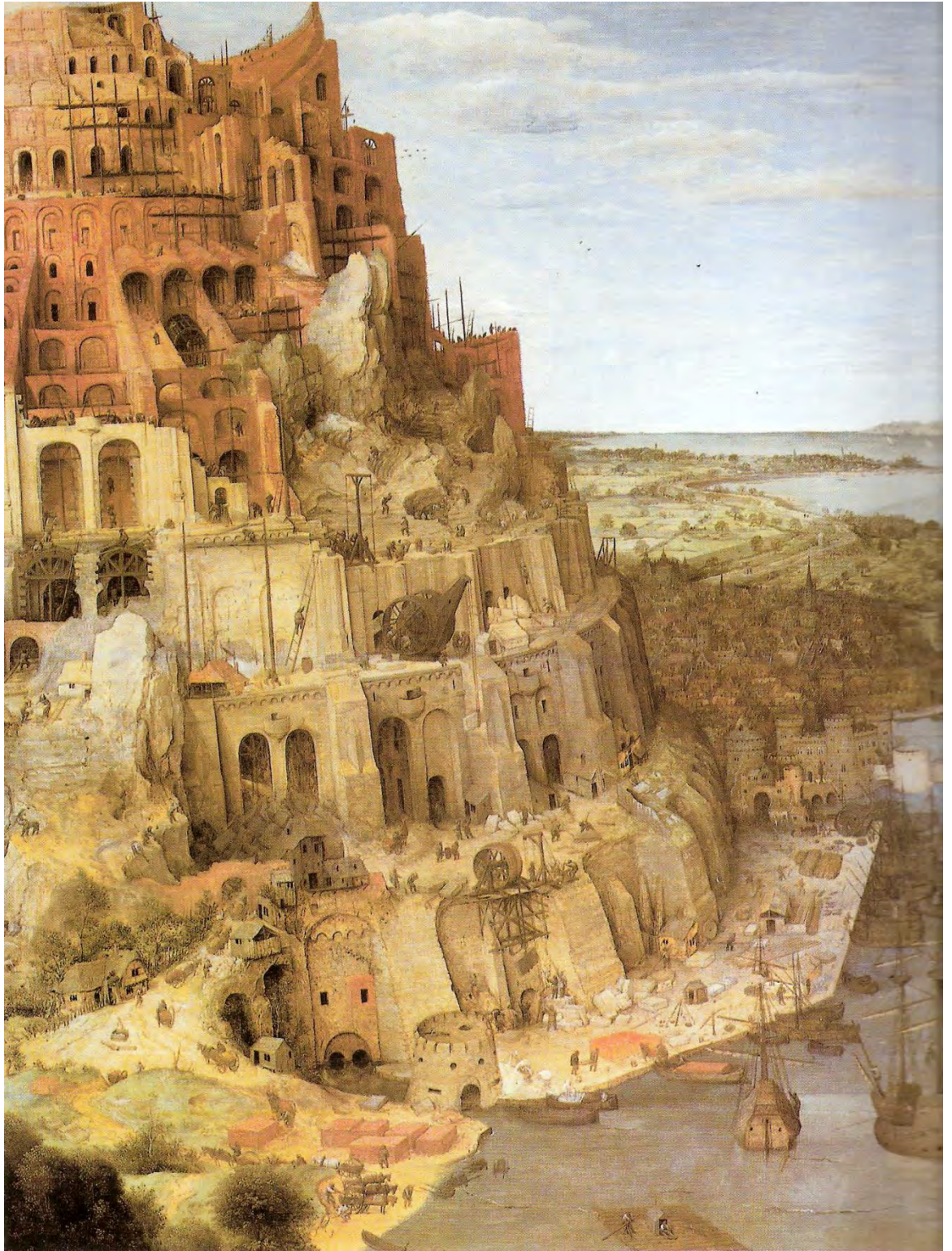


Fig. 1.7: Pieter Bruegel, *The Tower of Babel* (c. 1563), detail. Oil on Panel.

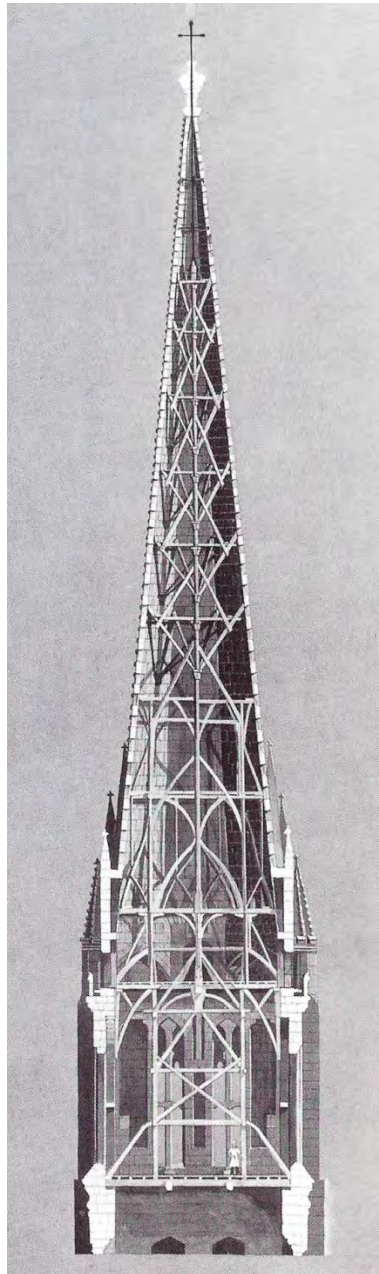


Fig. 1.8: Salisbury Cathedral Spire, scaffold, 1344-76d; below: From Hewett, *EHC*.

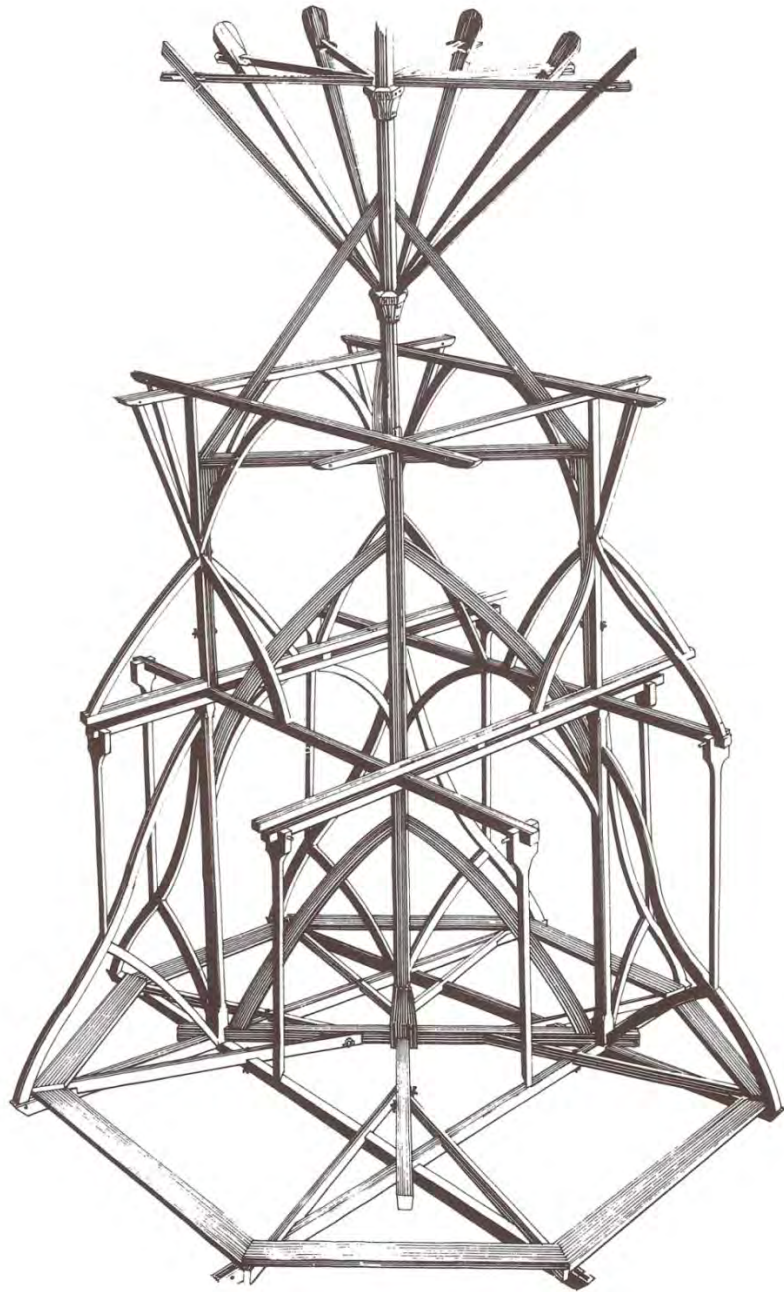


Fig. 1.9: Scaffold, Salisbury Cathedral Spire, middle section.
(From Hewett, *EHC*)

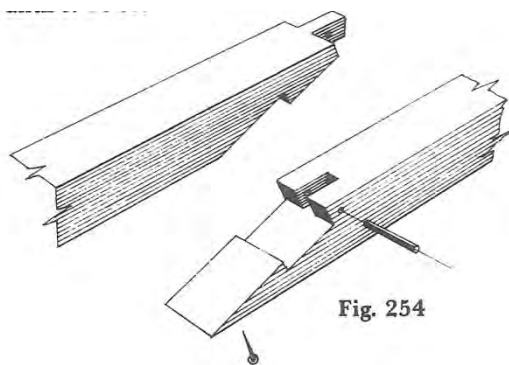


Fig. 1.10: Scarf joint, 'Splayed and tabled with bridled upper abutment', from the scaffold, Salisbury Cathedral Spire.
(Hewett, *EHC*, Fig. 1.254)

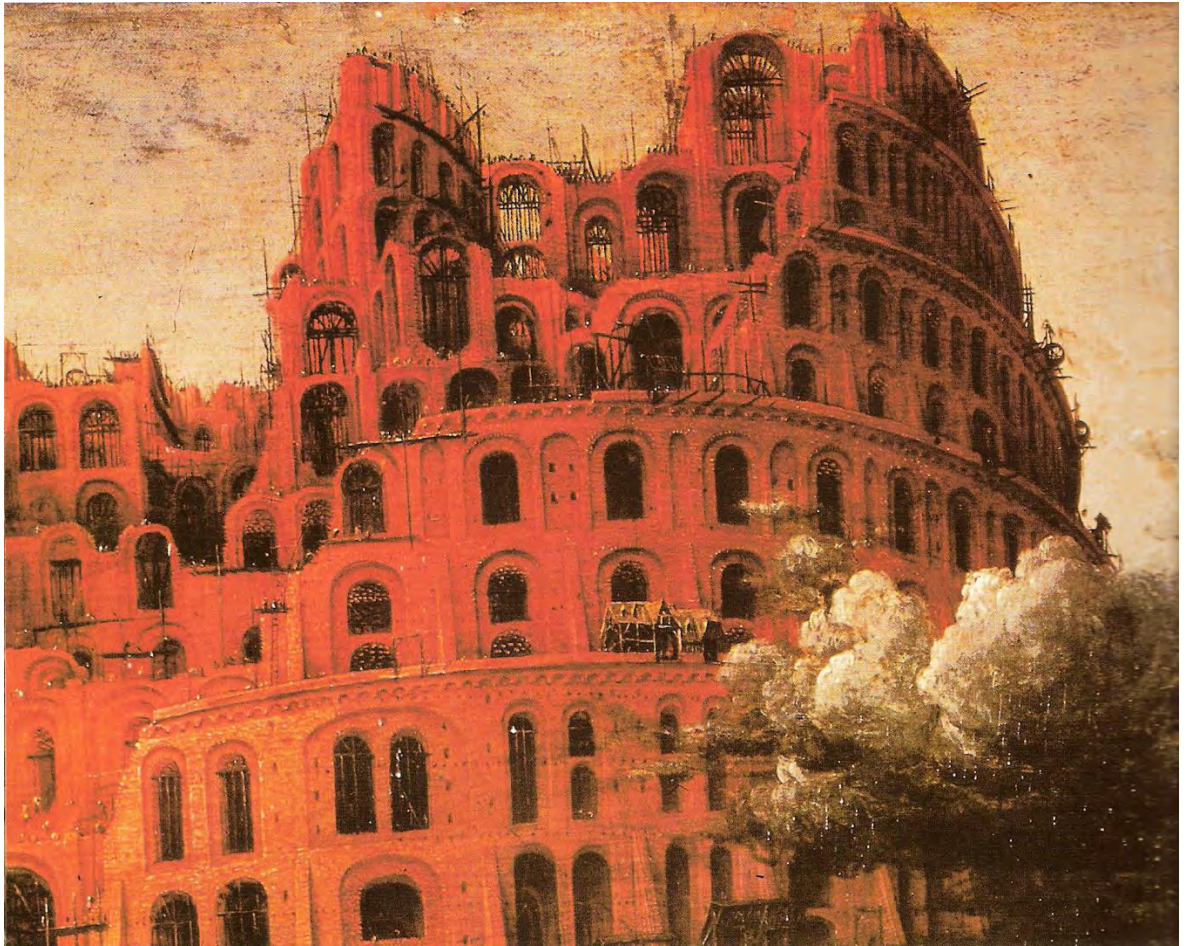


Fig. 1.11: Pieter Bruegel, *The 'Little' Tower of Babel*, c. 1563, (detail). Oil on panel.

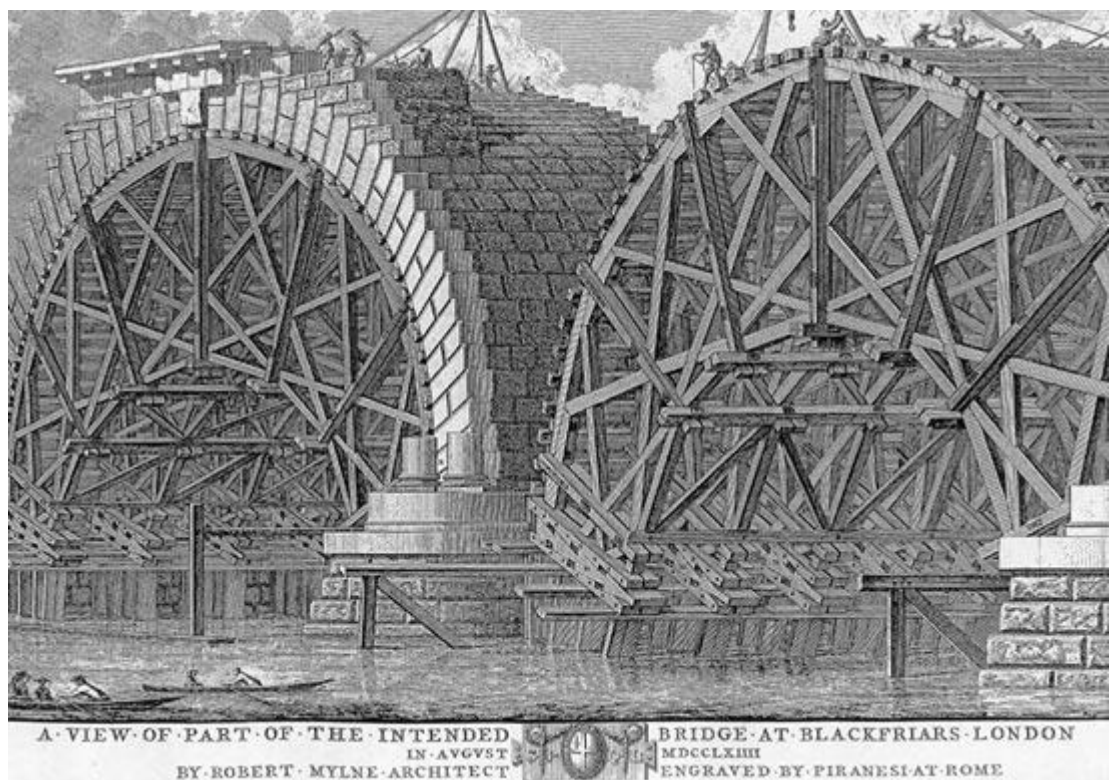


Fig. 1.12: Sophisticated centering in the eighteenth century: Robert Mylne's design for Blackfriars Bridge, London, 1759. The arches of the bridge are short tunnel vaults. Note the 'stepped' folding wedges at the base of the structures to facilitate incremental adjustment and 'striking.'

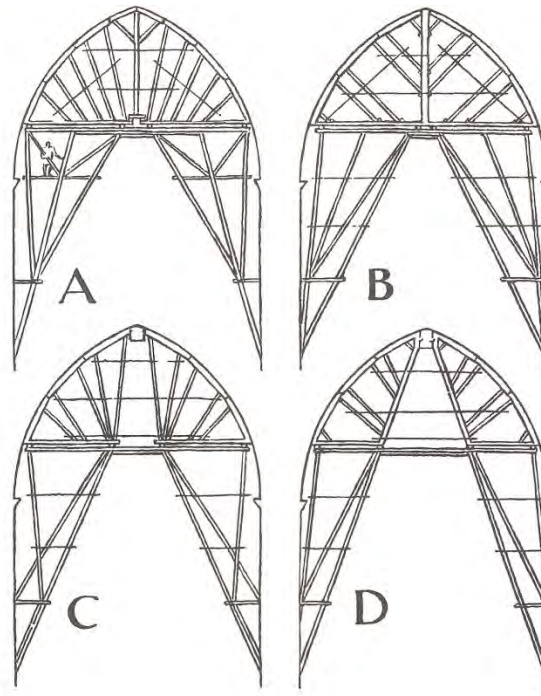


Fig. 1.13: Fitchen's suggestions for medieval centering and their sub-frames. These are views of transverse frames. Clearly, further centering structures would need to be carpentered accordant with the number of intersecting ribs.

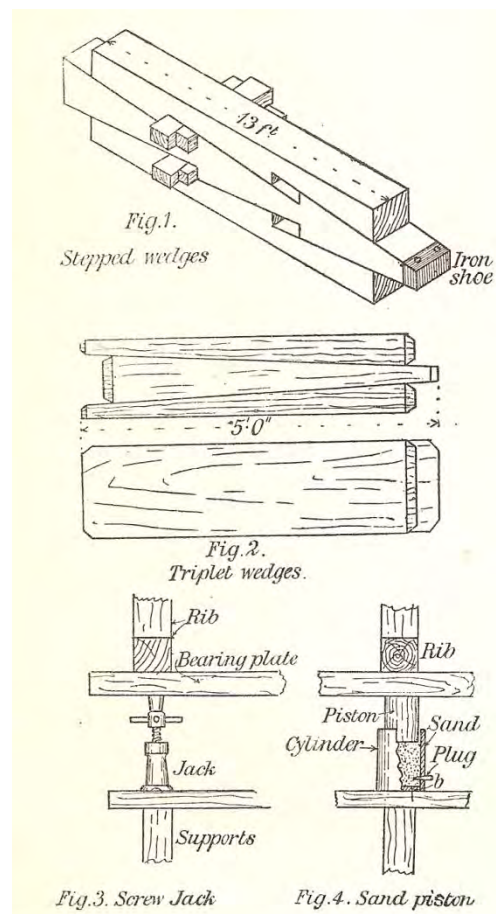


Fig. 1.14: George Ellis's suggested mechanical devices for the adjustment and striking of centering.

His Fig. 1.3, the modern screw-jack, can be ignored, but the other devices, especially wedging systems, would have been part of the medieval carpenter's repertoire. The advantage of the stepped wedge is twofold. It can be locked, by a pair of folding wedges as in the illustration, and, as there is less contact area between the sliding surfaces compared with triple folding wedges, friction is reduced permitting easier adjustment. (See also Fitchen 32-34)

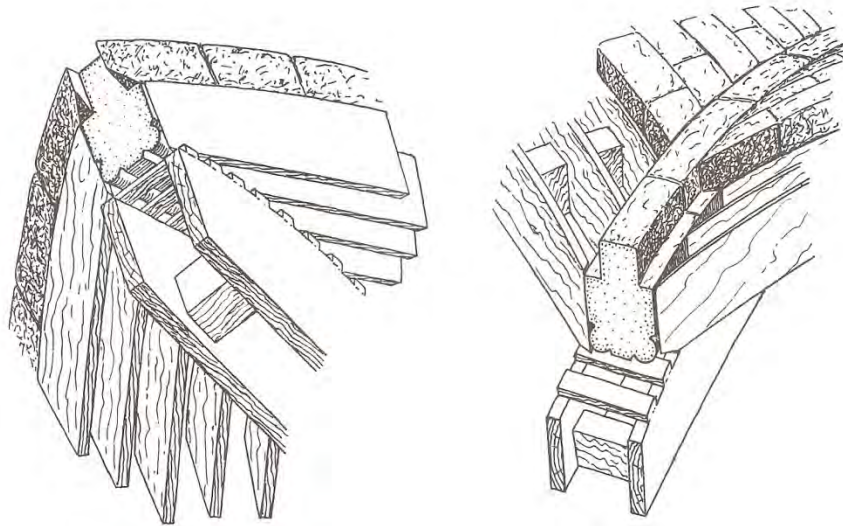


Fig. 1.15: Fitchen's suggestion for how carpenters dealt with the webbing in a gothic vault.

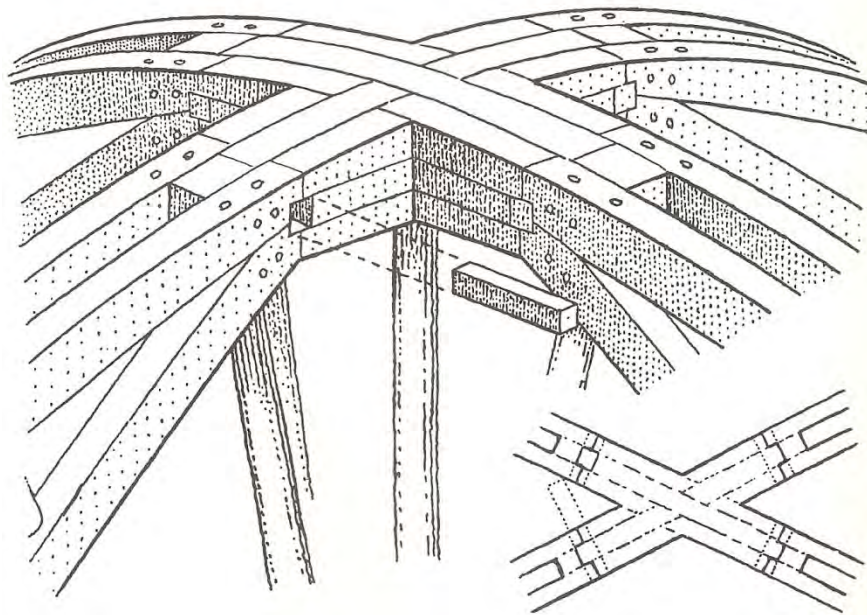


Fig. 1.16: Possible framing solution for the crown of the vault.
(From Fitchen)



Fig. 1.17: Boards inserted to support an area of vault webbing, Chichester Cathedral, choir gallery.

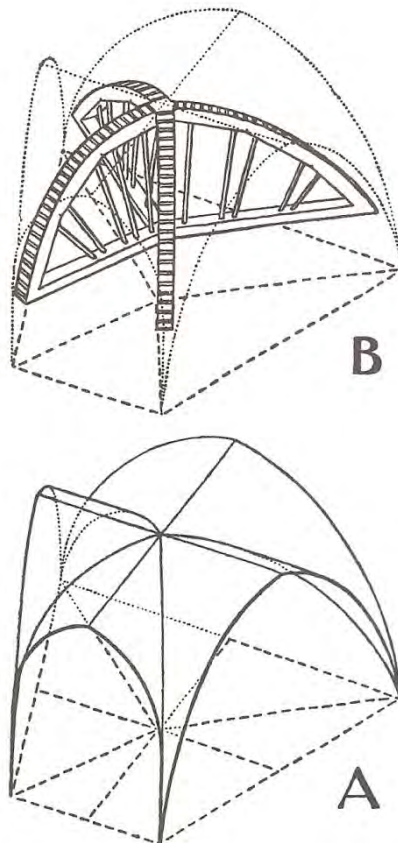


Fig. 1.18: Possible centering for a trapezoidal bay.
(From Fitchen)



Fig. 1.19: Soissons Cathedral, nave vault under reconstruction following World War I.



Fig. 1.20: Abbey of New Clairvaux, Vina, California, new Chapter House under construction, 2010.
(www.sbebuilders.com)



Fig. 1.21: Abbey of New Clairvaux. Note the wedges for fine adjustment of the voussoirs.

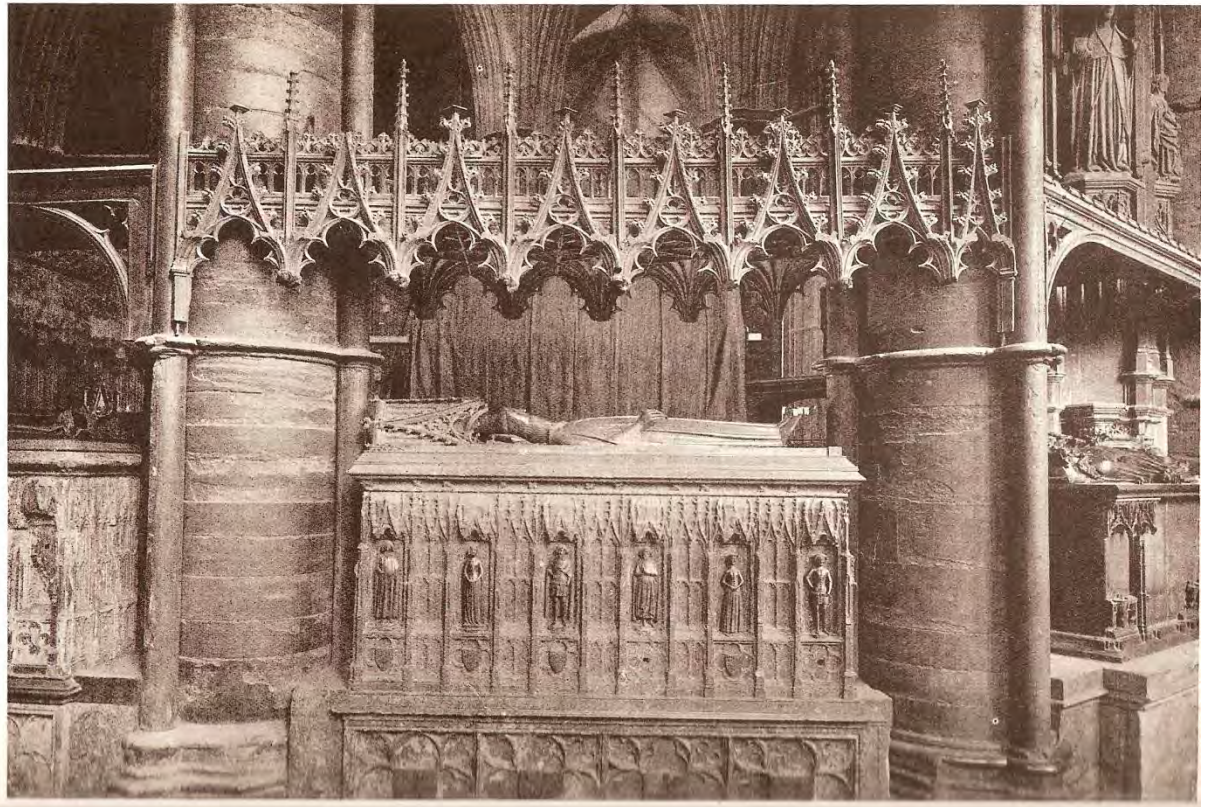


Fig. 1.22: Tomb of Edward III, 1377, Westminster Abbey.
(From Howard & Crossley)



Fig. 1.23: Tester of Tomb of Edward III, underside and details,
(from Caveler, 1839).

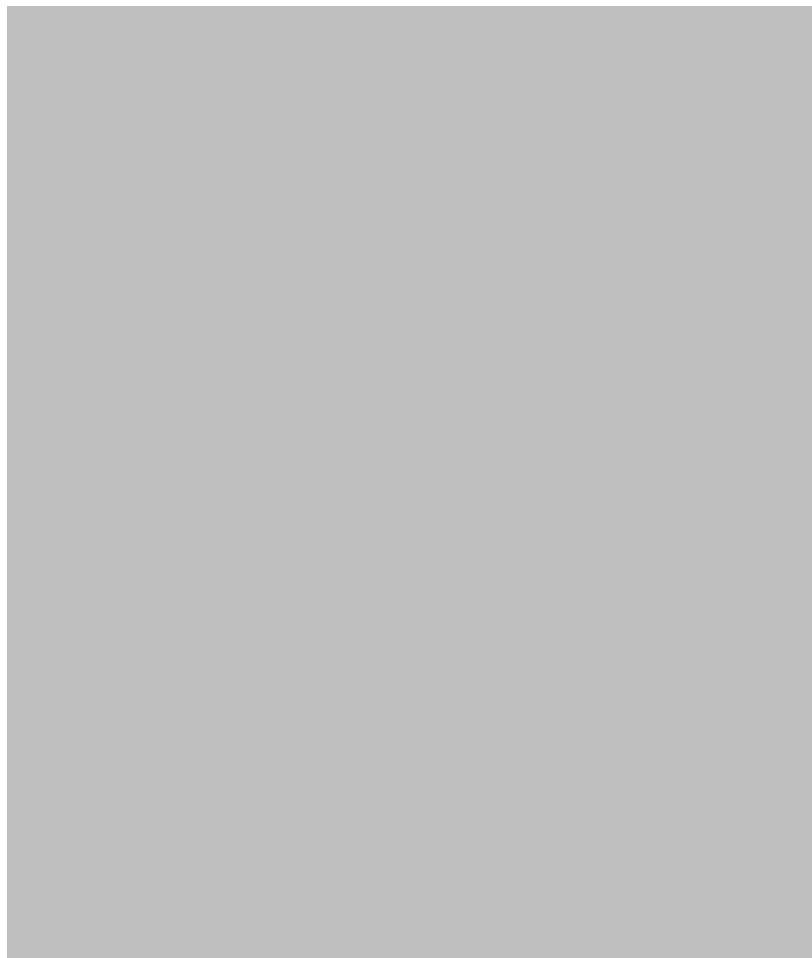


Fig 1.24: Tester of Tomb of Edward III, details.
(Caveler)



Fig. 1.25: Arundel Collegiate Church, timber vault in the Fitzalan Chapel, c. 1380-90, restored 1880.
(From Harvey, 1978)

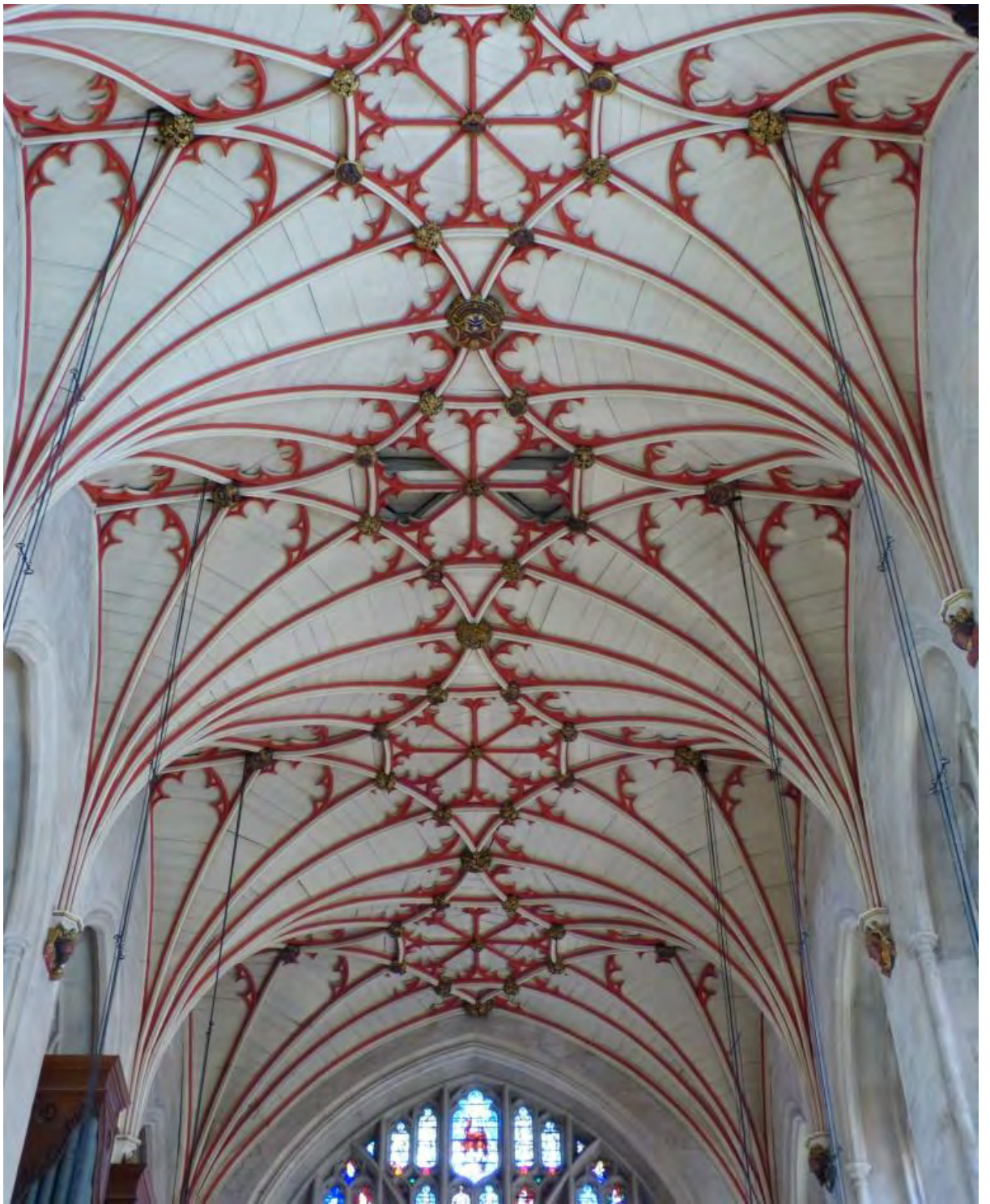


Fig. 1.26: Winchester College Chapel, timber vault, 1387-94, Hugh Herland.



Fig. 1.27: York Minster, Chapter House vault, 1275-90 (restored 1802-28).

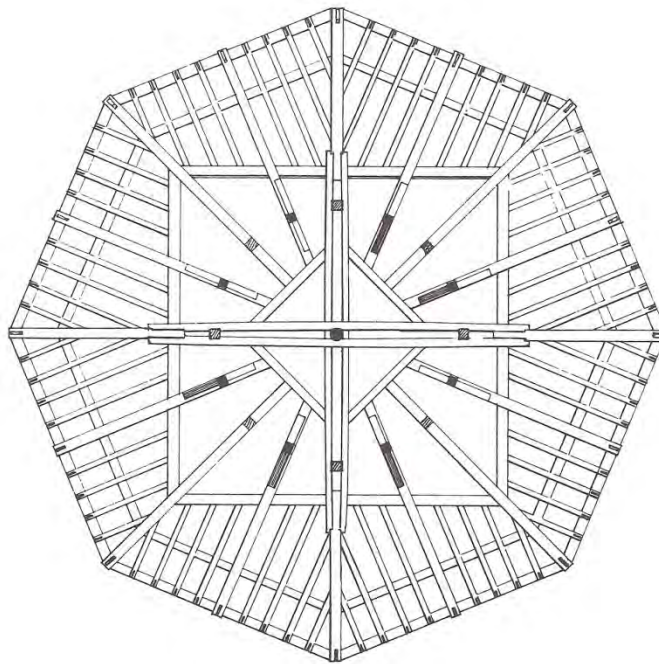


Fig. 1.28: York Minster, Chapter House, plan of spire carpentry at base, (Hewett, *EHC*)

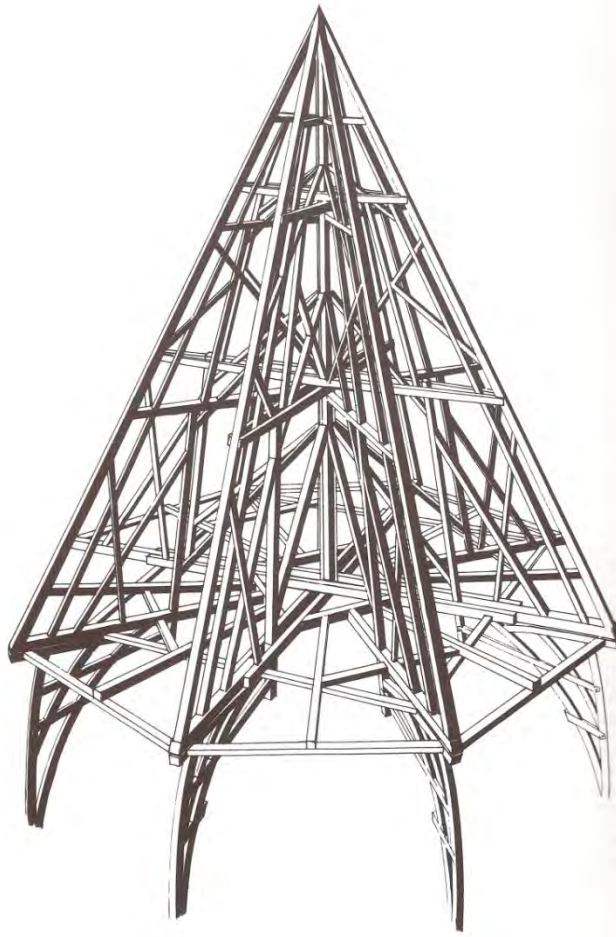


Fig. 1.29: York Minster, framing of Chapter House spire and vault.
(Hewett, *EHC*)

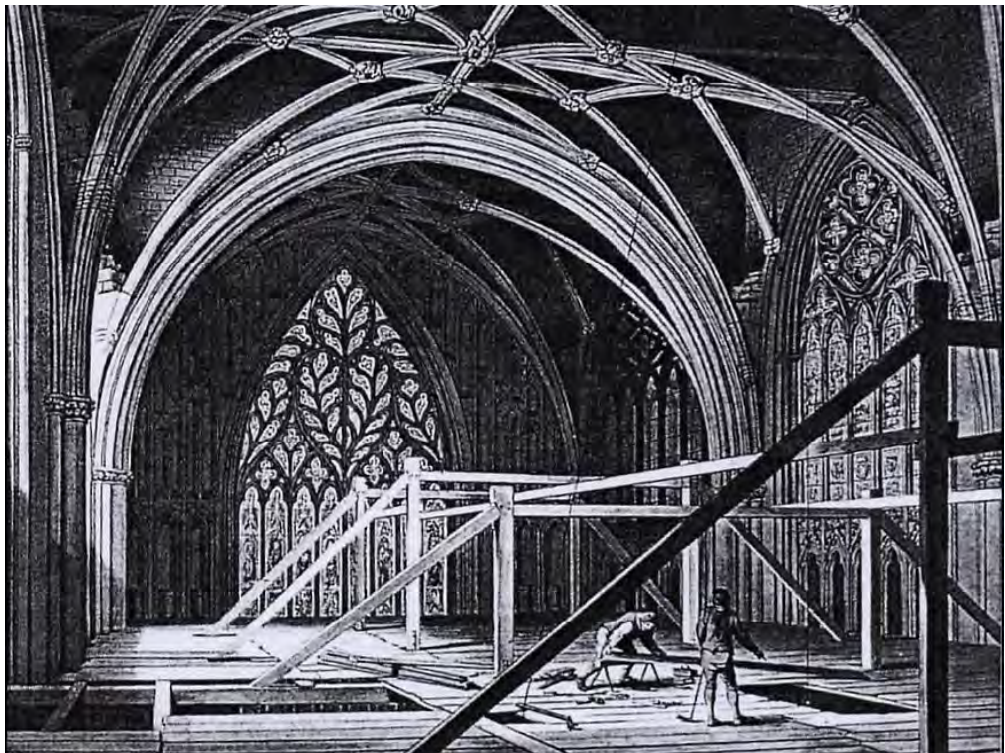


Fig. 1.30: York Minster, reconstruction of timber vault in the nave during the eighteenth century.
(Joseph Halfpenny, 1796)



Fig. 1.31: Westminster as depicted by Wenceslaus Hollar, 1647. The building on the left, then Parliament House, is St Stephen's Chapel

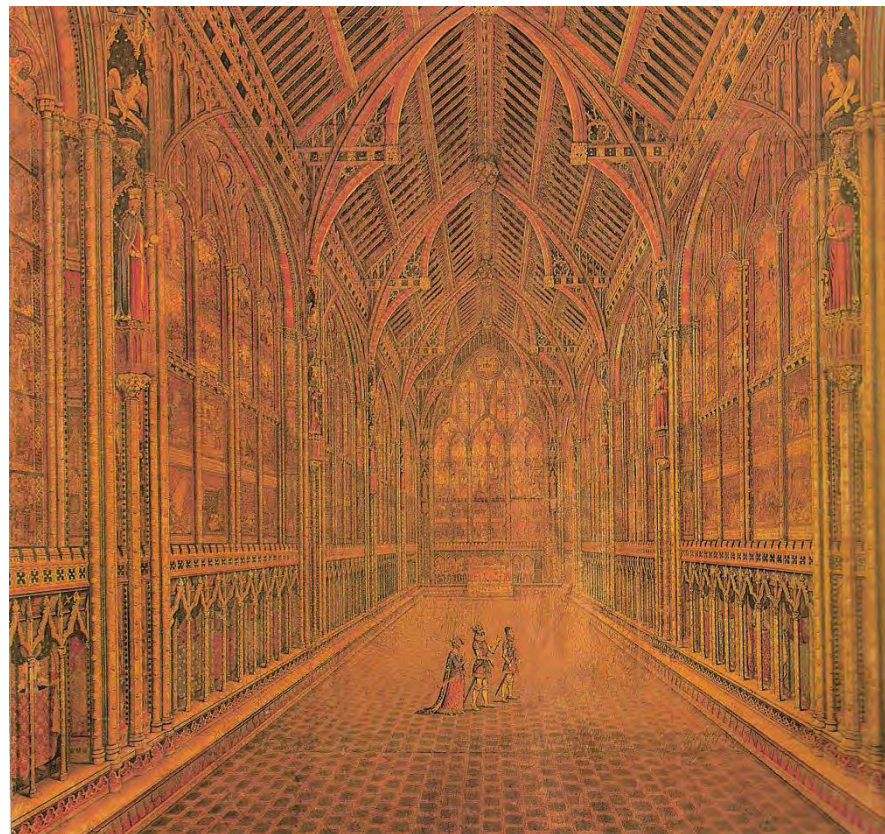


Fig. 1.32: St Stephen's Chapel, Westminster, comp. 1363. This early C19 reconstruction gives some idea of the sumptuous interior, but it depicts no clerestory and no timber vault - rather some form of hammer-beam roof in a style adumbrating Westminster Hall.
(From Jones, 1983)

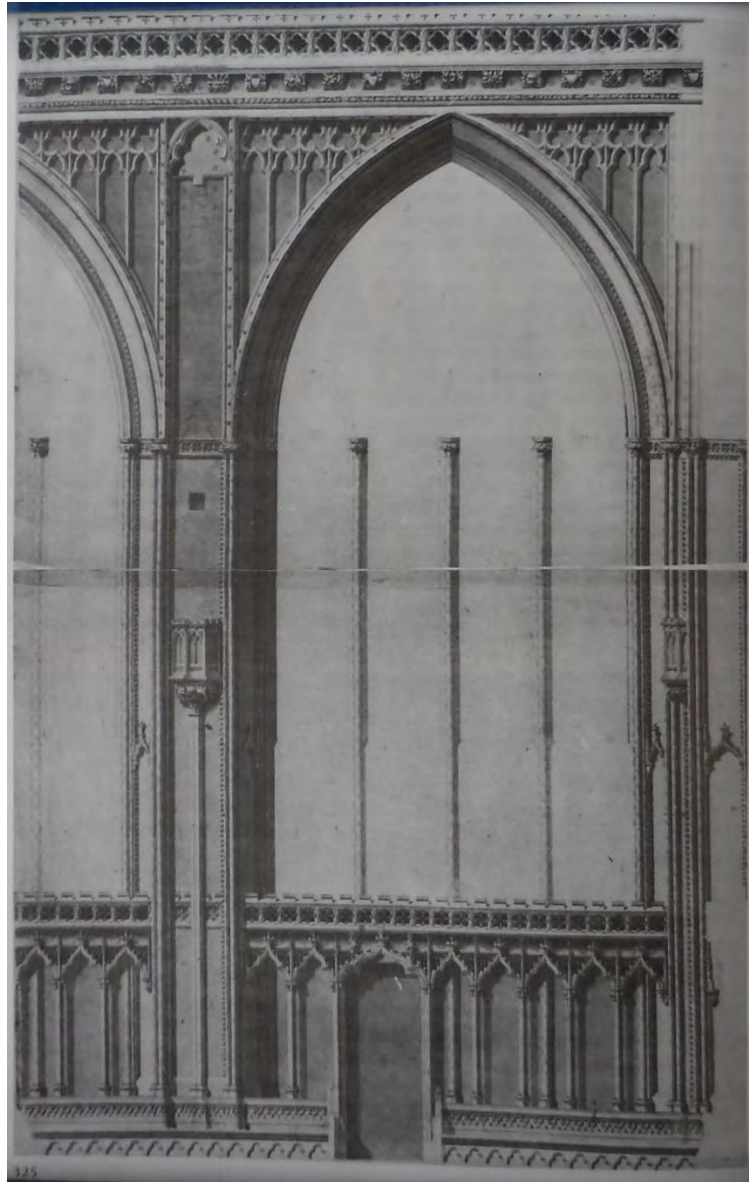


Fig. 1.33: St Stephens' Chapel, internal elevation of the north wall of the upper chapel of.
Recorded by Richard Dixon (c. 1800)
(From AC)



Fig. 1.34: Frederick Mackenzie's largely conjectural transverse section of St Stephen's Chapel (right)
(NYPL Digital Gallery)



Fig. 1.35: Waggon roofs. Left: Canterbury Cathedral, Chapter House, 1397; right: St Mary's, Bury St Edmunds, chancel, fourteenth-century (restored C19). Note how the construction permits the horizontal termination of the wall head.

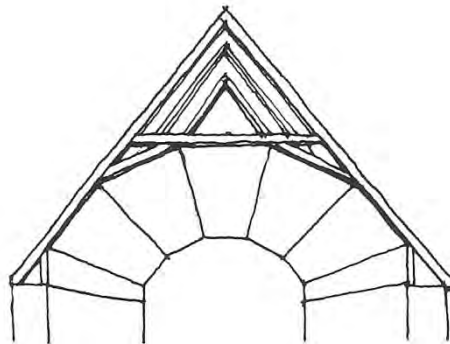


Fig 1.36: The structural principals behind a waggon roof. The internal faces of the ashlar pieces, the rafters, struts and collars all receive the boarding to form the continuous ceiling, to which high degrees of ornament can be applied, as above. The ashlars and struts can be curved and lengthened in order to form a smooth arc. Strictly speaking, illustrated is a seven-cant roof.
(From Brunskill)



Fig. 1.37: Church of St Peter and St Paul, Shepton Mallett, Somerset, oak waggon roof (c. 1450).

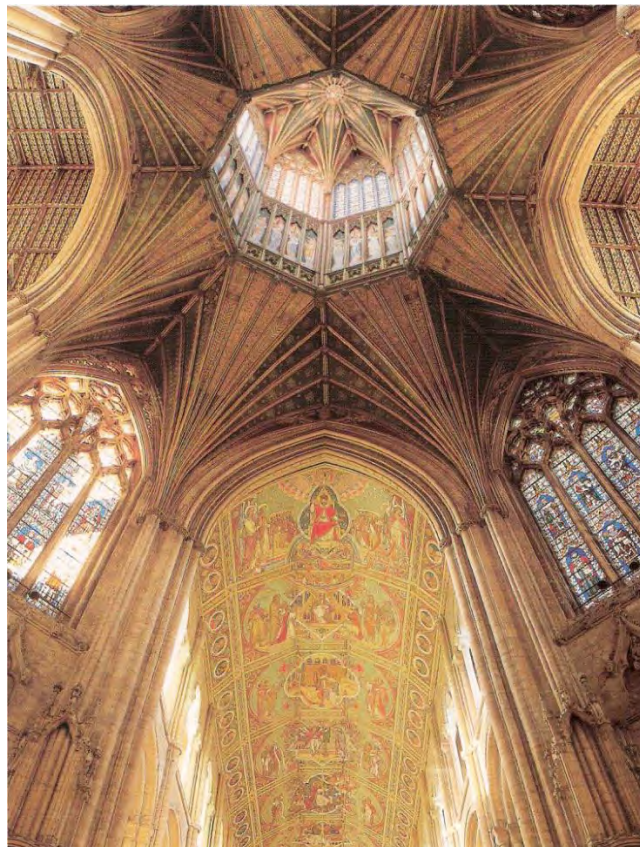


Fig. 1.38: Ely Cathedral, the nave, and the octagon and lantern (comp. 1339), looking west.



Fig. 1.39: The earliest English fan vault: Gloucester Cathedral, cloister, east walk, c. 1351-64, looking south.



Fig. 1.40: Peterborough Cathedral, retro choir, 1496-1508.



Fig. 1.41: Diminutive early fan vault: Tewkesbury Abbey, The Edward Despenser Chantry, 1375. Note the full extension of the rims of the conoids due to the square-plan bays. Span: 1.66 metres.



Fig. 1.42: Sherborne Abbey, choir, looking south east, begun c. 1425



Fig. 1.43: Early Pendant-boss vault: Collegiate Church of St Mary, Warwick, Dean's Chapel, 1441-52.



Fig. 1.44: Divinity School, Oxford, 1479-83
(welcome2britain.com)

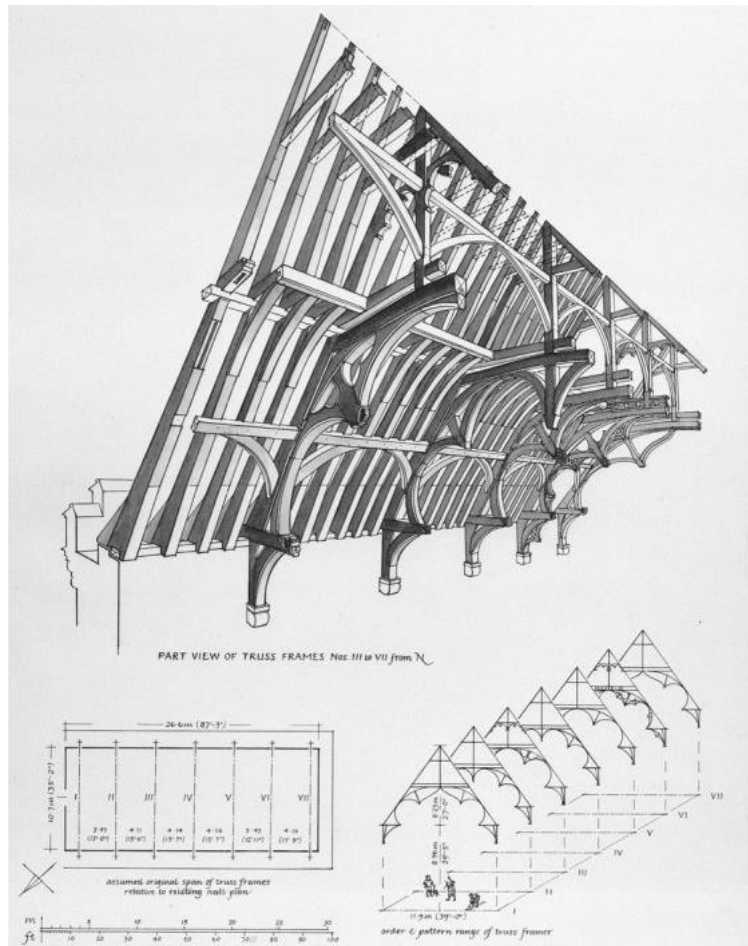


Fig. 1.45: Darnaway Castle, Moray, 1387d. Details of main roof framing.
(Stell & Baillie, 1993)



Fig. 1.46: Darnaway Castle, Roof of Great Hall.

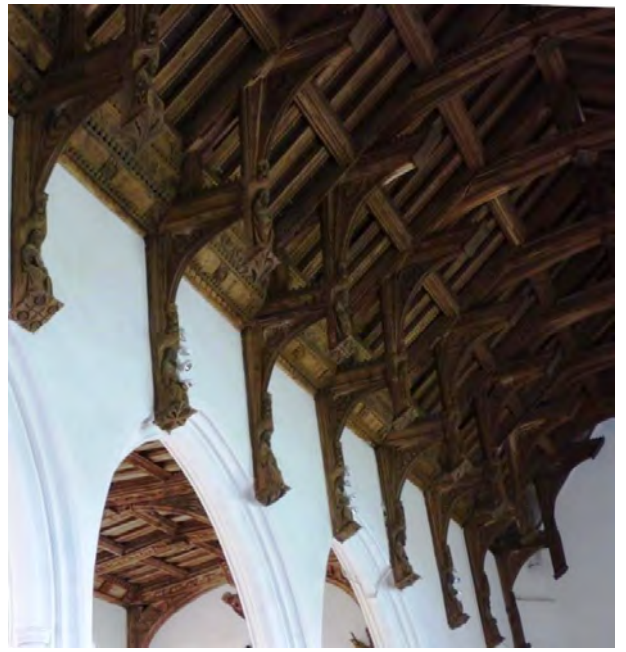


Fig. 1.47: Pendant post hammer-beam roofs. Clockwise from top left: Cotton Church Suffolk, c. 1471 (with alternate arch-braced frames); Wetherden, Suffolk; Grundisburgh; Suffolk (pendants are in the upper tier of hammer posts), both probably late fifteenth-century. Gestingthorpe Church, Essex, 1489. All double hammer-beams.



Fig. 2.1: Westminster Hall, c. 1393-98. Carpenter: Hugh Herland (d. 1405)
(From Crossley, 1951)

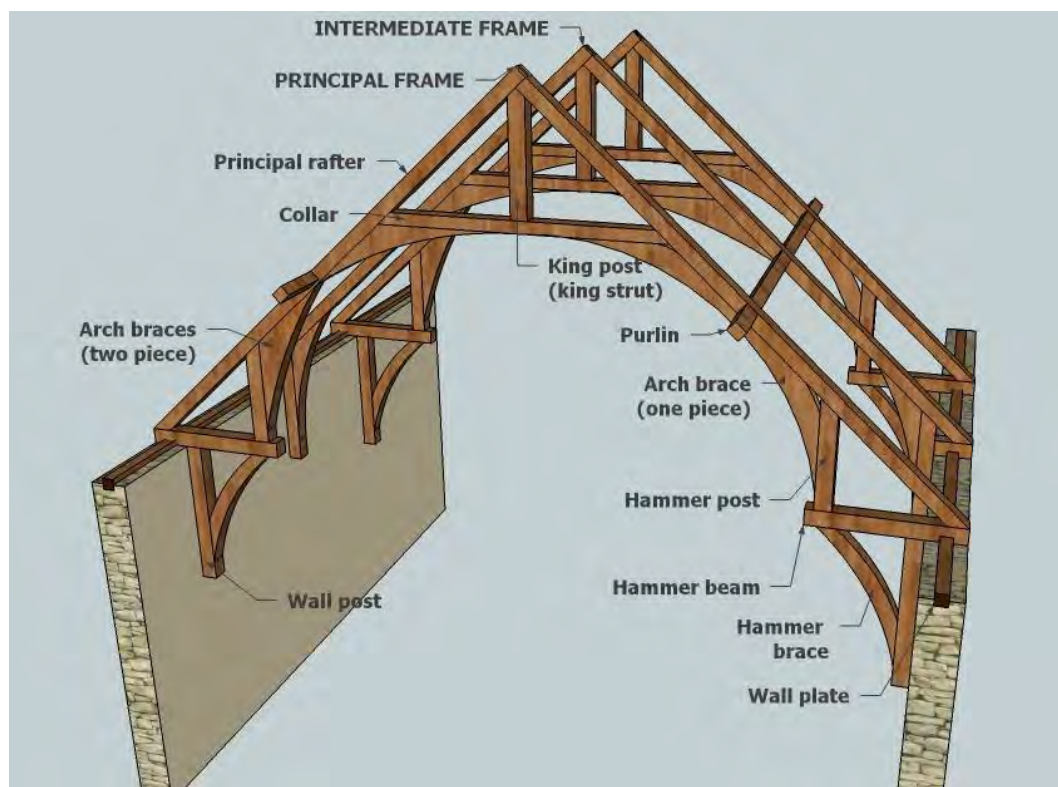


Fig. 2.2: Generic Hammer-beam construction.

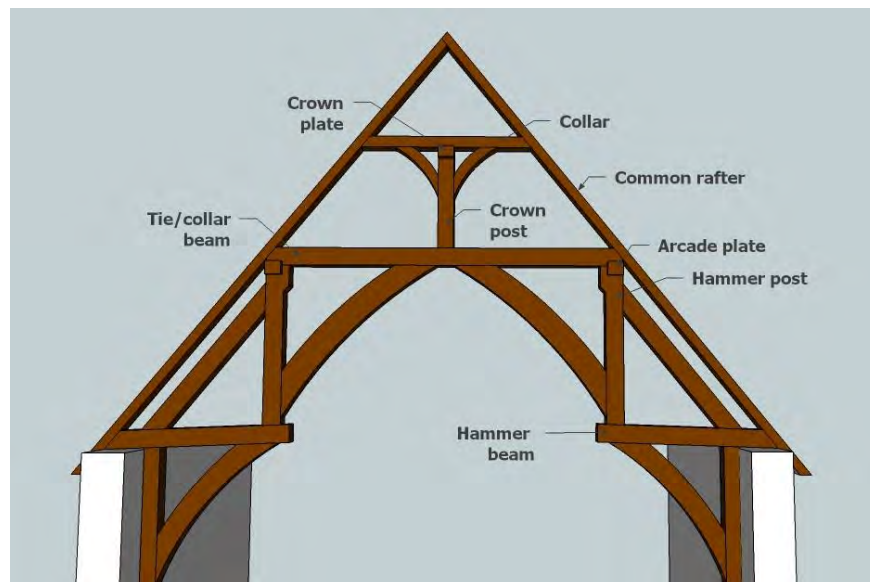


Fig. 2.3: Hammer-beam truss, after CBA's F8, B.

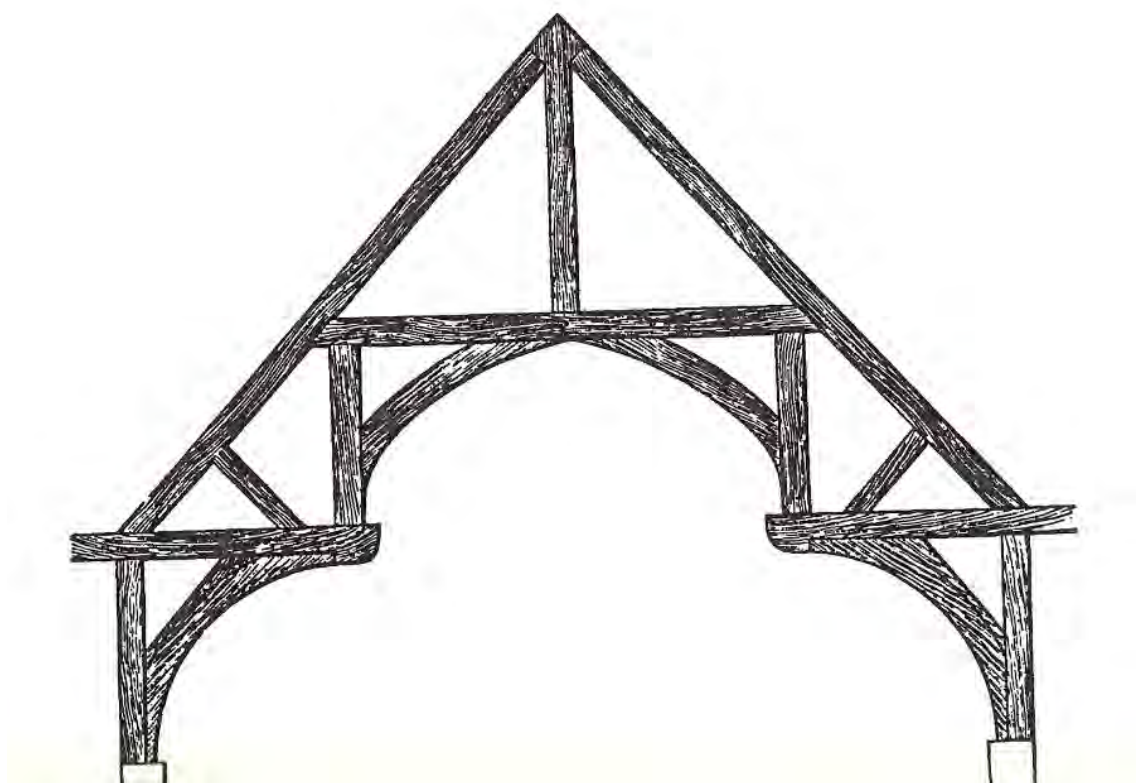


Fig. 2.4: Westminster School, hammer-beam frame of former dorter, medieval, precise date uncertain, now destroyed.
(From Morris, 1871)

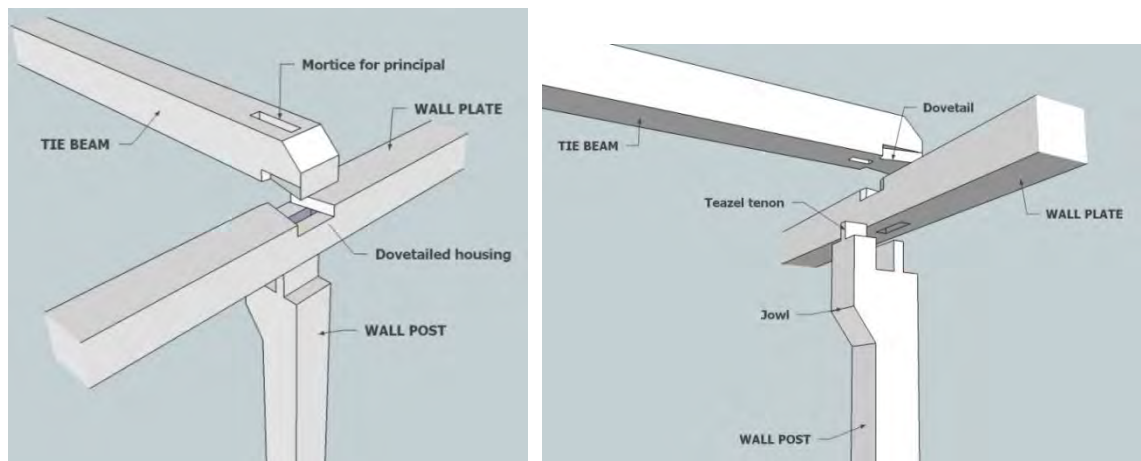


Fig. 2.5a: Generic English Tying Joint in 'normal assembly'. Left, from above; right, from below.



Fig. 2.5b: Normal assembly, porch at Hartpury Church, Worcs., probably fourteenth-century.

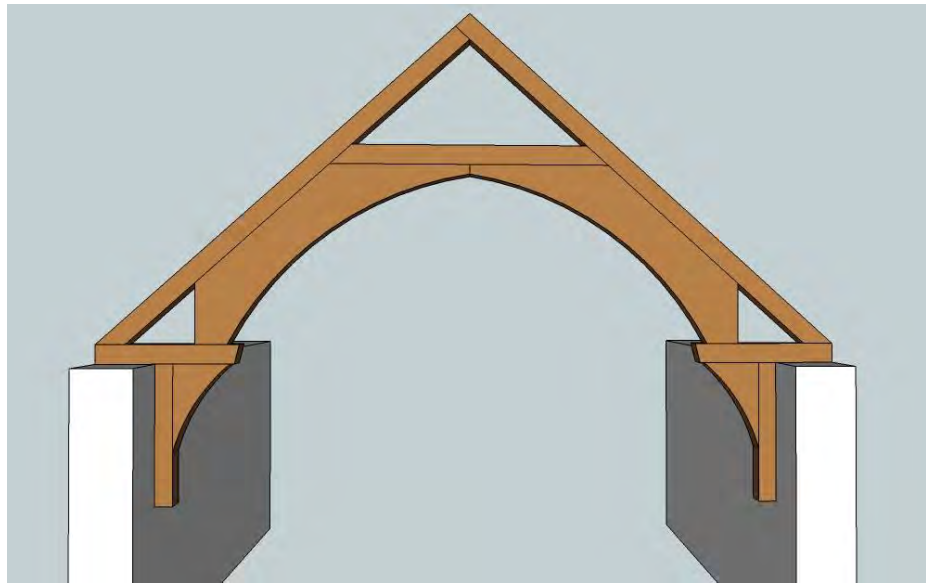


Fig. 2.6: 'False' hammer-beam truss, after CBA. Decorative elements removed for clarity.

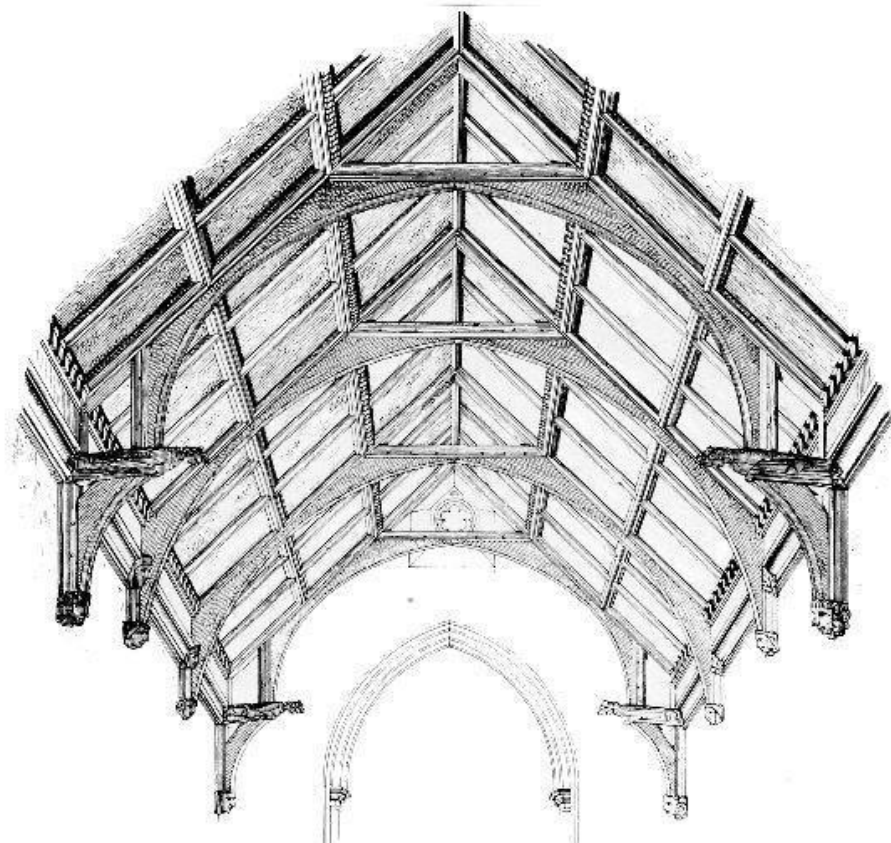


Fig. 2.7: Church of St Mary Magdelene (C.15), Little Welnetham, Norf.
(Illustration after Brandon)

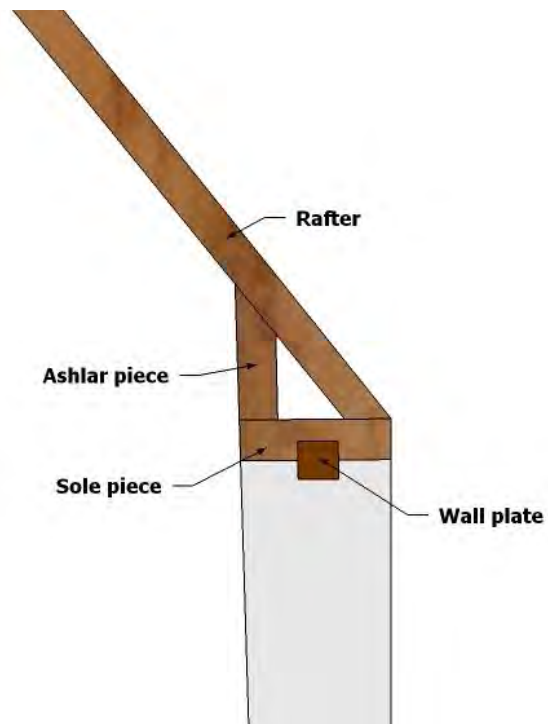


Fig. 2.8: Foot of rafter.

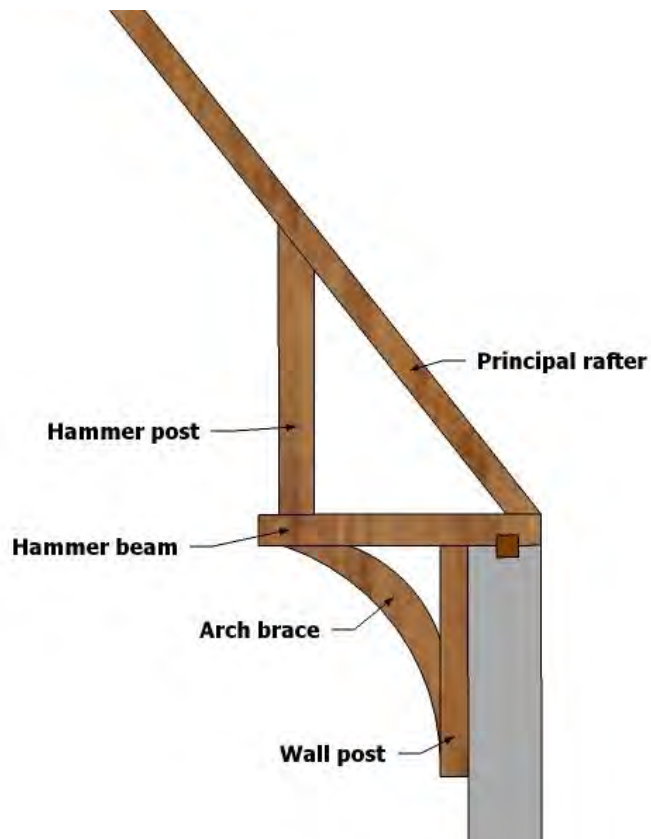


Fig. 2.9: Representation of how, with the addition of the wall post and curved brace, extending a sole piece of heavier scantling can become a hammer beam, and the ashlar piece the hammer post. The principal rafter, rather than the common, is also key to this configuration.

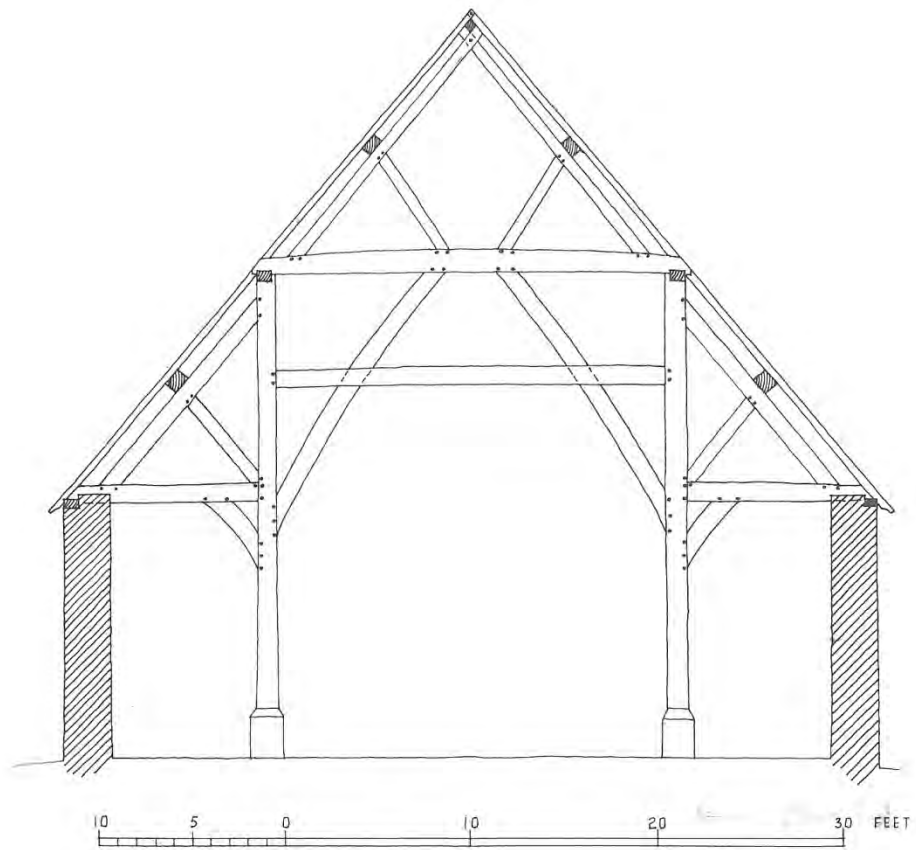


Fig. 2.10: A medieval aisled structure, Bredon Barn, Worcs., C14.
(From Charles, 1970)

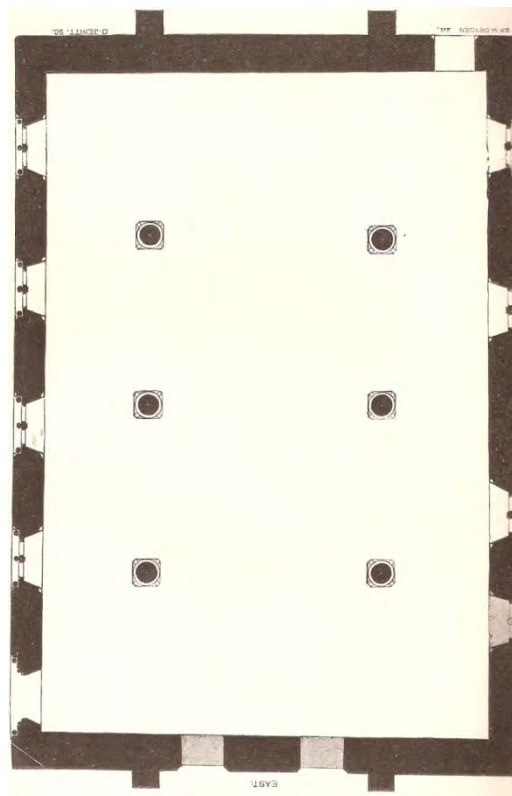


Fig. 2.11: A medieval aisled hall, plan of Oakham Castle, Rutland (late C12)
(From Turner, 1851)

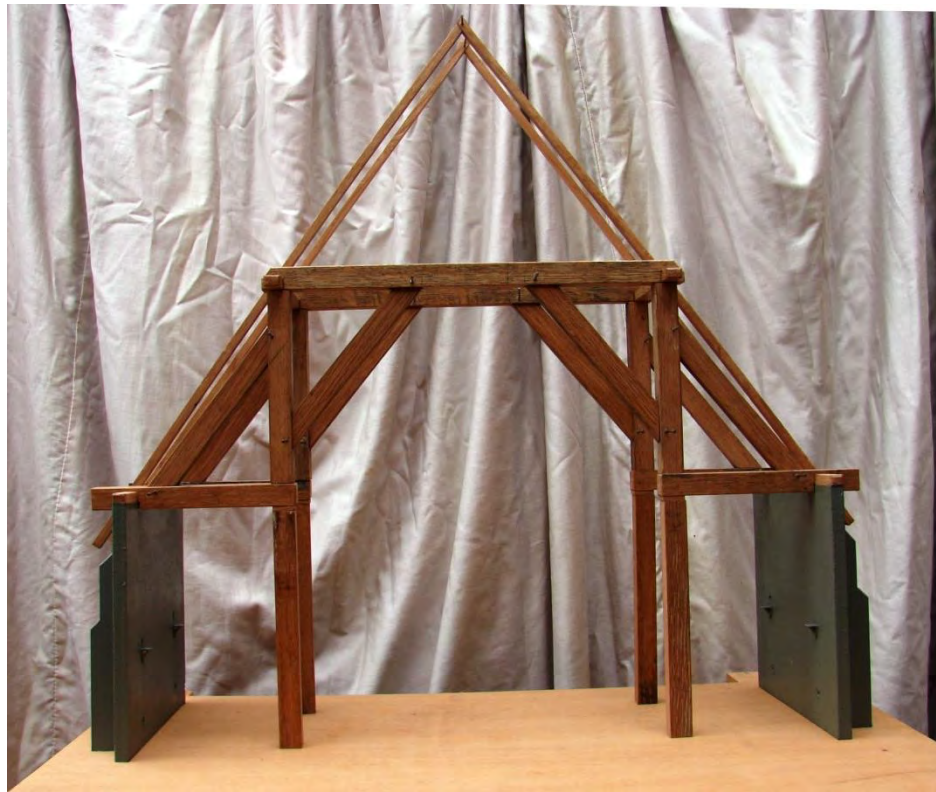


Fig. 2. 12a: Model of a medieval aisled building with arcade posts. For clarity only main timbers are included. (Scaled from Charles's drawing, Fig. 2. 12.)

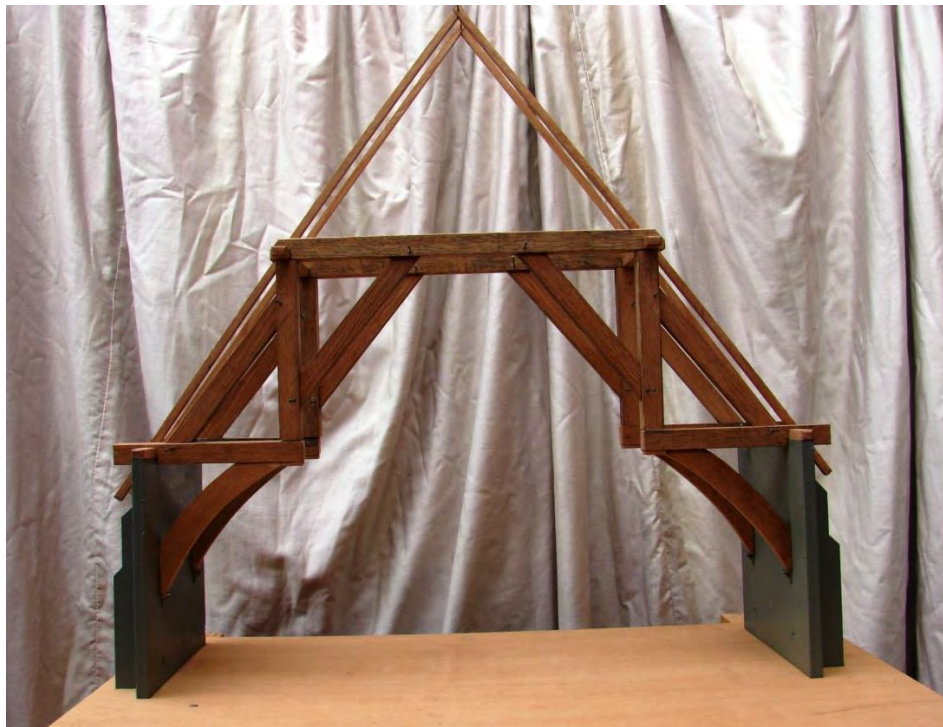
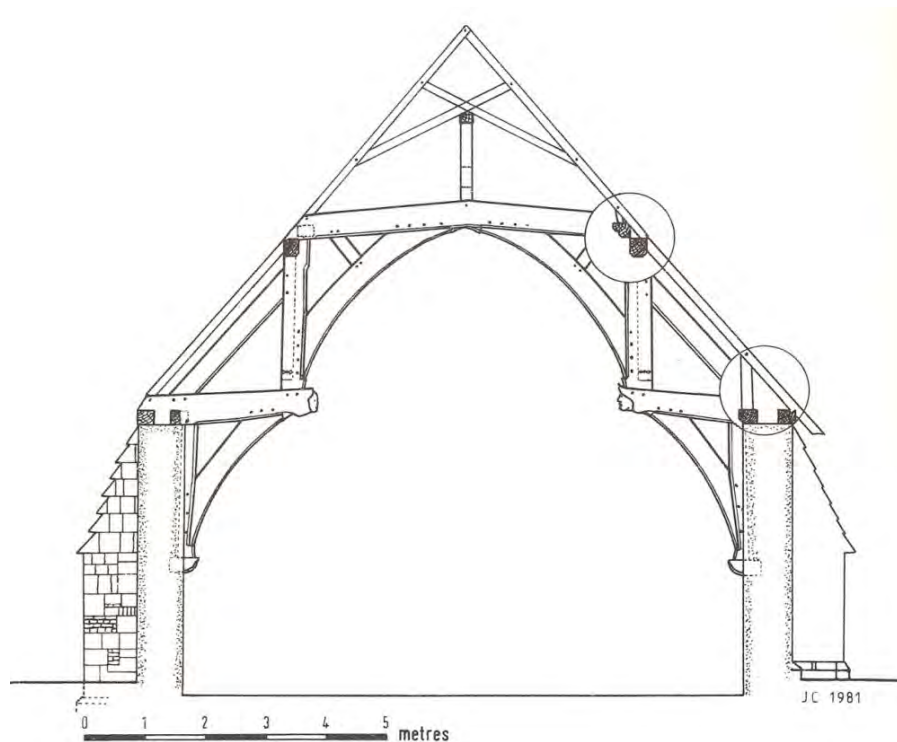


Fig. 2.12b: Demonstration of how hammer-beam construction enables the aisle posts to be removed and the building to remain standing. It is interesting to see how the aesthetic is transformed. 12a conveys a sense of verticality and lightness; 12b a squat bulkiness. Yet the proportions, and the dimensions of the timbers, remain the same.



Figs. 2.13: Pilgrims Hall, Winchester, 1310-11d; below: truss IV from north.
(Drawing J. C. Crook, 1981)

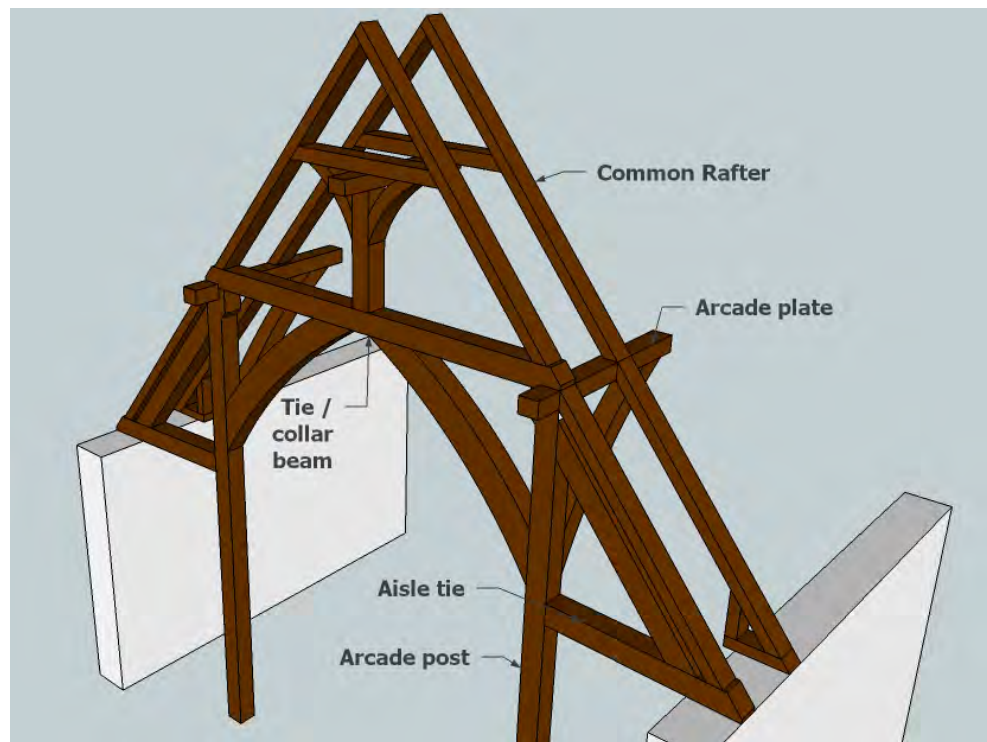


Fig. 2.14: Generic medieval aisled construction.

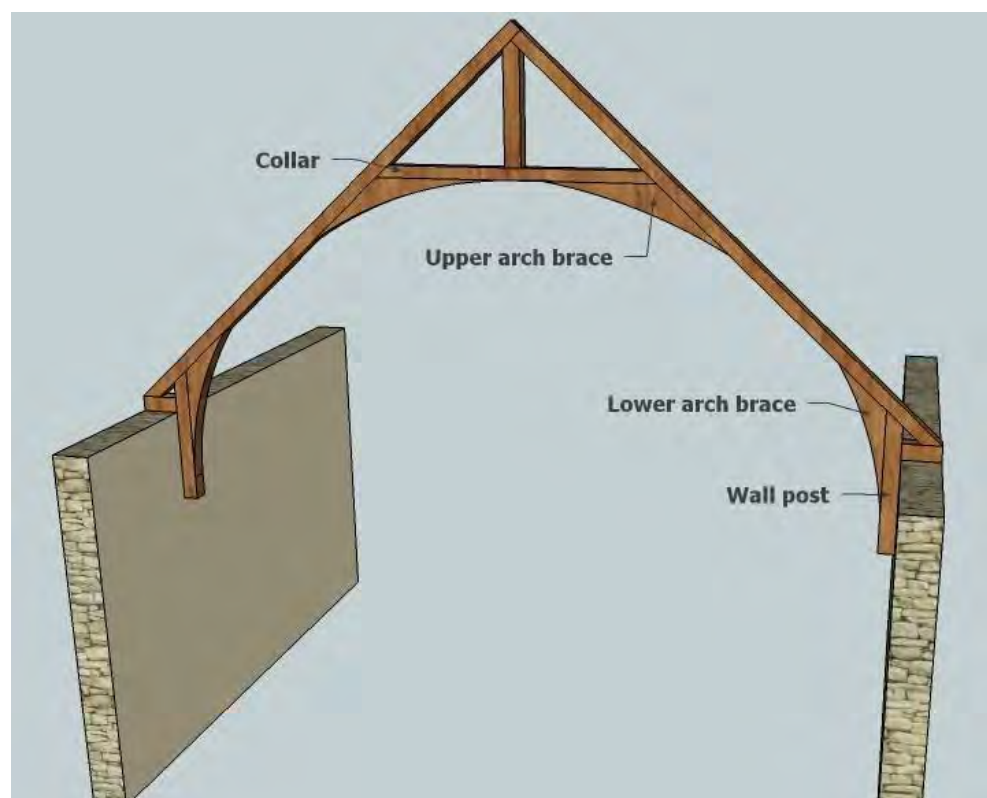


Fig. 2.15: Generic arch-braced frame.



Fig. 2.14: Bishop' Kitchen, Chichester, c.1300, possibly earlier.
(Nineteenth-century illustration from, Haslam, 1986. © Country Life)

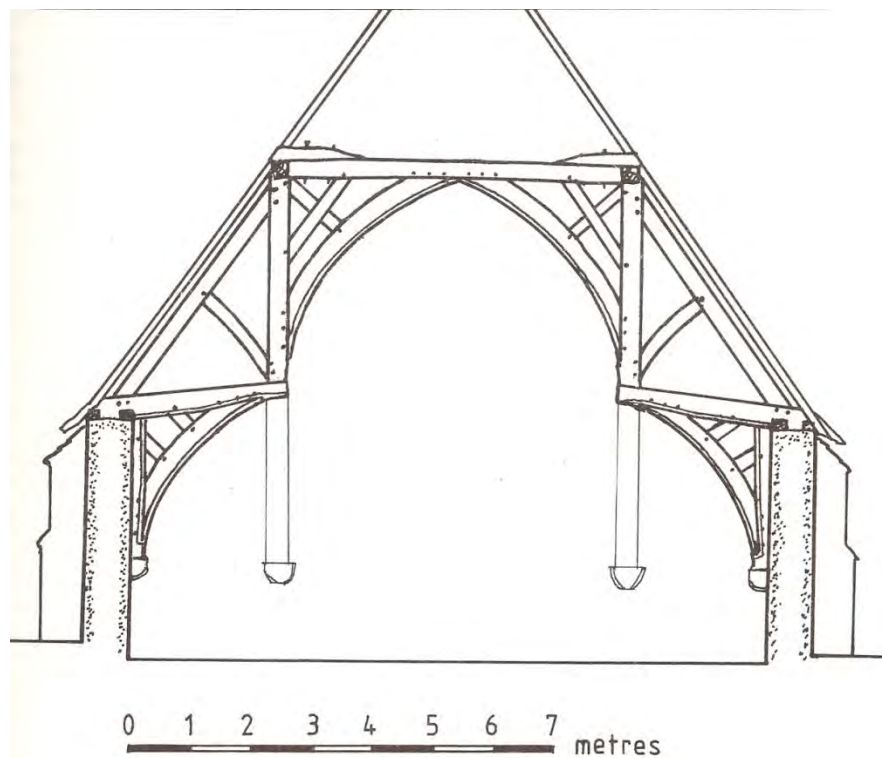


Fig. 2.15: The Bishop's Kitchen.
(From Crook, 1991)

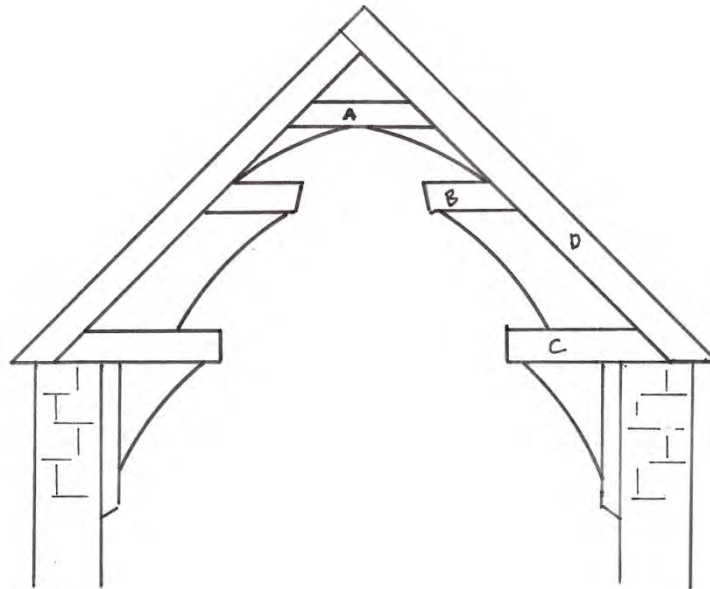


Fig. 2.16: Representation of 'false', double hammer-beam truss.

A: collar B: upper hammer beam C: lower hammer beam D: principal rafter.

Structurally 'false' elements: the upper arch braces spring from the principal rafter to support the collar (a), not from hammer beam (b); the hammer beams are tenoned *into* the principal rafter. Note two tiers of hammer beams, which renders this a 'double' hammer-beam truss.

(Features exaggerated for illustrative purposes.)



Fig. 2.17: Tilney All Saints Church, fifteenth-century, Norfolk. 'False' double hammer-beam carpentry in the upper tier of hammer beams. Visible are the metal tie-rods inserted to rectify the poor capacity of this structure to counteract lateral thrust.



Fig. 2.18: Wetherden Church Suffolk, late fifteenth-century.

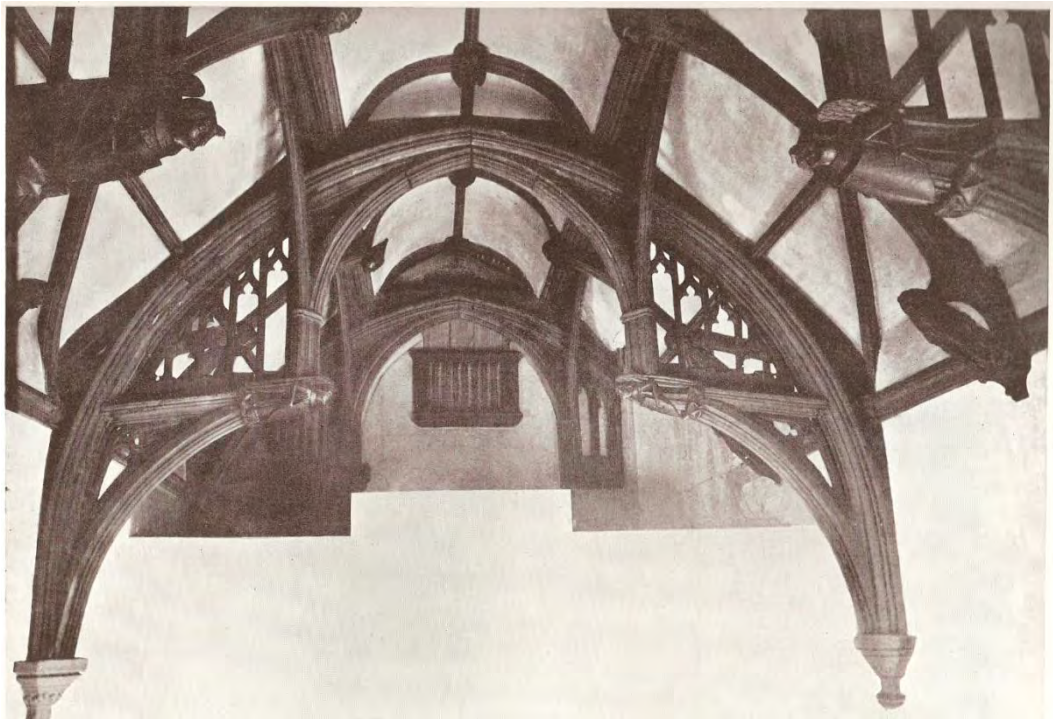


Fig. 2.19: Exeter Law Library, probably late 15th century.



Fig. 2.20: Exeter Law Library, detail of hammer-beam bracket.
(Cescinsky & Gribble)



Fig. 2.21: Cadhay House, Devon, C16.
(Photograph courtesy of John Walker)

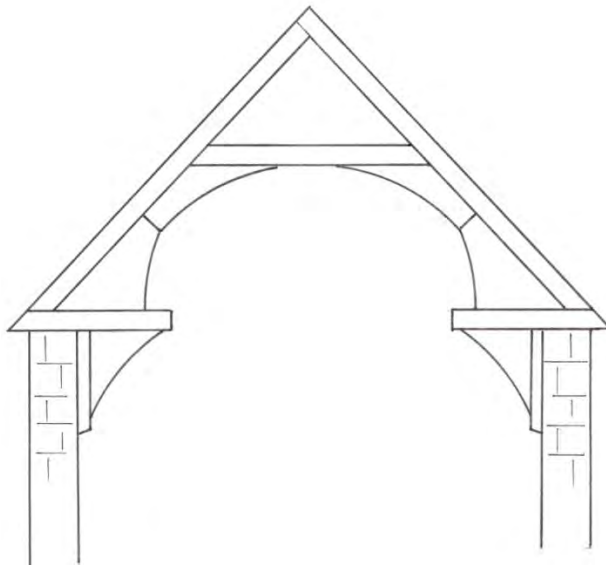


Fig. 2.22: 'False' Hammer-beam, after Cordingley's Fig. 2. 10, IV c.

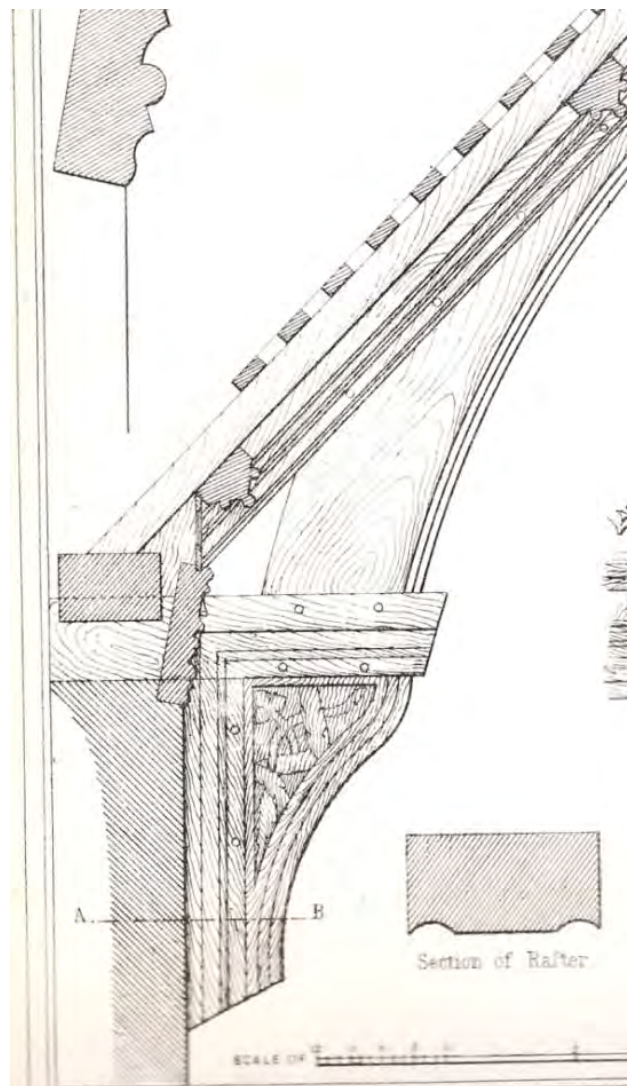


Fig. 2.23: Church of St Mary, Capel St Mary, Suffolk, C15.
Detail of hammer beam configuration.
(From Brandon)



Fig. 3.1: Brandon category 1: Church of St Mary Magdalene, Little Welnetham, Suffolk.

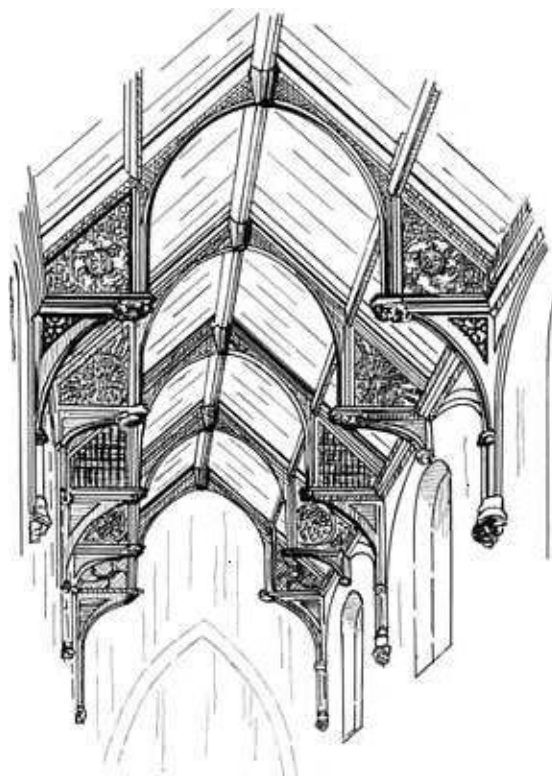


Fig. 3.2: Brandon cat. 2, Church of St Botolph, Trunch, Norfolk.

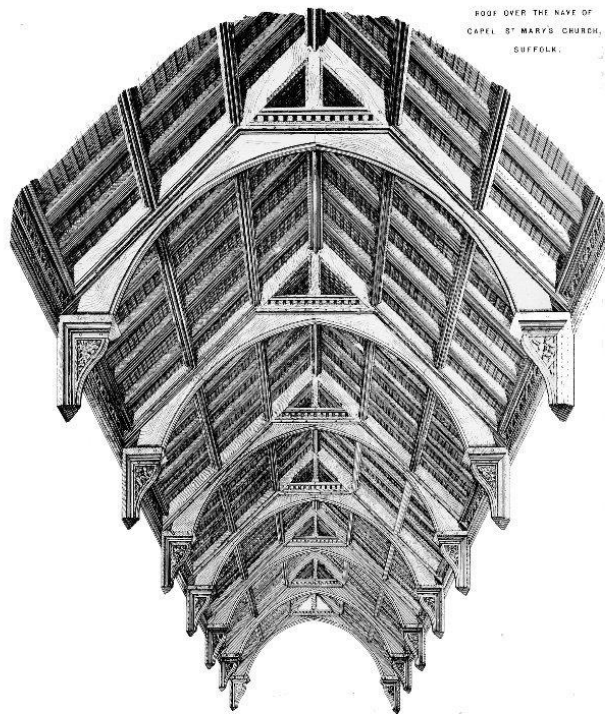


Fig. 3.3: Brandon cat. 3, Church of St Mary, Capel St Mary Suffolk.

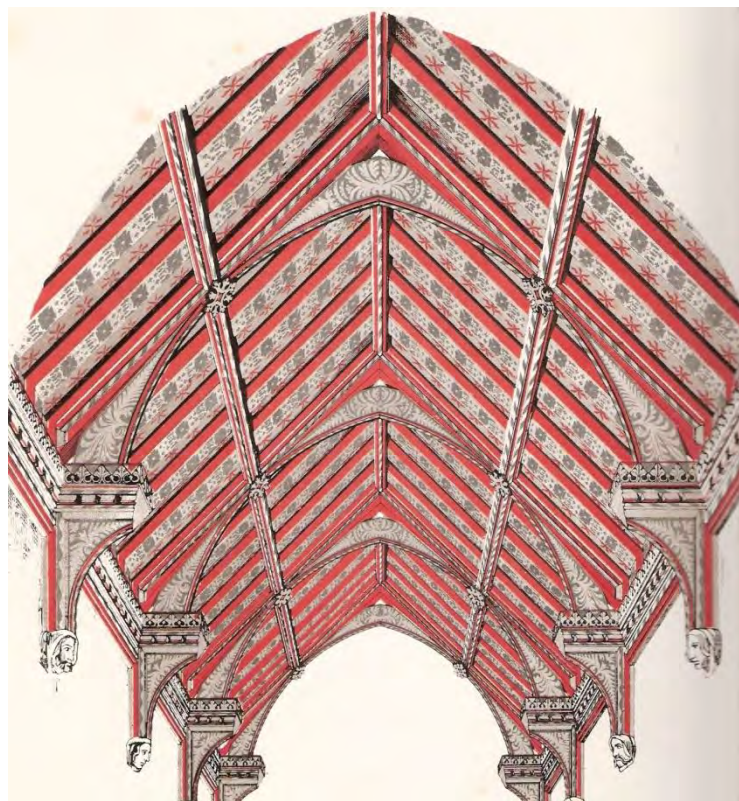


Fig. 3.4: Brandon cat. 4, Church of St Peter, Palgrave, Suffolk



Fig. 3.5: Chapel of St Thomas, Wymondham, Norfolk, probably sixteenth-century.



Fig. 3.6: St Peter Mancroft, Norwich, c.1431.

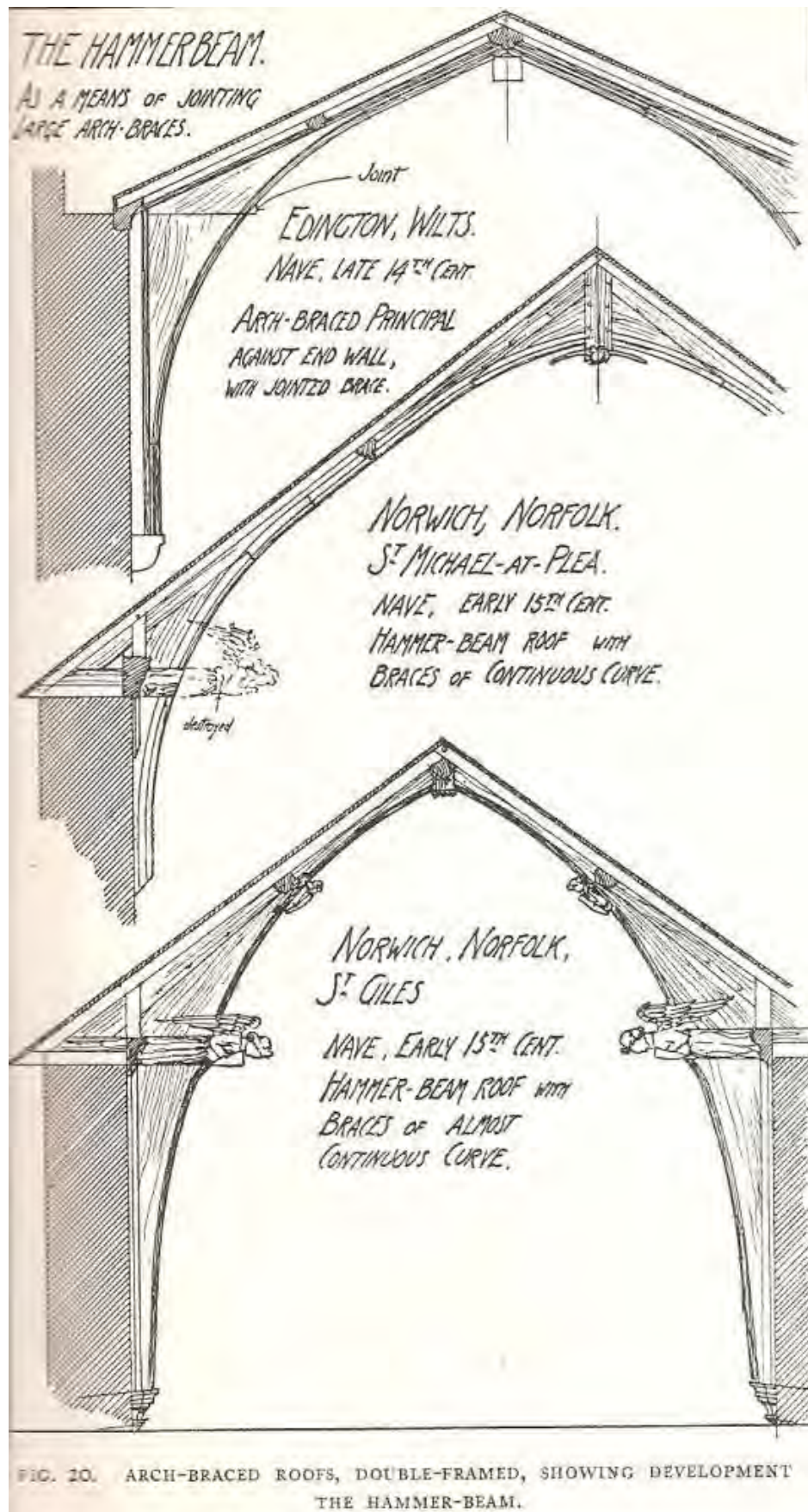


Fig. 3.7: Development of the hammer-beam roof as proposed by Howard.



Fig. 3.8: Edington Church, Wiltshire. Top: nave, looking east; below: detail of jointed arch brace. The main structure of the church dates to the mid fourteenth century, but the date of the roof is uncertain.



Fig. 3.9: The arch-braced roof of the nave of Tunstead Church, Norfolk, C15.
(Brandon)

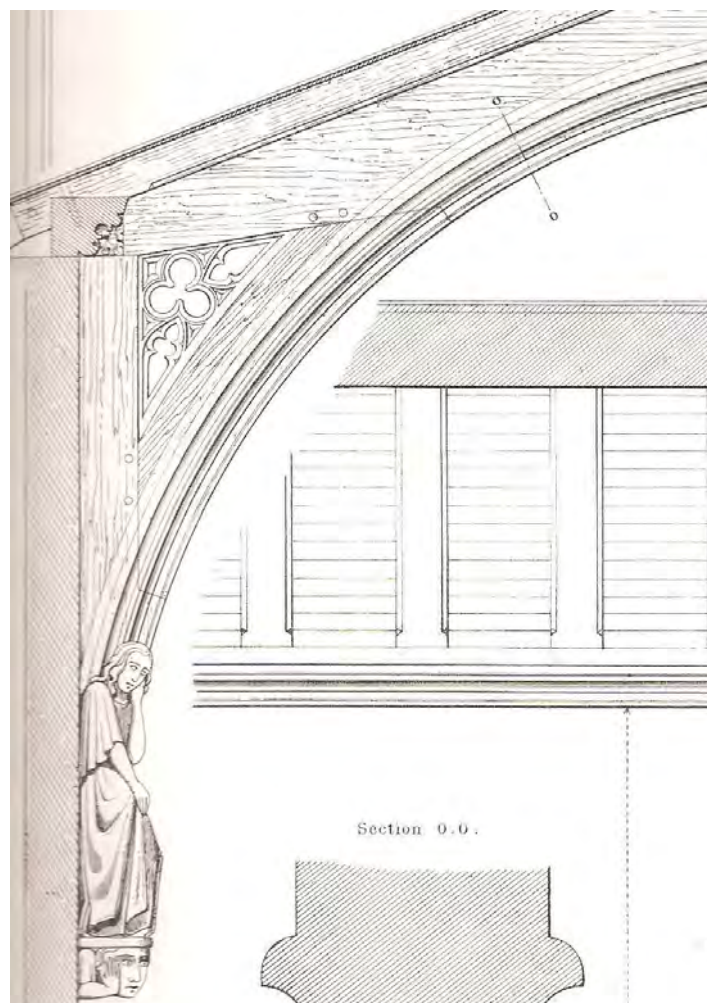


Fig. 3.10: Tracery-filled spandrel, St Martin's, Leicester, south aisle, fifteenth-century.
(Brandon)



Fig. 3.11: Arch-braced collar roof in the hall of St Cross Hospital, Winchester, 1444 ± 7d.



Fig. 3.12: Tuddenham St Martin Church, Suffolk, detail of nave roof, fifteenth-century.



Fig. 3.13: Mildenhall Church, Suffolk, detail of nave roof, c. 1420-30.

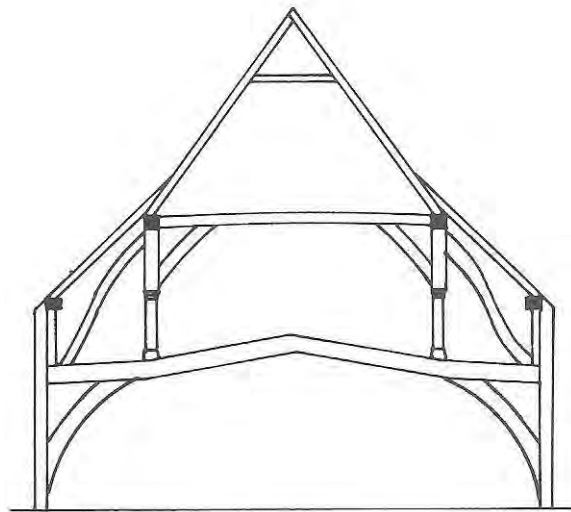


Fig. 3.14: Method of removing arcade posts: a 'raised aisle' hall, Gate House Farm, Felsted, Essex, c.1300
(From Smith, 1970)

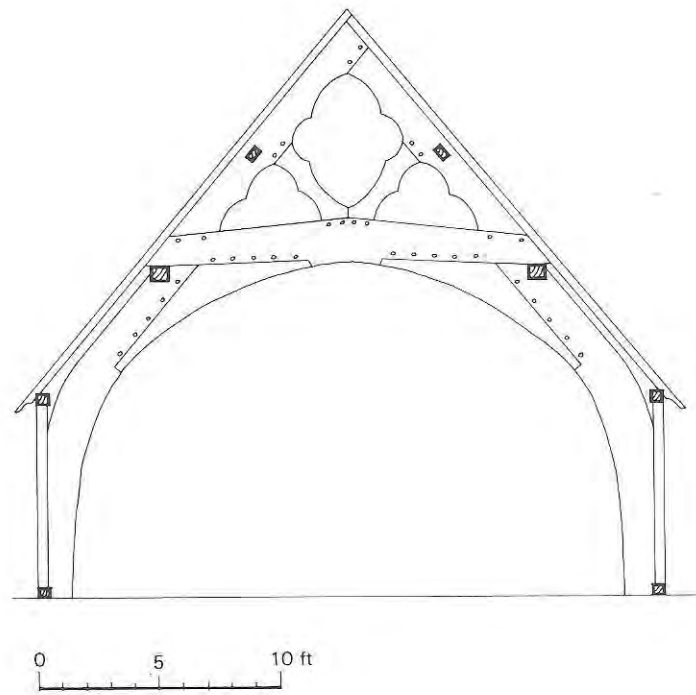


Fig. 3.15: Method of removing arcade posts: 'base cruck', Amberley Court nr. Hereford, Early C14.
(Charles, 1984)



Fig. 3.16: Pilgrims' Hall. Note longitudinal bracing from base of hammer post to arcade plate, a configuration typical of aisled construction.

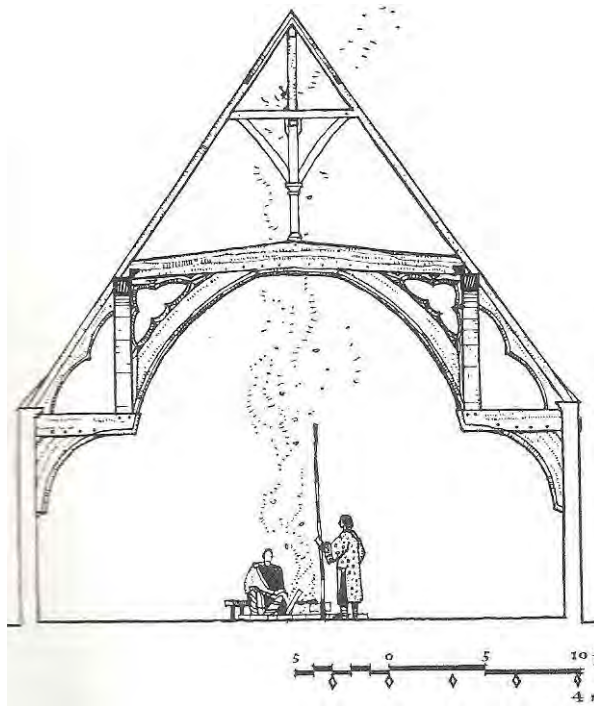


Fig. 3.17: Tiptofts, Wimbish, Essex, 1308±21d, transverse section of hall.
(From Wood, 1983)

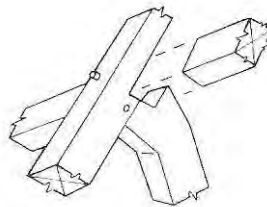


Fig. 3.18: 'Clasped purlin' construction
(From CBA)

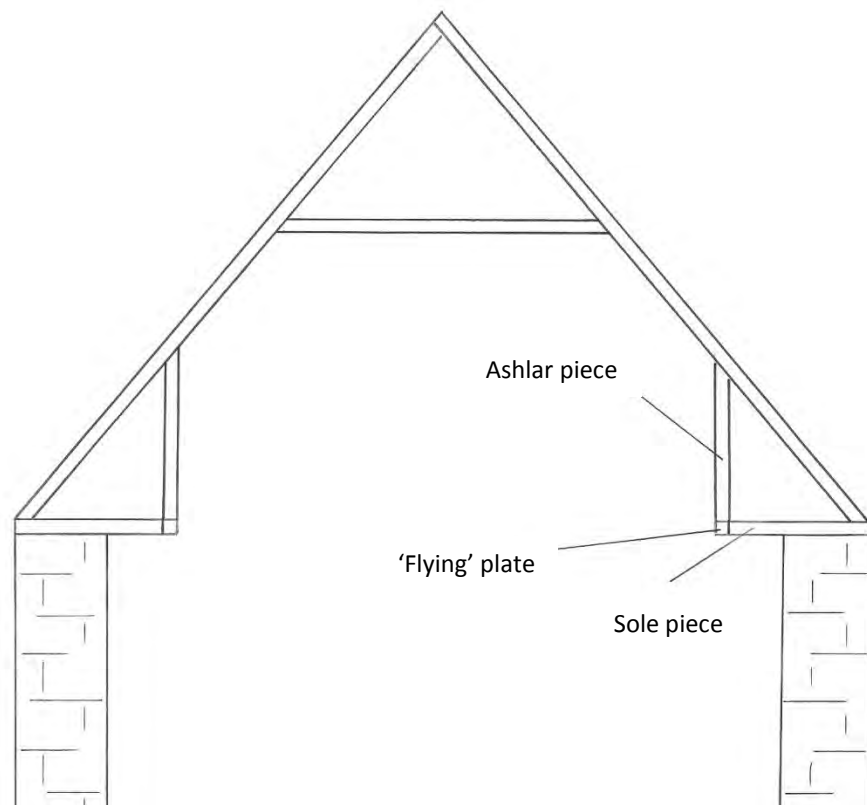


Fig. 3.19: Generic example of extended sole piece / flying plate construction

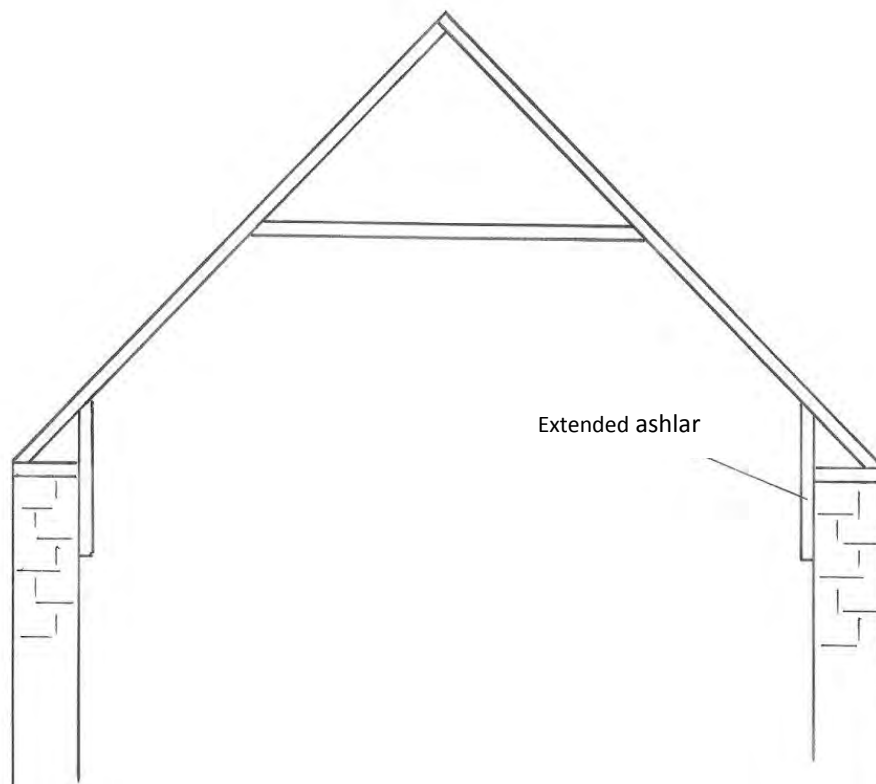


Fig. 3.20: Generic example of extended ashlar construction.



Fig. 3.21: Extended Ashlars *in situ*, Bradford on Avon Tithe Barn, Wiltshire, 1334-79d.

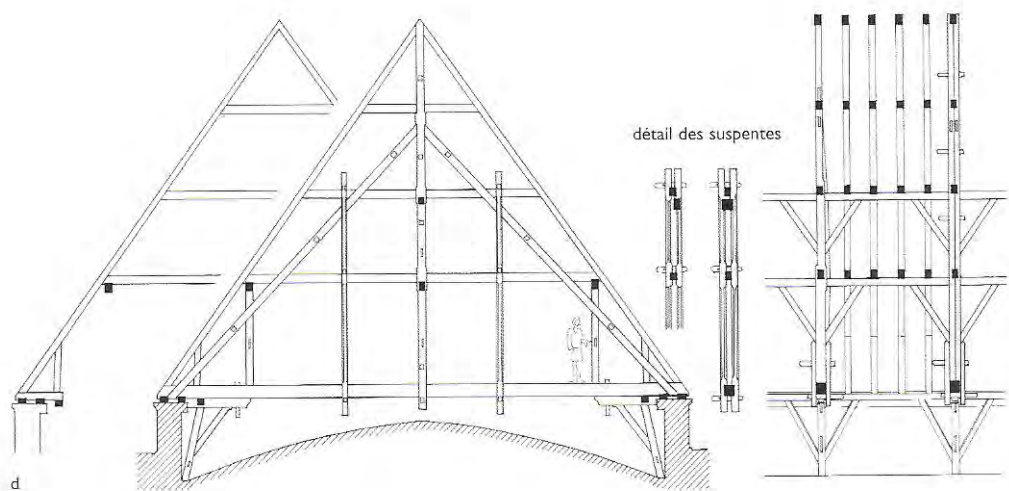


Fig. 3.22: 'Saddle' brackets, nave roof of Notre Dame, Paris, c. 1220d. The saddle brackets are the two lowest components supporting either end of the tie-beam.
(Hoffsummer, 2009)

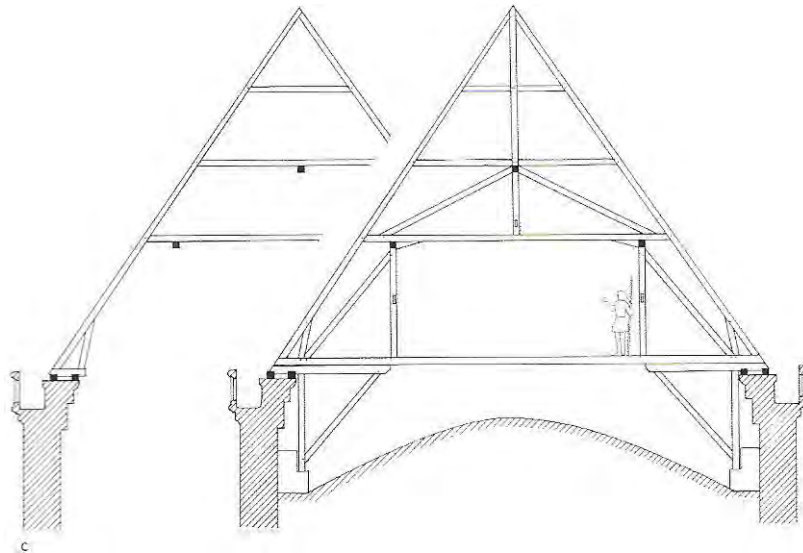


Fig. 3.23: Meaux, St Etienne Cathedral, chancel roof, early thirteenth-century.
(Hoffsummer, 2009)



Fig. 3.24: Example of extended sole piece construction, Wingfield Church, Suffolk, nave, c. 1415. The internal 'wall plate' is a moulded cornice.



Fig. 3.25: Extended sole piece construction, nave of Cawston Church, Norfolk, mid C15.
Ingression of the rafter foot is greater, facilitating a more elaborate cornice.



Fig. 3.26: Extended sole piece construction in a hammer-beam roof, St Mary at Quay, Ipswich, chancel, mid fifteenth-century.



Fig. 3.27: Medieval bracketed structure: staircase, Great Hall, Stokesay Castle, c. 1290.



Fig. 3.28: Medieval bracketed structure: jettying on north tower, Stokesay Castle, c. 1290.
Interestingly, a number of these brackets have no corbels.

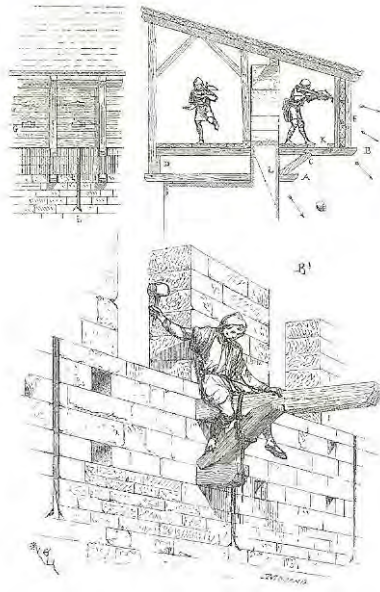


Fig. 3.29: Carpenters understood the function of brackets sufficiently to construct wooden fortifications.
(From Viollet-le-Duc)

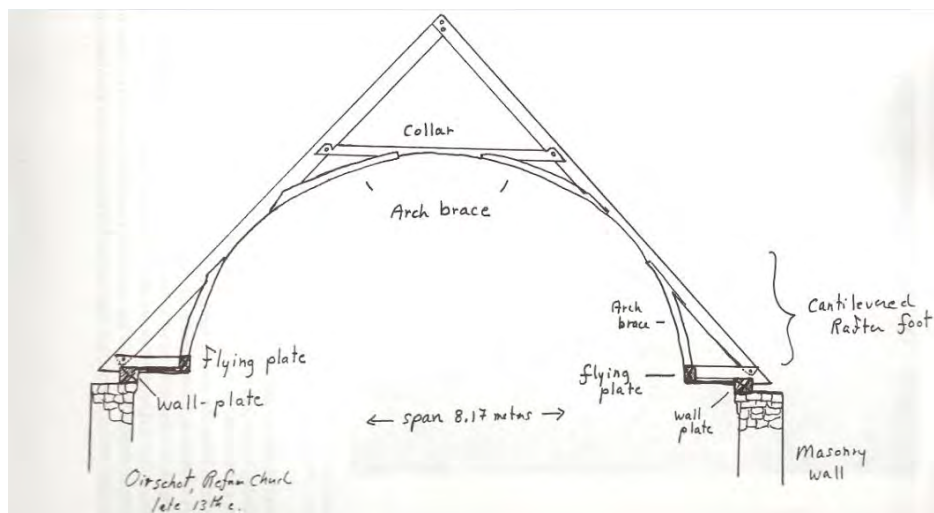
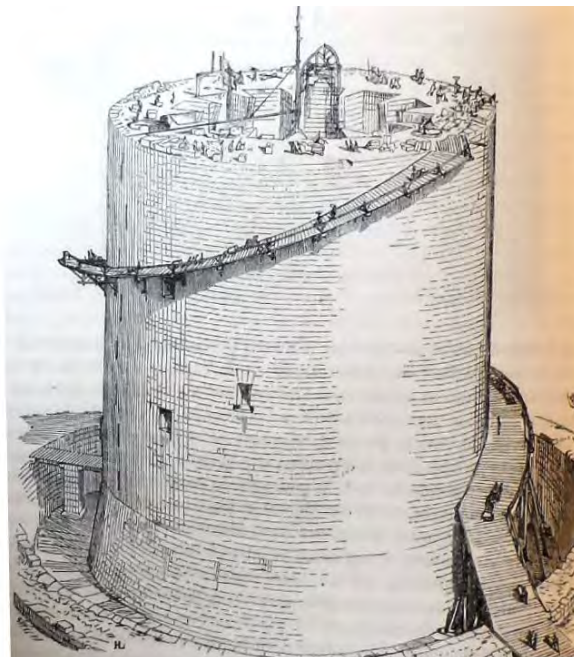
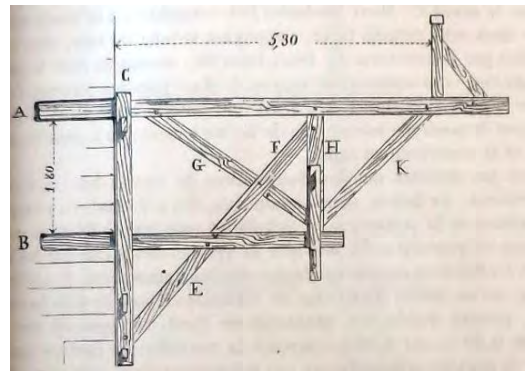
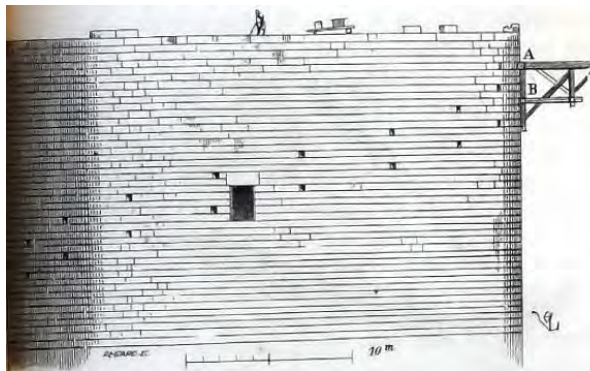


Fig. 3.30: Oirschot Reform Church, Netherlands, c. 1290.
(Courtenay, 1985)



Fig. 4.1: Fourteenth-century scaffolding, and detail.
(British Library, Egerton MS. 1894, fol. 5v.)



Figs. 4.2-3: Antoine Moles's suggestions for how timber brackets may have been used to construct a round tower (1949).



Fig. 4.4: Projecting timber-framed structure supported by brackets, second half of fourteenth century.
(British Library, Egerton MS. 3277, fol. 120v)



Fig. 4.5: Medieval lifting device, c. 1327-35
(British Library, Add MS. 47682, fol. 27.r)



Fig. 4.6: Sketches of roofs, Villard De Honnecourt, c. 1220-50, fol. 17r.
(Hahnloser)

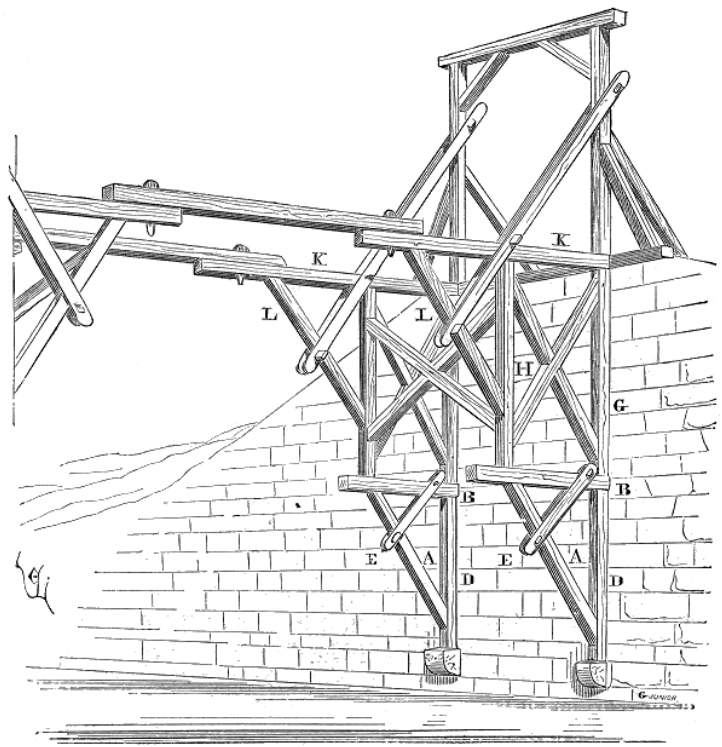


Fig. 4.7: Left, sketch of a bridge, Villard De Honnecourt, fol. 20r (Hahnloser). Right, conjectural drawing of Villard's bridge in Viollet-le-Duc, *Dictionnaire...* (1854).

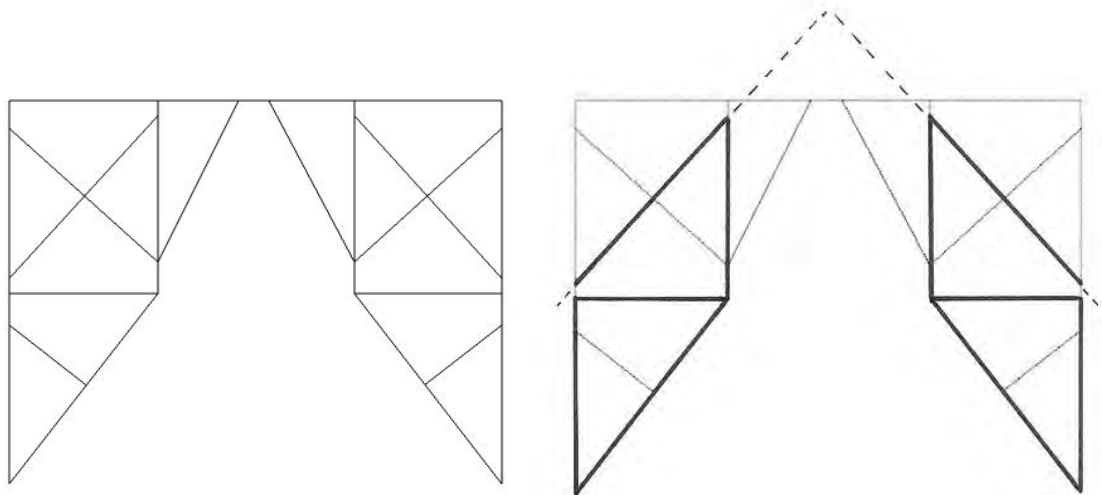


Fig. 4.8: Villard's Bridge. Emboldened lines, right, show how similar framing techniques and the elongation of timbers would result in a hammer-beam cross frame. The lower diagonal timbers would usually be arcuated.



Fig. 4.9: Stokesay Castle, corbelled wall posts and struts against south gable.



Fig. 4.10: The Old Deanery, Salisbury, c. 1265.
(Drinkwater)



Fig. 4.11: Old Soar Manor, Plaxtol, Kent, corbelled wall post and strut in the solar, late thirteenth-century.



Fig. 4.12: Great Coxwell Barn, Oxfordshire, framing on south gable, 1300-1310d.

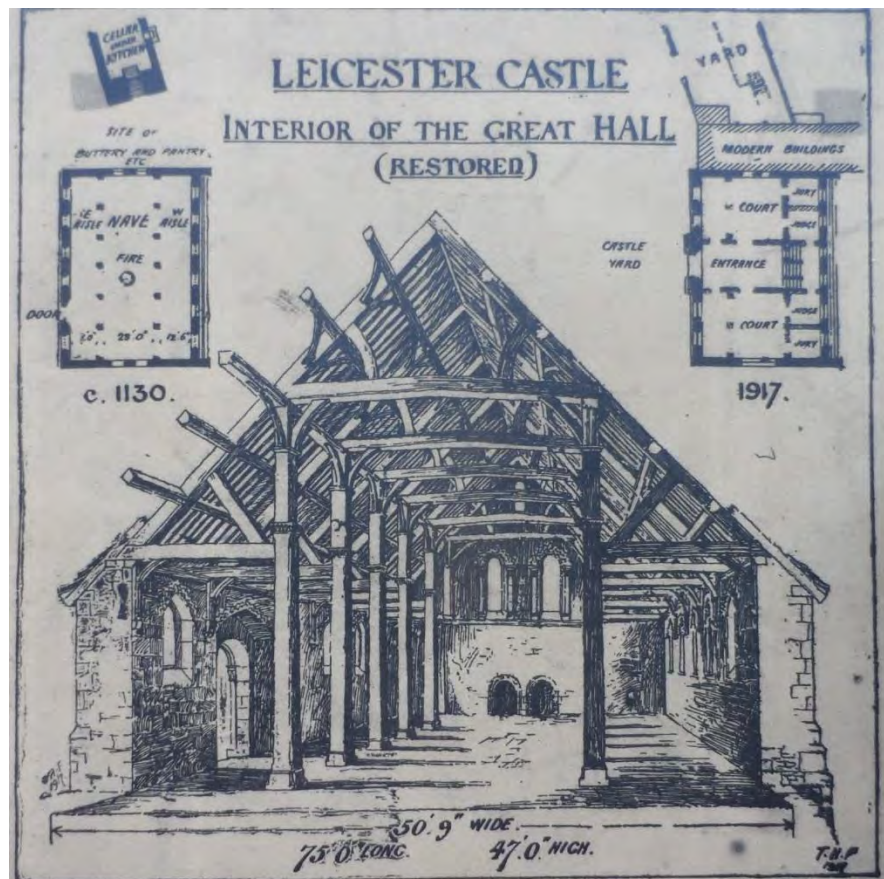


Fig. 4.13: Leicester Castle, Great Hall c. 1150d. The aisle ties arch-braced to corbelled wall posts are just visible. (Reconstruction by Thomas Fosbrooke, 1919)



Fig. 4.14: Great Coxwell Barn, aisle-ties arch-braced to corbelled wall post, west wall.



Fig. 4.15: Aisle tie and hammer-beam framing, barn, Ter Doest Abbey, Lissewege, Belgium, 1365-85d.
(<http://visitbruges.be>)

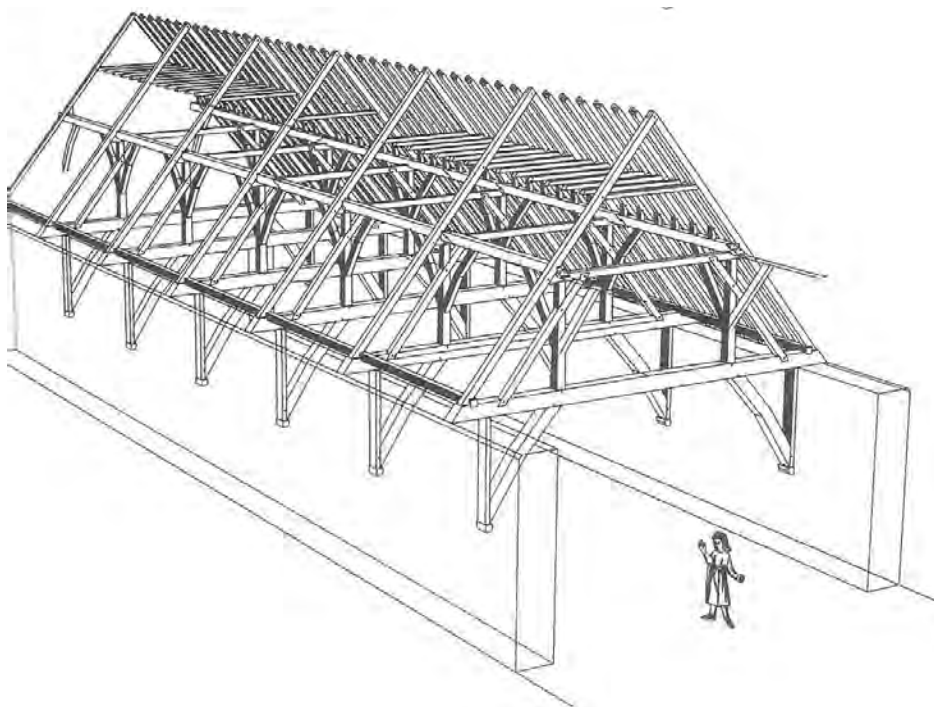


Fig. 4.16: Wherwell Abbey, Hampshire, probable infirmary, 1250-80d
(John Walker)



Fig 4.17: Great Coxwell Barn, 'germinal ... hammer-beam', detail of framing in intermediate frame.

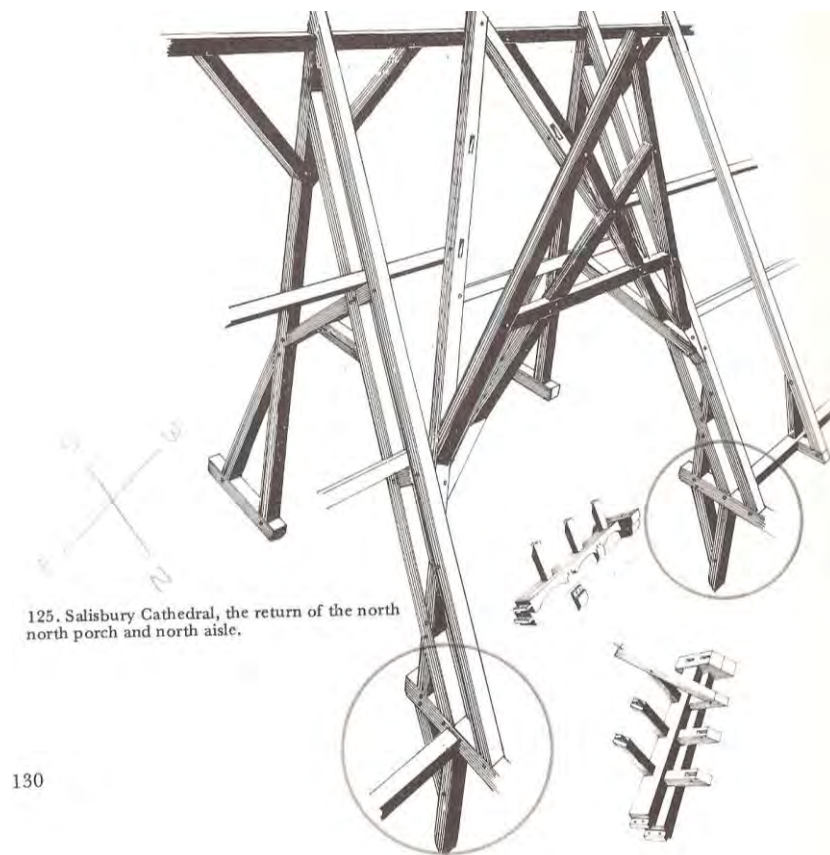


Fig 4.18: Salisbury Cathedral, conjunction of north triforium and north porch roofs, 1252d.
(Hewett, 1985)



Fig. 4.19: Salisbury Cathedral, conjunction of north triforium and north porch roofs, detail of bracket. Walkway to left is a later insertion.



Fig. 4.20: Chichester Cathedral, roof of the north aisle of the choir, possibly late thirteenth-century.



Fig. 4.21: Chichester Cathedral, roof of the north aisle of the choir, detail of framing.

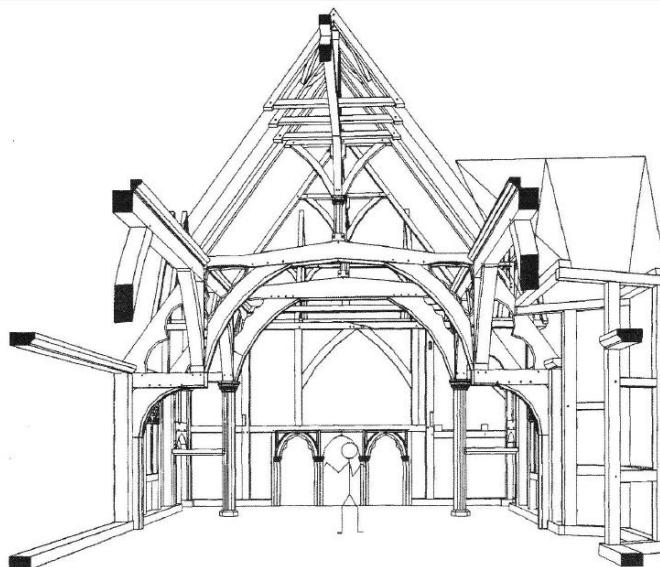


Fig. 4.22: Tiptofts Manor, reconstruction of the hall looking towards the service end.
(VAG/John Walker)

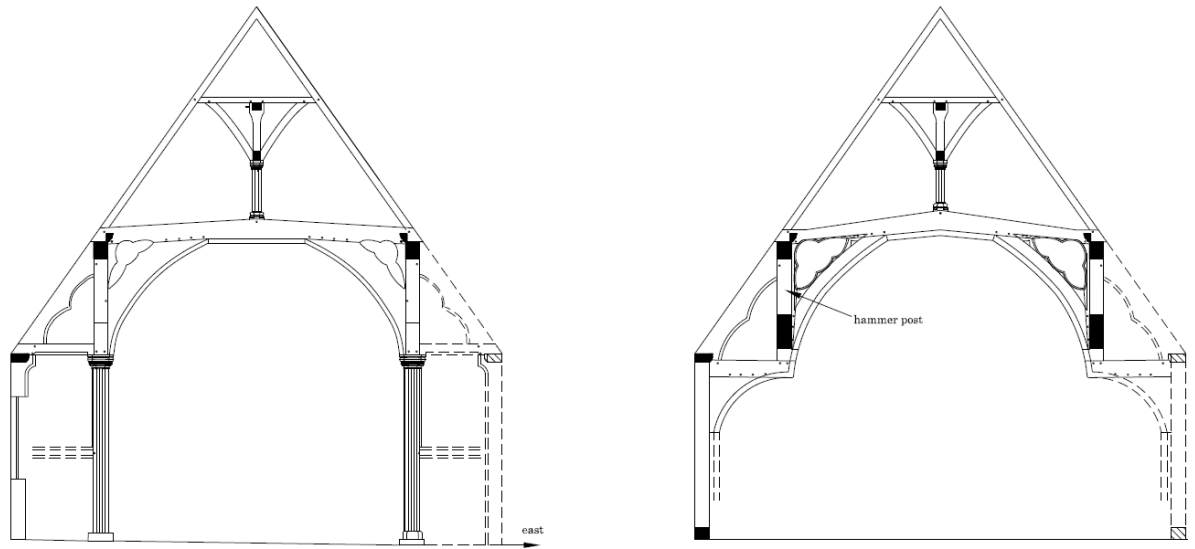


Fig. 4.23: Tiptofts, spere truss (left), and hammer-beam frame
(John Walker)

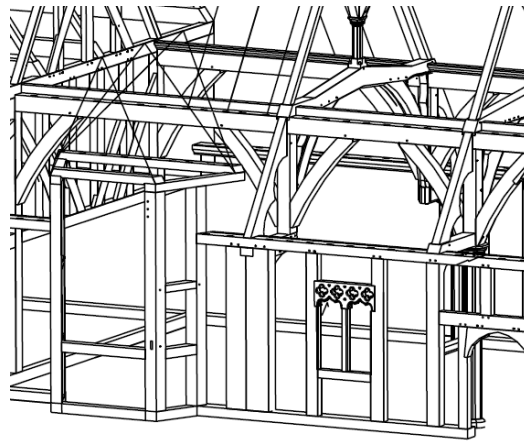


Fig. 4.24: Tiptofts, from the south-east. Detail of wall post framing. Compare the increased dimensions and doubling of the wall posts in the hammer-beam frame (centre) with the post in the spere truss (right).
(John Walker)



Fig. 4.25: Kitchen of the Bishop's Palace, Chichester.



Fig. 4.26: Gainsborough Old Hall, Lincolnshire, roof framing of the kitchen, 1462-70.

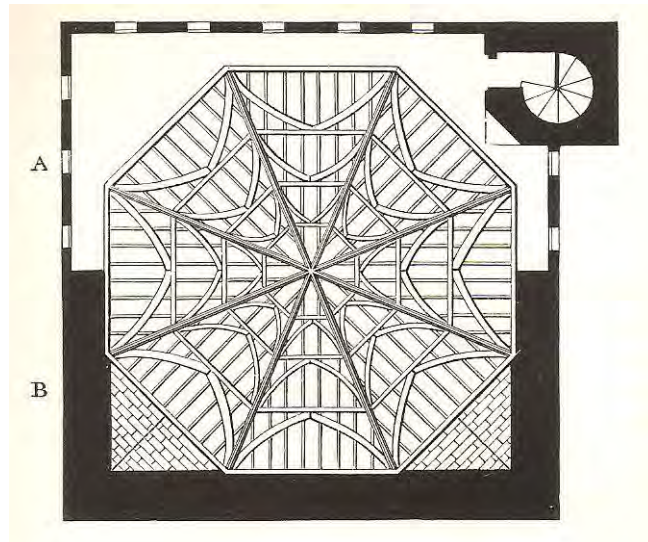


Fig. 4.27: Stanton Harcourt Manor, Oxfordshire, plan of kitchen roof, c. 1485.
(Parker, 1859)



Fig. 4.28: Candle and taper burns on oak lintel, kitchen, Gainsborough Old Hall.

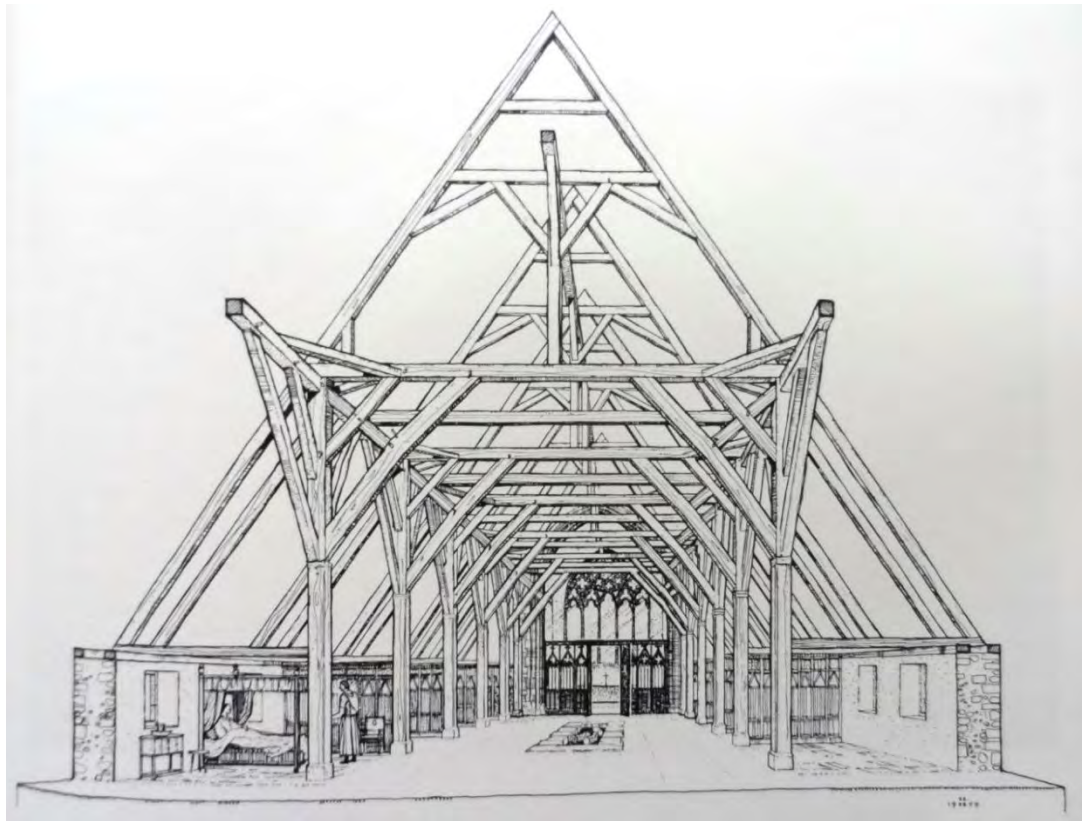


Fig. 4.29: St Mary's Hospital, Chichester, c. 1290. Presumed original internal arrangement. Note how the aisle ties, with the attached drapes, serve to compartmentalise the bays. (Horn and Born, *St Gall*, Vol II)

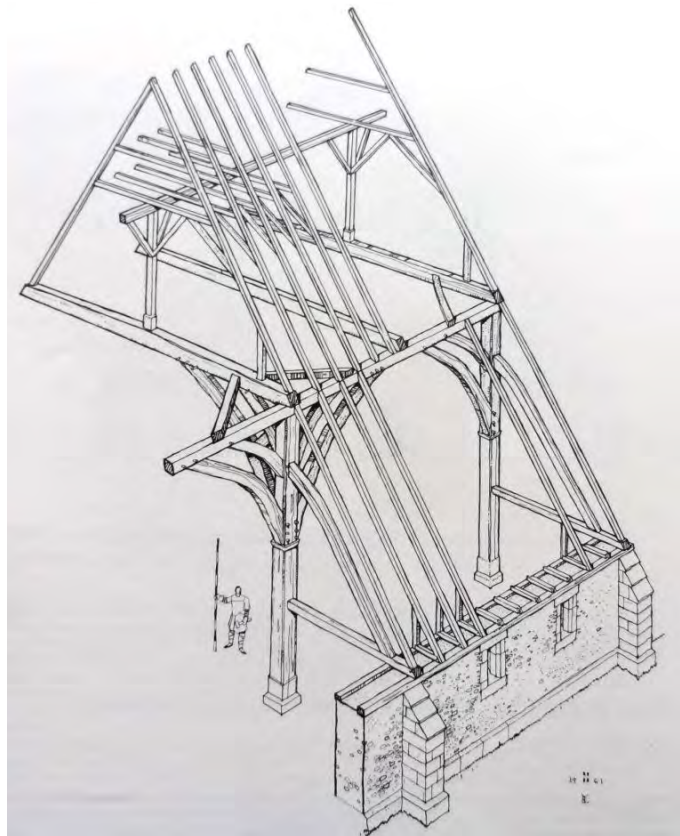


Fig. 4.30: St Mary's Hospital, Chichester, axiometric view of framing details. (Horn and Born, *St Gall*)



Fig. 4.31: Late thirteenth-century Chichester Carpentry. Left: St Mary's Hospital, arcade post framing; Right: Bishop's Kitchen, hammer-beam arrangement

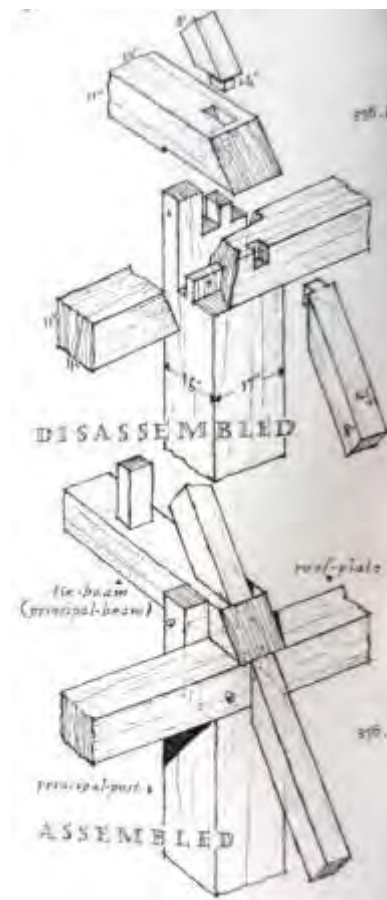


Fig. 4.32: St Mary's Hospital, framing details at head of arcade post.
(Horn and Born, *St Gall*)

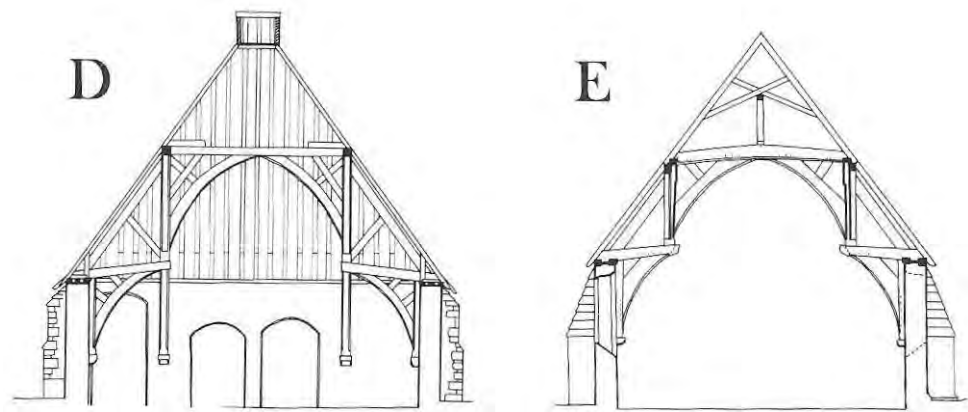


Fig. 4.33: Bishop's Kitchen (left) and Pilgrims Hall.
(Munby, 1985)



Fig. 4.34: Fordingbridge Church, Hampshire, north chapel, fifteenth-century. Angel 'hammer beams' interrupt arch braces to the tie beam.



Fig. 4.35: William Wykeham's House (the Court House), East Meon, Hampshire; hall, c. 1396.
(Roberts)

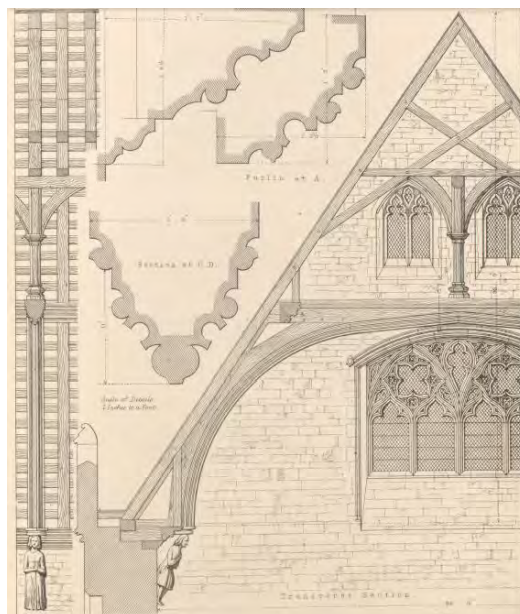


Fig. 4.36: Penshurst Place, Kent, roof of Great Hall.
(Dollman and Jobbins)

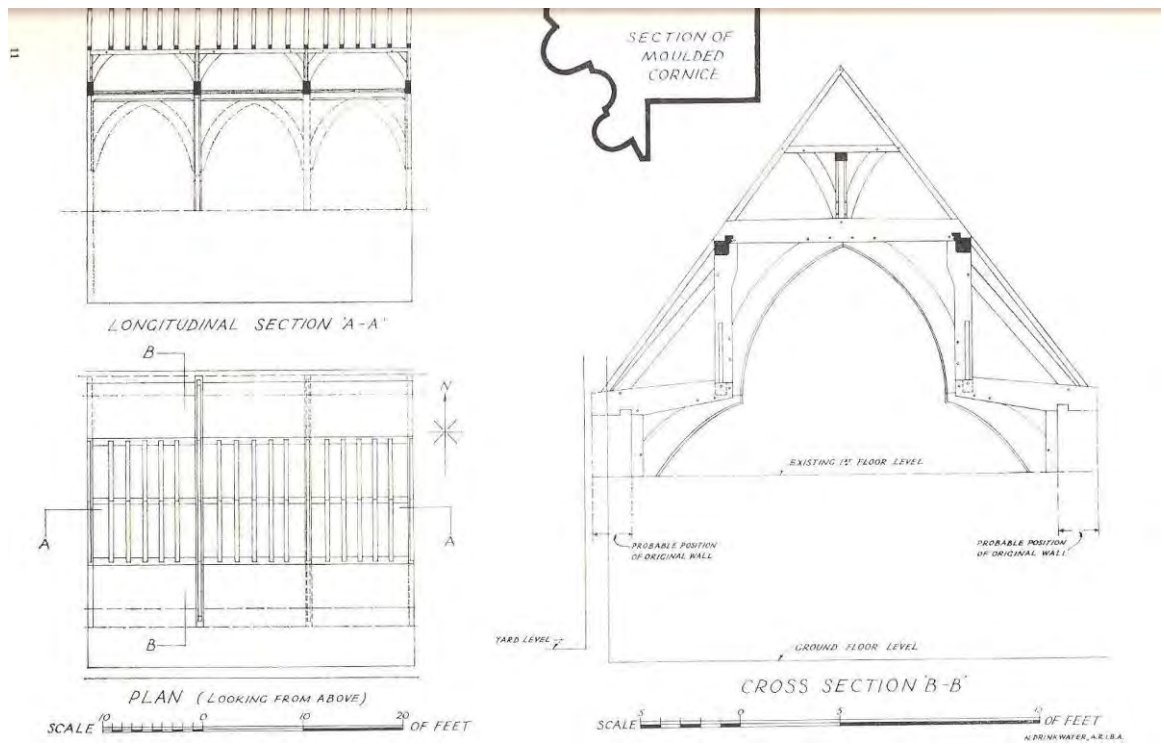


Fig. 4.37: Balle's Place Salisbury, 1370-85 (now lost).
(Bonney)



Fig. 4.38: Boxford Church, Suffolk, timber north porch, fourteenth-century.



Fig.4.39: Boxford Church, north porch, detail of shafts and 'vault' springing.

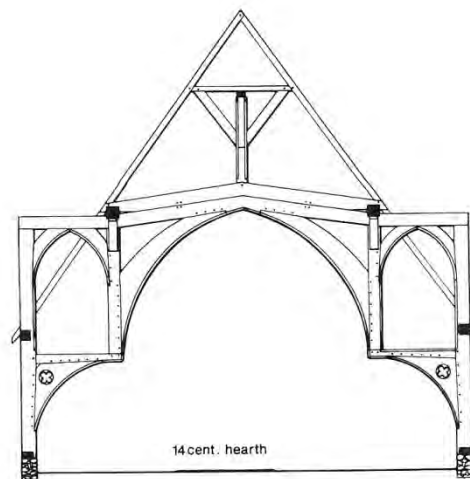


Fig. 4.40: Upton Court, Berkshire, hall, 1319-20d, archaeological reconstruction of central frame.
(Thornes and Fradgley)

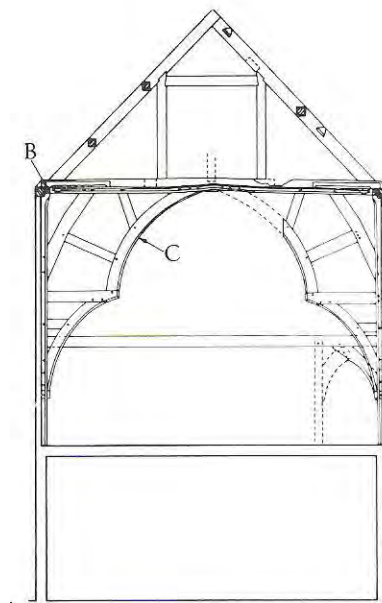


Fig. 4.41: William Russell's House, (9 Queen Street) Salisbury, transverse frame, c. 1306.
(RCHME)



Fig. 4.42: William Russell's House, detail of tie-beam bracing. Note slight scanting in comparison to structural hammer-beam framing of the Pilgrims' Hall (Fig. 3.16)

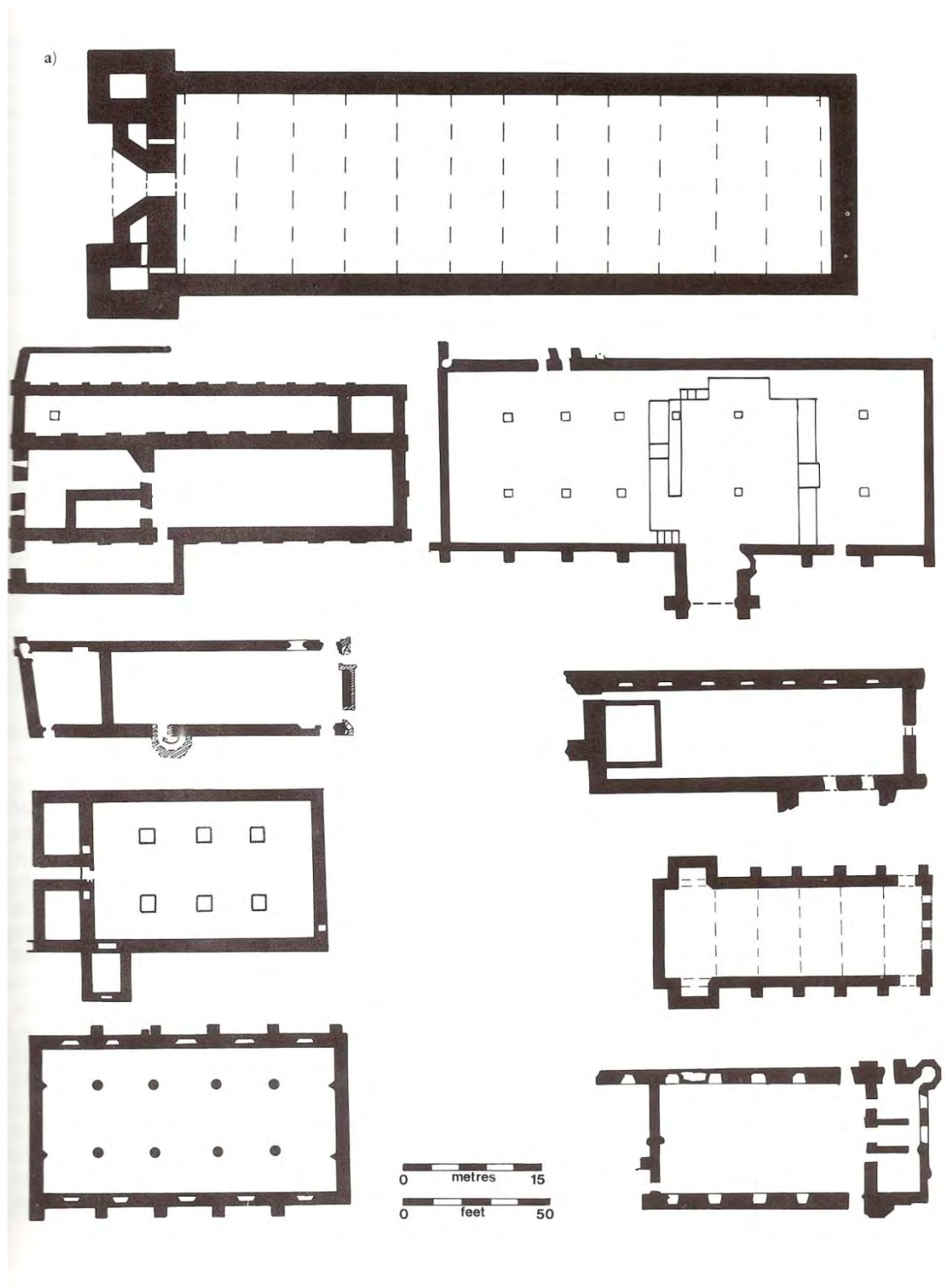


Fig. 5.1: Relative plans of English medieval great halls. Clockwise from top: Westminster Hall; Canterbury, Archbishop's hall; Windsor Castle; Eltham Palace; Hampton Court; Winchester Castle; Clarendon; Lincoln, east hall; Wolvesey Palace, east hall.
(T. B. James)



Figs 5.2 & 5.3: Westminster Hall, remains of Norman masonry in the lower portions of the west wall.

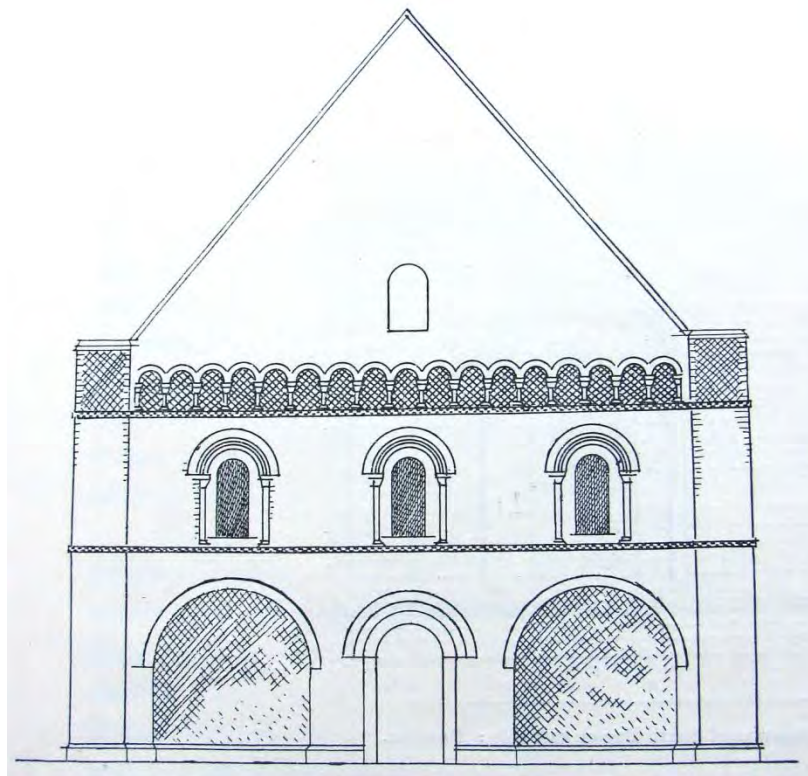


Fig. 5.4: The Great Hall of William Rufus, north elevation. As proposed by Lethaby (1906)



Fig. 5.5: Westminster Hall, east wall, interior; Norman arcading as drawn by the office of Frank Baines, HM Office of Works, 1913-14. The ghostly lines correspond with the arcading on the opposite side of the hall; the eleventh-century masons constructed the bays out of square.
(National Archives)

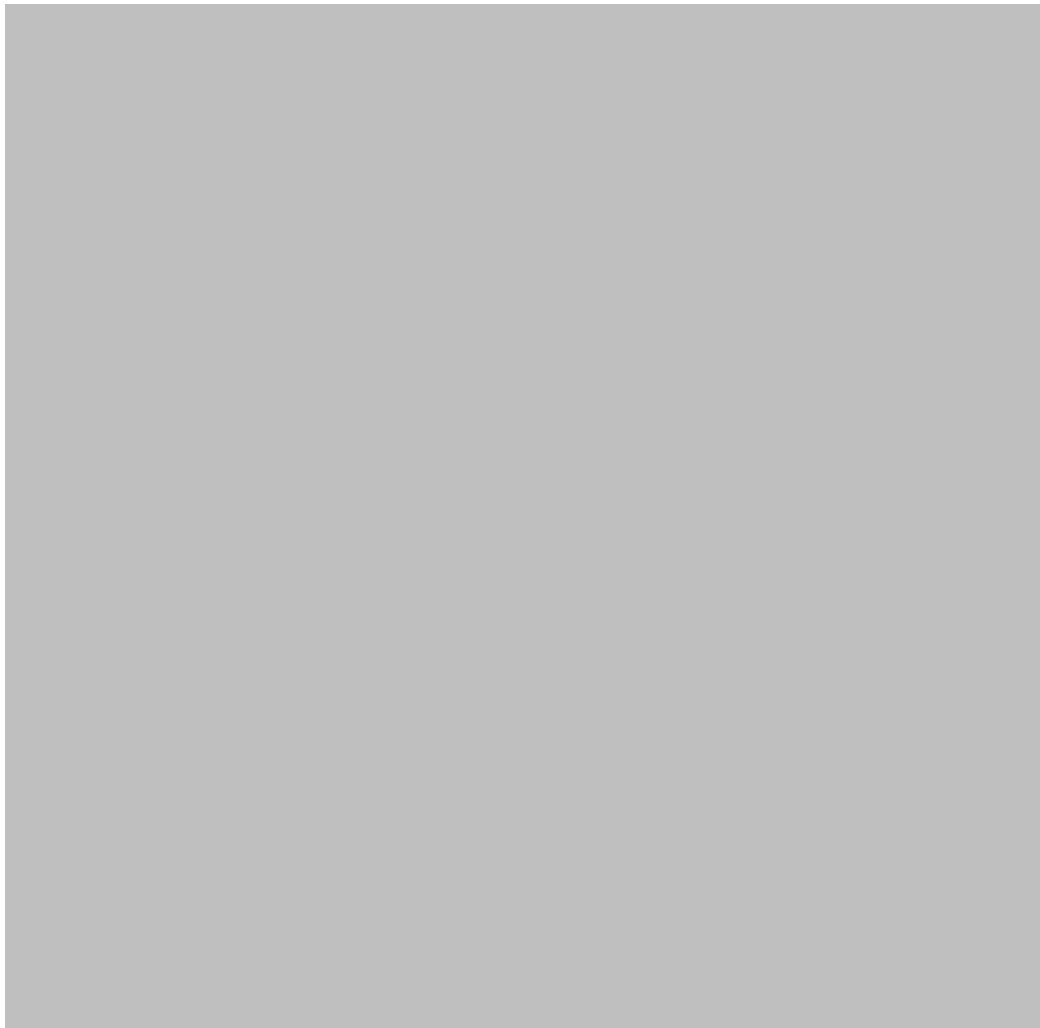


Fig. 5.6: Section through east wall showing Norman arcading, office of Frank Baines.
(National Archives)



Fig. 5.7: Winchester Cathedral, south transept, clerestory gallery.



Fig. 5.8: Oakham Castle, 1180-90.
(Parker, 1853)

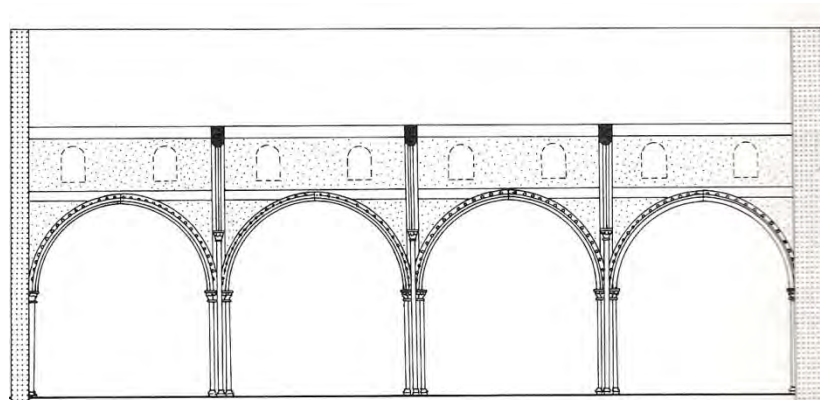


Fig. 5.9: Bishop's Palace Hereford, 1179d. Reconstruction of arcading, east wall.
(John Blair)

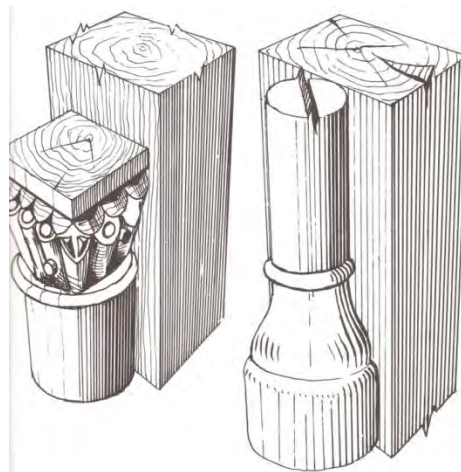


Fig. 5.10: The Bishop's palace, Hereford. Details of the arcade posts.
(Hewett, *EHC*)

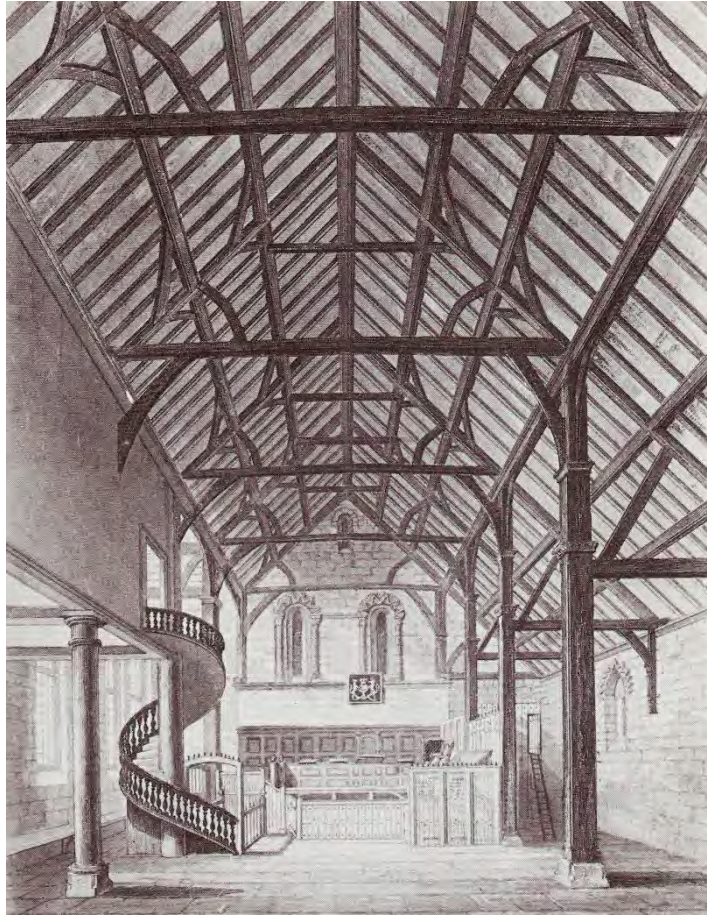


Fig. 5.11: Leicester Castle Great Hall, c. 1150d, looking south.
Early C19 illustration by Henry Goddard showing later additions and alterations, particularly on the east side, many now removed.



Fig. 5.12: Leicester Castle, aisle post, capital.
(Horn)

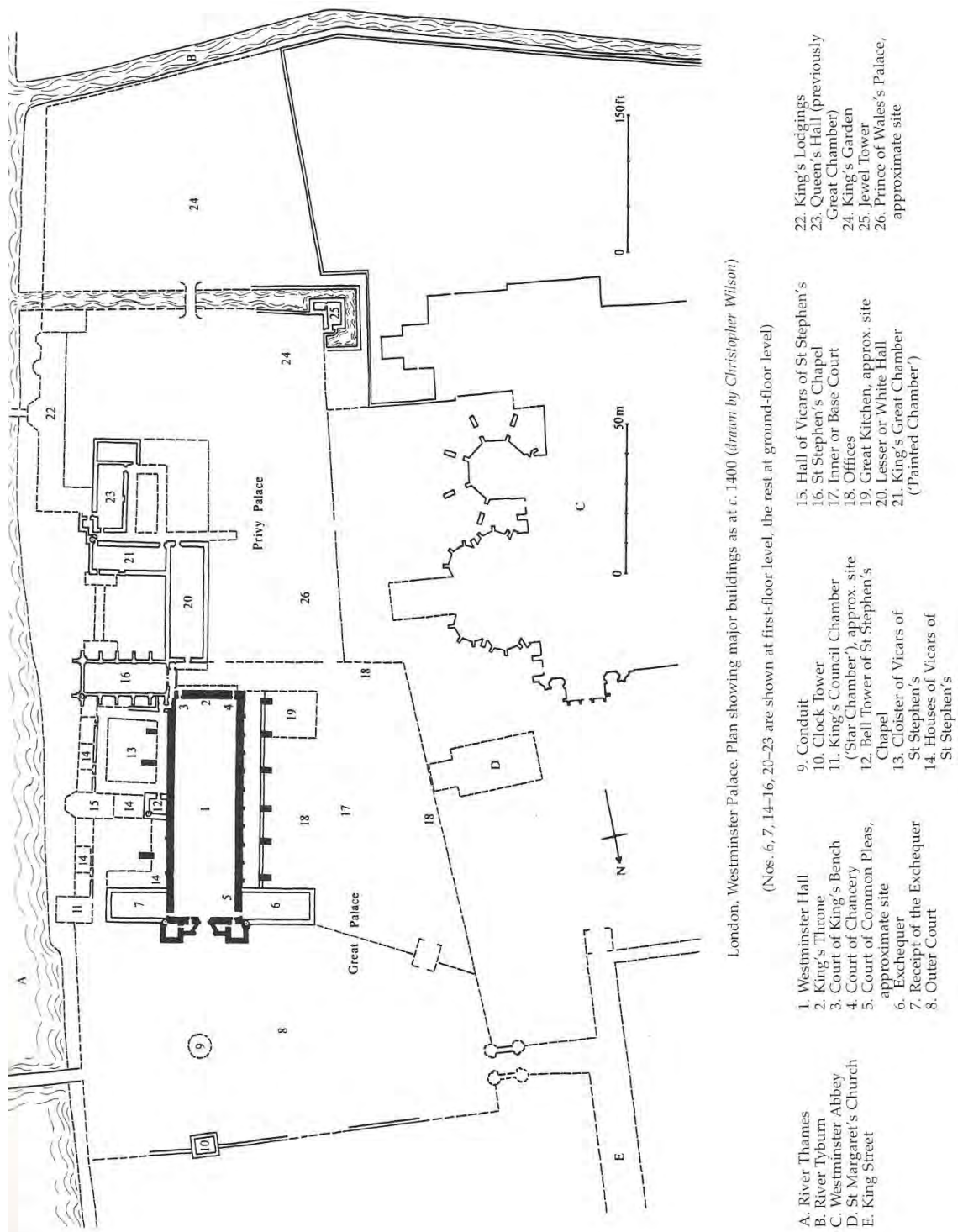


Fig. 5.13: Plan of medieval Westminster c. 1400.
(Wilson, 1997)



Fig. 5.14: Charles Mosley after Hubert-François Gravelot. *The First Day of Term*, 1738.
 Engraving, 10 $\frac{3}{8}$ x 12 $\frac{1}{2}$ in.
 (British Museum)



Fig. 5.15: Westminster Hall, south wall, statues of English kings (1385).
 (Wilson, 1997)



Fig. 5.16: The Wilton Diptych, c. 1364, detail of the kneeling Richard II.
(from Gordon, 1993)

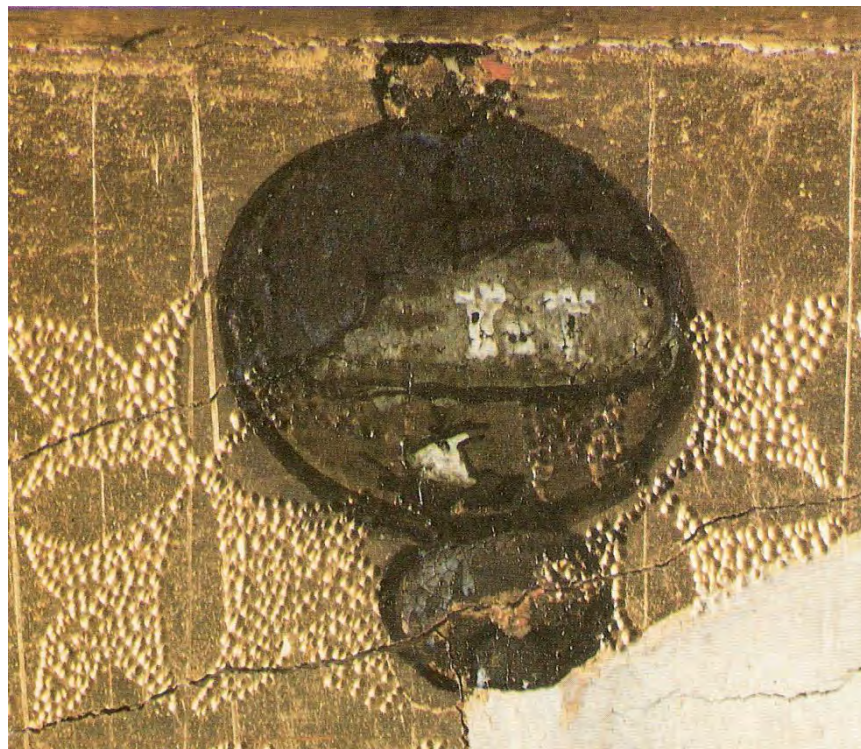


Fig. 5.17: The Wilton Diptych, c. 1364, detail of the orb at the top of the standard.
(Gordon)

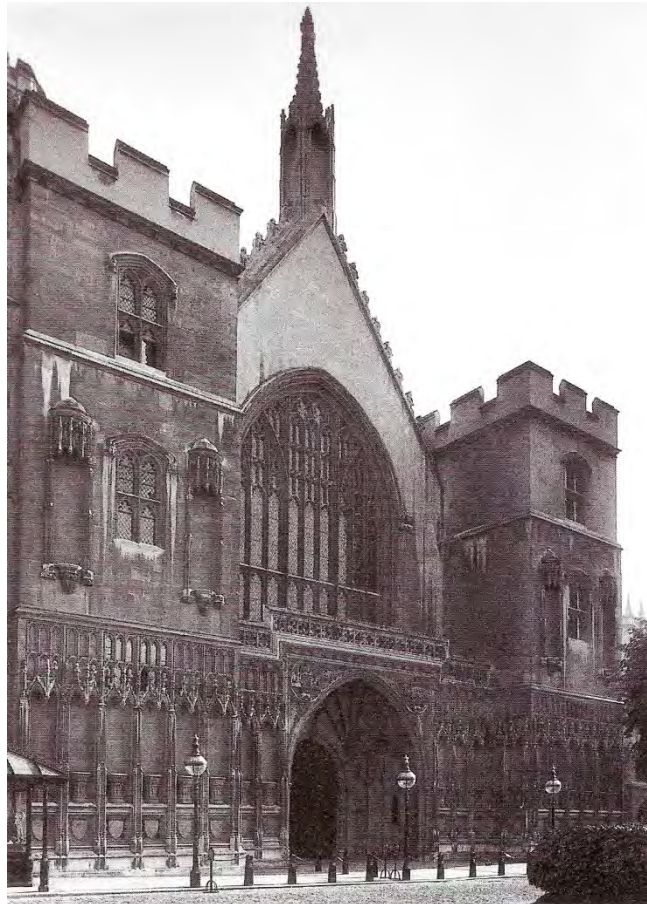


Fig. 5.18: Westminster Hall, north elevation, 1393-1398.
(Wilson/RCHME)



Fig. 5.19: Westminster Hall, north facade, statuary arcading. Compare Fig. 5.22 below.
(Wilson/RCHME)



Fig. 5.20: Westminster Hall, north façade seen c. 1807, watercolour by John Coney. Note that some of the original statuary is still in place. Early in the nineteenth century the coffee houses and other shops that adjoined the façade were removed, and ‘many of the original statues were found in an excellent state of preservation, but they were unfortunately removed, not unlikely stolen, as was usual in those days.’ (Pearson, 1884, 14.) (British Museum)



Fig. 5.21: Exeter Cathedral, west façade, mid fourteenth-century.



Fig. 5.22: The hammer-beam roof of Westminster Hall, Hugh Herland, begun 1393.



Figs. 5.23: Westminster Hall, details of hammer-beam angel, as drawn by the office of HM Office of Works architect Frank Baines, c. 1913-14. The wings are believed to be seventeenth-century replacements (personal communication with Dr Mark Collins, Westminster Palace Estates Archivist). The original wings were probably swept forward, as in the manner of some later East Anglian hammer-beam roofs.

(National Archives)



Fig. 6.1: Reconstruction of Westminster Hall lower framing at scale of 1:4 in green oak
(Robert Beech & Chris Dalton)



Fig. 6.2: Winchester Castle, roof of Great Hall, much restored, but original probably by Hugh Herland, c. 1392.



Fig. 6.3: Winchester College, hall roof, 1819-20 by William Garbett, said to be faithful to the design of Herland's original roof of the 1390s.



Fig. 6.4: Top: Winchester College, detail of hall wall-post framing. Below: Abbot's Hall, Westminster, c. 1376, detail of same.



Fig. 6.5: Stanton Harcourt Church, Oxfordshire, detail of nave roof, c. 1400. Note how the arch brace is tenoned into the wall post horizontally, as evidenced by the vertical shoulder of the joint and the position of the pegs.



Fig. 6.6: Boxford Church, Suffolk, timber north porch, fourteenth-century; right: detail of wall post to rib framing.

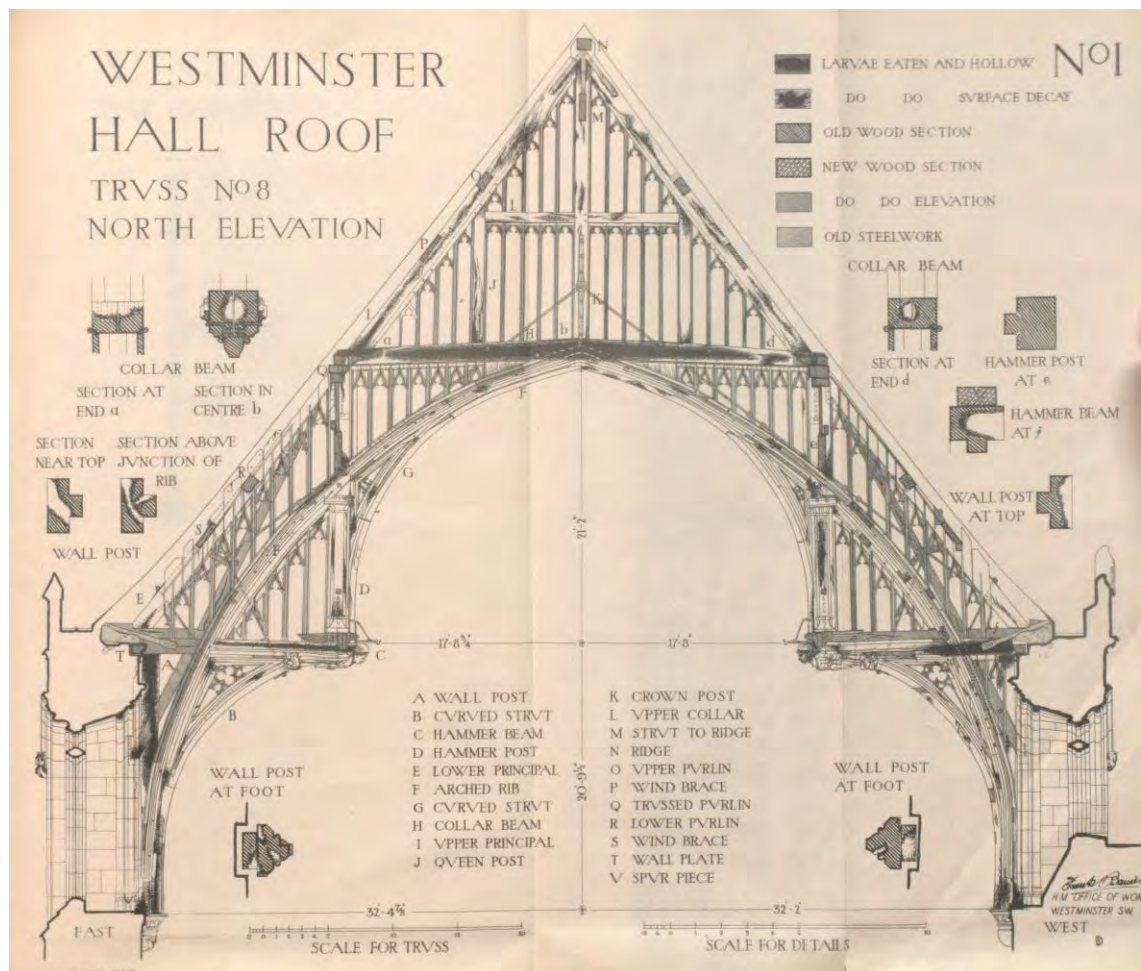


Fig. 6.7: Westminster Hall, 'Truss No. 8', Baines Report, 1914.



Fig. 6.8: Westminster Hall, detail of main 'trussed' purlin, showing composite 'keyed' construction, HM Office of Works, 1914.
(National Archives: 'Works' 29/3521)



Fig. 6.9: Westminster Hall, main purlin, detail of construction. HM Office of Works, 1914.
(National Archives: 'Works' 29/3522)

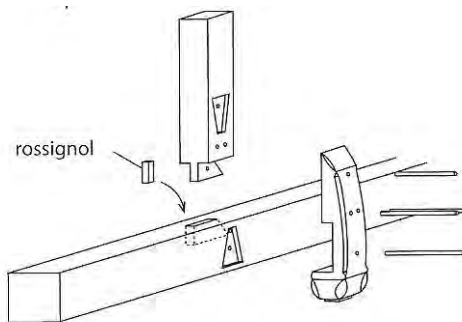


Fig. 6.10: Saint-Lazare de Beauvais, Oise, France
(1219-20d), detail of king post to tie beam framing
(Épaul)

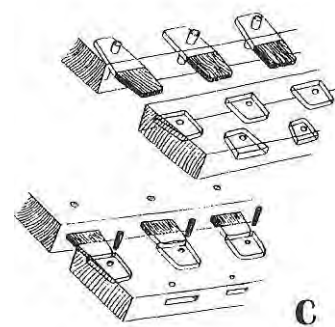


Fig. 6.11: Pegged loose tenon and mortice joint, From third / fourth-century boat discovered on the Thames in London
(McGrail)



Fig. 6.12: Westminster Hall, detail showing upper king-post truss. The steelwork is a later repair.

(‘Schedules’, drawing 29. Schedules 29 and 29a are Baines’s ‘Constructional’ drawings showing the framing of the roof stripped of ornament)



Fig. 6.13: Detail of Schedule 29 showing ‘joggled’ king post



Fig. 6.14: Westminster Hall, detail of framing at the intersection of hammer post, main 'trussed' purlin, collar beam and upper principal
(Schedules, drawing 29a)

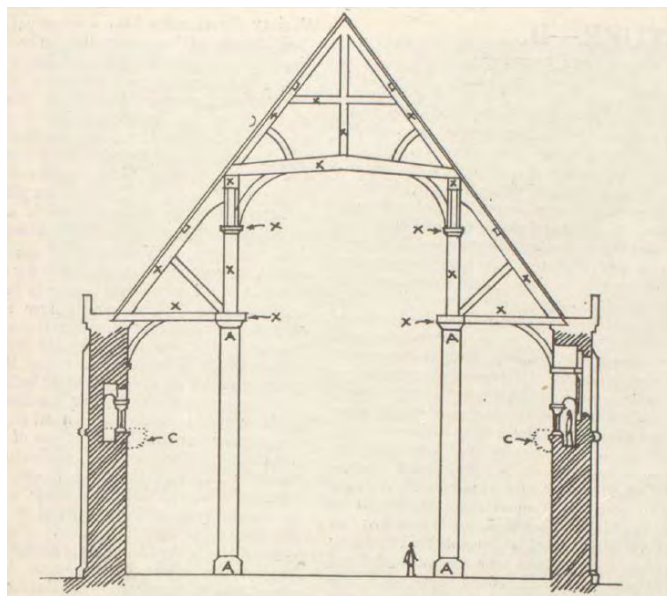


Fig. 6.15: Westminster Hall, conjectural reconstruction of Norman framing.
(William Harvey, 1921)



Fig. 6.16: Westminster Hall, lower principal framing, detail of Schedule 29.

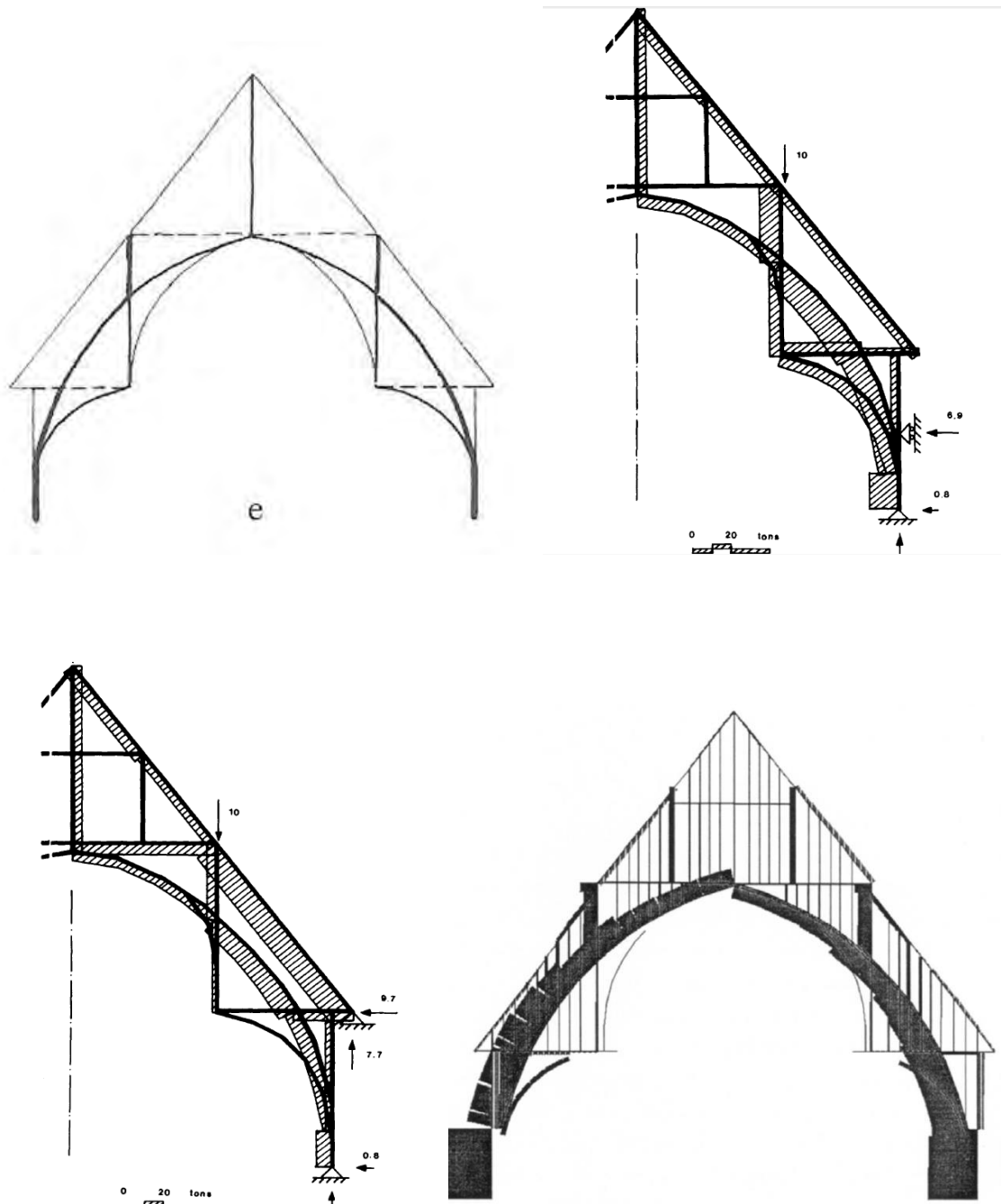


Fig. 6.17: Westminster Hall, structural theories from the late-twentieth century in schematic form. Force intensity is indicated by the heaviness / degree of hatching of the lines. Dotted lines indicated tension members. Top left: Mainstone, 1975; top right and lower left: Courtenay & Mark, 1987; lower right: Toby-Morris *et al.*, 1995.



Fig. 6.18: West façade of the Abbot's Hall, Westminster, c. 1376.
(Photographs courtesy of David Risley)



Fig. 6.19: Westminster Hall, two views in plan of the composition of the arched rib. Top: in the lower framing, near its conjunction with the wall post; below: in the middle tier of framing between hammer post and hammer beam.
(‘Schedules’, 29)



Fig. 6.20: Reconstruction of the Westminster Hall lower framing showing nature of arched rib before moulding; note **u** section formed by tripartite arched rib. The large timber running right to left in the foreground is the wall post.



Fig. 6.21: Westminster Hall, detail of arched rib. Note the simple longitudinal jointing of the outer laminates at top right and bottom left.
(Schedule 29)

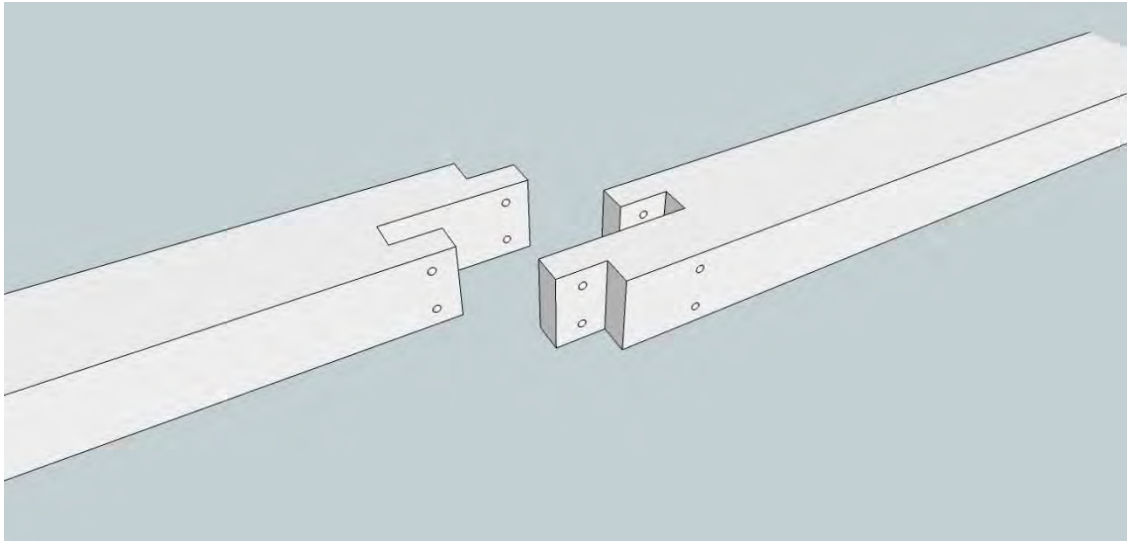


Fig. 6.22: Scarf joint, face halved and bladed.



Fig. 6.23: Westminster Hall, detail of hammer post / arched rib framing.
(Schedule 29a)



Fig 6.24: Reconstruction of Westminster framing, hammer beam / arched rib configuration; left: cogging of the hammer beam, note also the core is tenoned into the hammer beam; right, the outer laminate of the arched rib; note reduced section where it passes through the hammer beam.



Fig. 6.25: Westminster Hall, detail of arched rib / hammer beam framing. Note narrowing of the laminate as it passes across the hammer beam. The dotted line is the outline of the core timber.

(Schedule 29)



Fig. 6.26: Reconstruction of Westminster framing, note narrowing of the laminate as it passes through the hammer beam.



Fig. 6.27: Part of an original wall post from Westminster Hall removed during the restoration of 1914. Note, middle right, the lack of a tenon for the outer laminate, and the peg-hole (now split) showing how the laminate was simply face-pegged to the wall post.
(Museum of London)

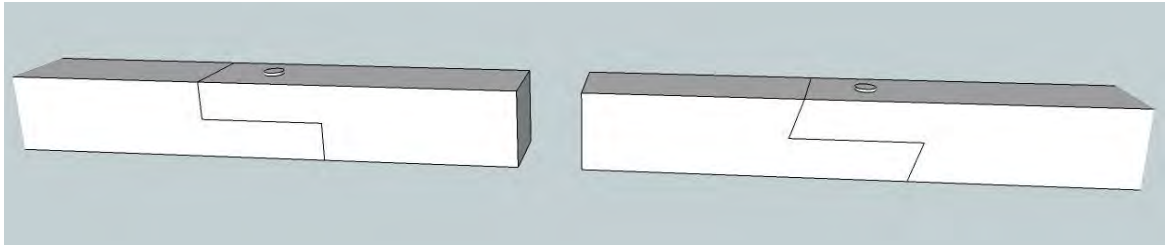


Fig. 6.28: Under-squinting in a simple scarf joint. Left: conventional abutment; right: under-squinted.



Fig. 6.29: Westminster Hall, detail of arched rib / hammer beam framing (Schedule 29a)



Fig. 6.30: Westminster Hall, lower hammer beam bracket.
(Schedule 29)



Fig. 6.31: Reconstruction of Westminster Hall framing, showing the complex contignation where the ribs meet the wall post.

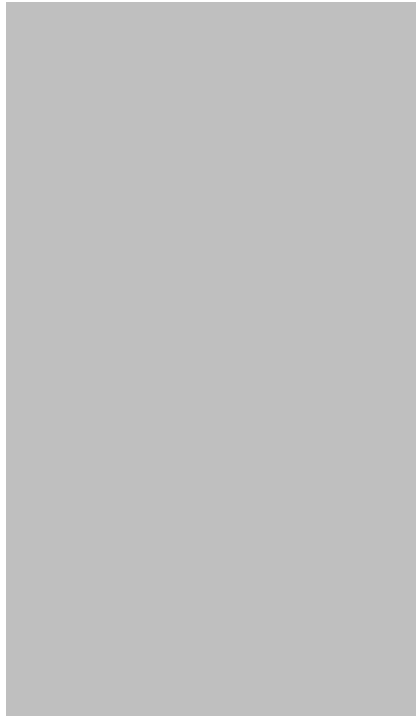


Fig. 6.32: Westminster Hall, detail of core / strut framing showing dovetailed key.
(Schedule 29)



Fig. 6.33: Reconstruction of Westminster framing, assembly procedure for dovetailed key at the conjunction of core / curved strut. Top left: key and packing piece prepared. Top right: inserted into mortice in core (the packing piece remains to be trimmed). Lower left: packing piece trimmed; the key cannot now be withdrawn (the peg hole cannot be bored until the joint is assembled). Lower right: joint assembled and pegged through curved strut.



Fig. 6.34: Fressingfield Church, Suffolk, detail of nave roof, fifteenth-century. Note the absence of corbels, but interestingly, the presence of mortices from which suspended corbels may once have been framed.



Fig. 6.35: Westminster Hall, detail of wall post showing cavity in the masonry.
(Schedule 13)



Fig. 6.36: Westminster Hall, plan of wall post and rear spur. Note dovetailed housing of the spur.
(Schedule 5)

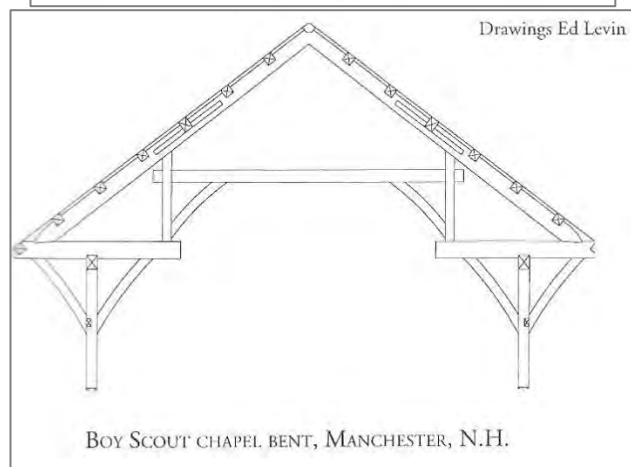
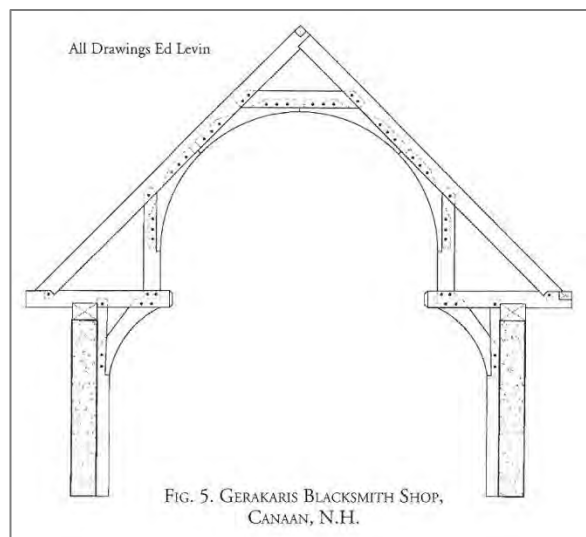


Fig. 6.37: Designs for late twentieth-century American hammer-beam roofs. Note how the wall post / wall plate framing acts as a fulcrum to the hammer-beam.
(Timber Framing)



Fig. 7.1: Bristol Cathedral, south aisle of the choir, c. 1310



Fig. 7.2: Willingham Church, Cambridgeshire, sacristy, fourteenth-century.



Fig. 7.3: Minchinhampton Church, Gloucestershire, south transept, fourteenth-century.



Fig. 7.4: Conway Castle, North Wales, great hall c. 1346, remains of roof. Left: mid-19th century watercolour by J. H. Pollen. By the 20th century only one arch remained, but note the springing points of the lost arches.

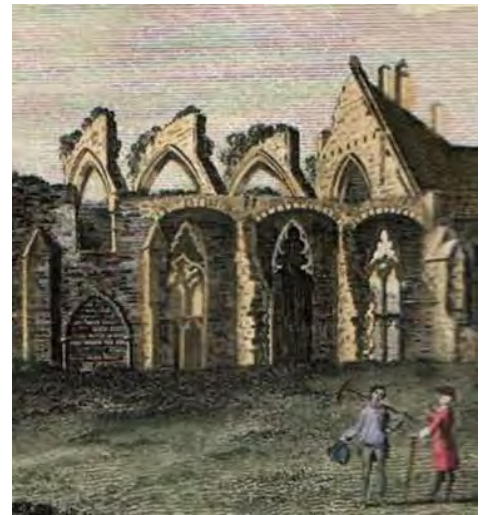


Fig. 7.5: Mayfield Palace, East Sussex, hall. Left: watercolour by Samuel Hieronymus Grimm, 1783. Right: detail of engraving by S. Hooper, late eighteenth-century.
(<http://www.theweald.org/m13.asp?PicIdto=9903223>)



Fig. 7.6: Mayfield Palace (now a school), hall, as reconstructed by E. W. Pugin in 1863-6.

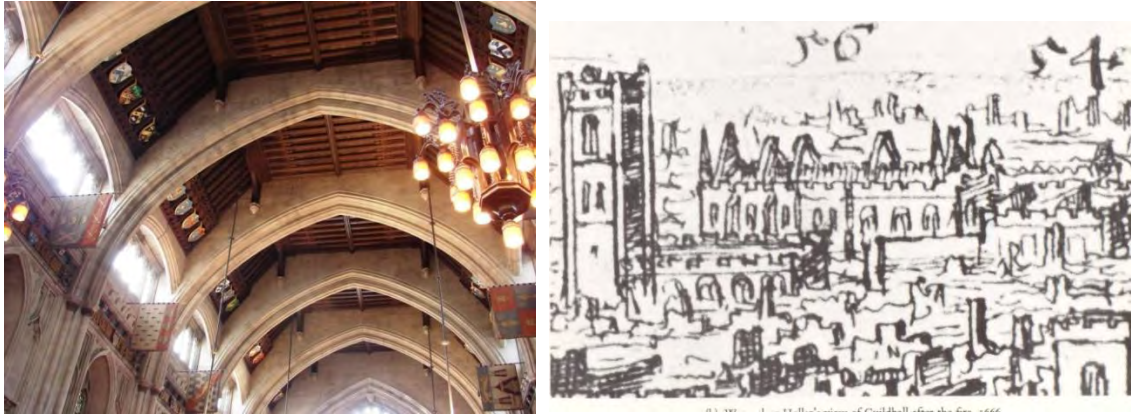


Fig. 7.7: London Guildhall, left: as reconstructed by Giles Gilbert Scott, 1954; right: Wenceslaus Hollar, *London after the Fire*, 1666, detail.
(British Museum)

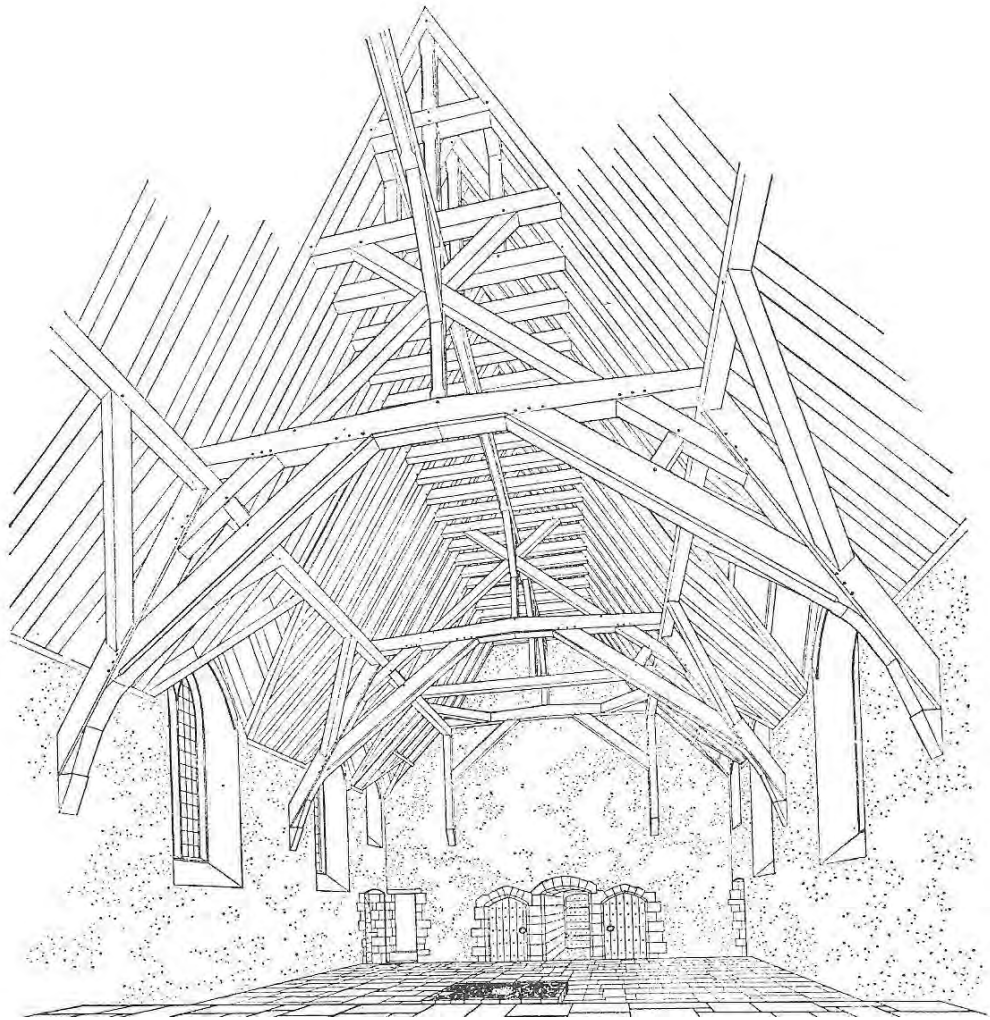


Fig. 7.8: The Old Deanery, Salisbury, 1258-74
(Margaret Wood, 1983)

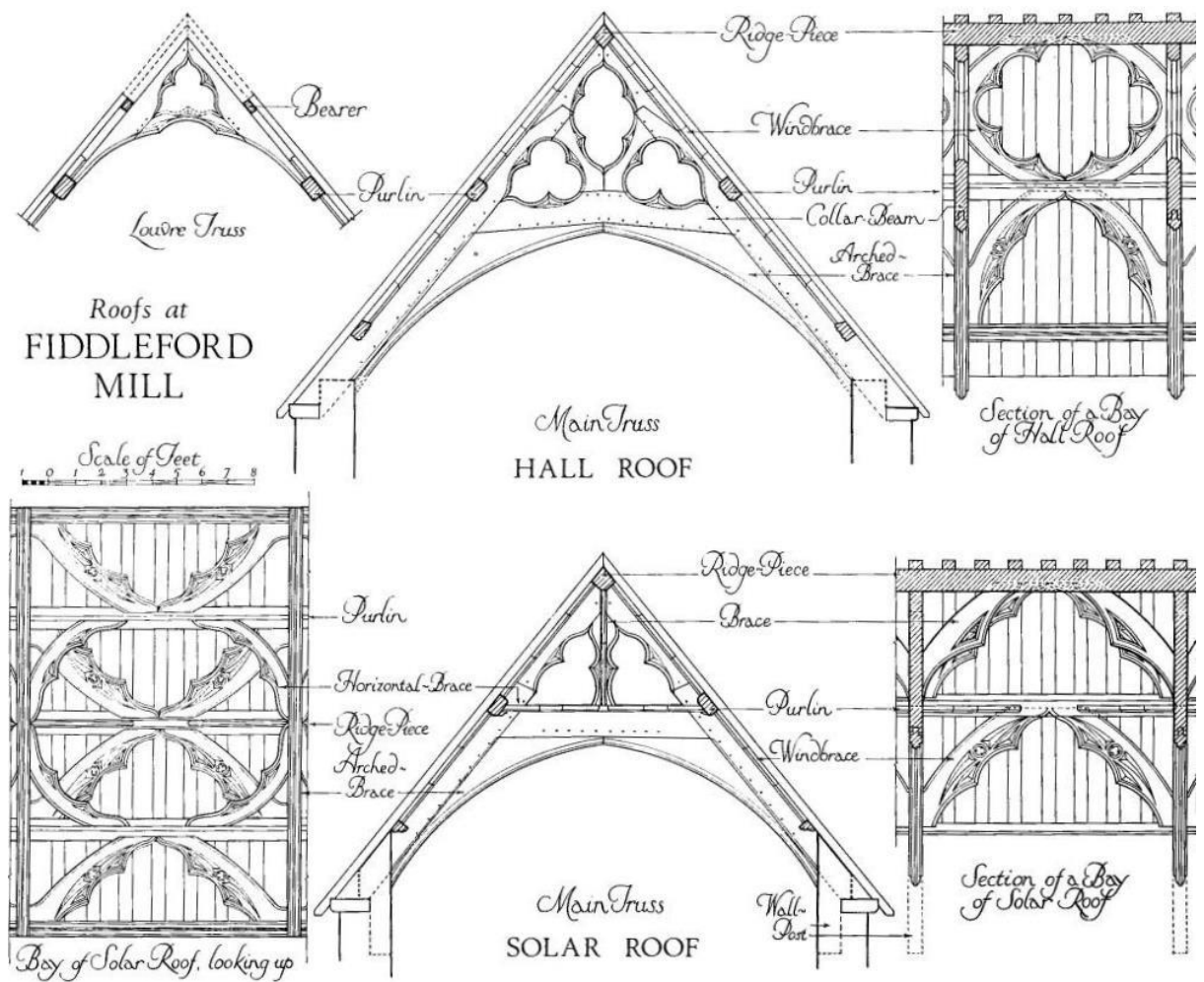


Fig. 7.9: Fiddleford manor, Dorset, arch-braced roofs, 1324–1333d (RCHME)

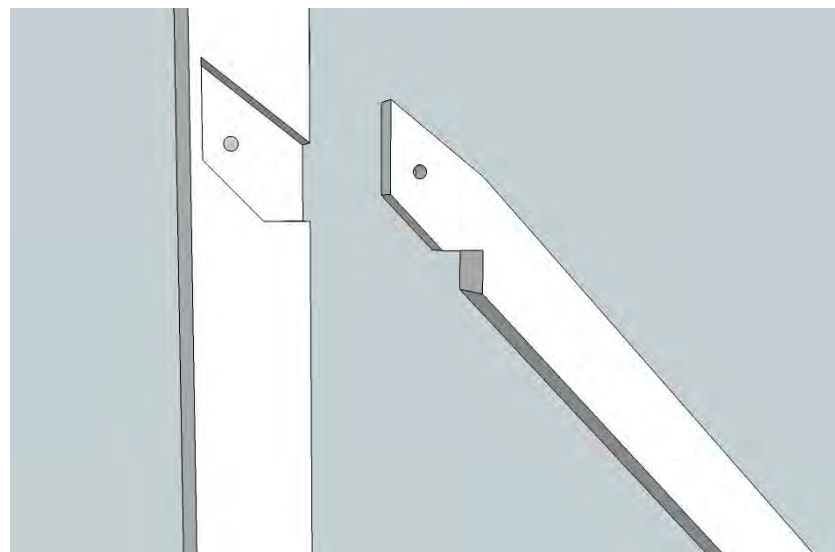


Fig. 7.10: Notched lap joint.



Fig. 7.11: Ely Cathedral. Left, looking east from the crossing, the boundary between the early thirteenth-century work and that of the early fourteenth century (foreground) can clearly be seen. Right: detail of same looking west.



Fig. 7.12: Left, Wells cathedral, nave c.1185-1213 ; right, Exeter Cathedral, nave, 1328-75.



Fig. 7.13: 'Flying' ribs. Left: Bristol Cathedral, ante-chapel to the Berkeley Chapel, early fourteenth-century; right: St Mary's, Warwick, chancel, c. 1392.



Fig. 7.14: Wenceslaus Hollar, *Banquet in St George's Hall, Windsor*, c. 1663–72. (British Museum)



Fig. 7.15: Lambeth Palace, London, the Guard Room, probably late fourteenth-century.

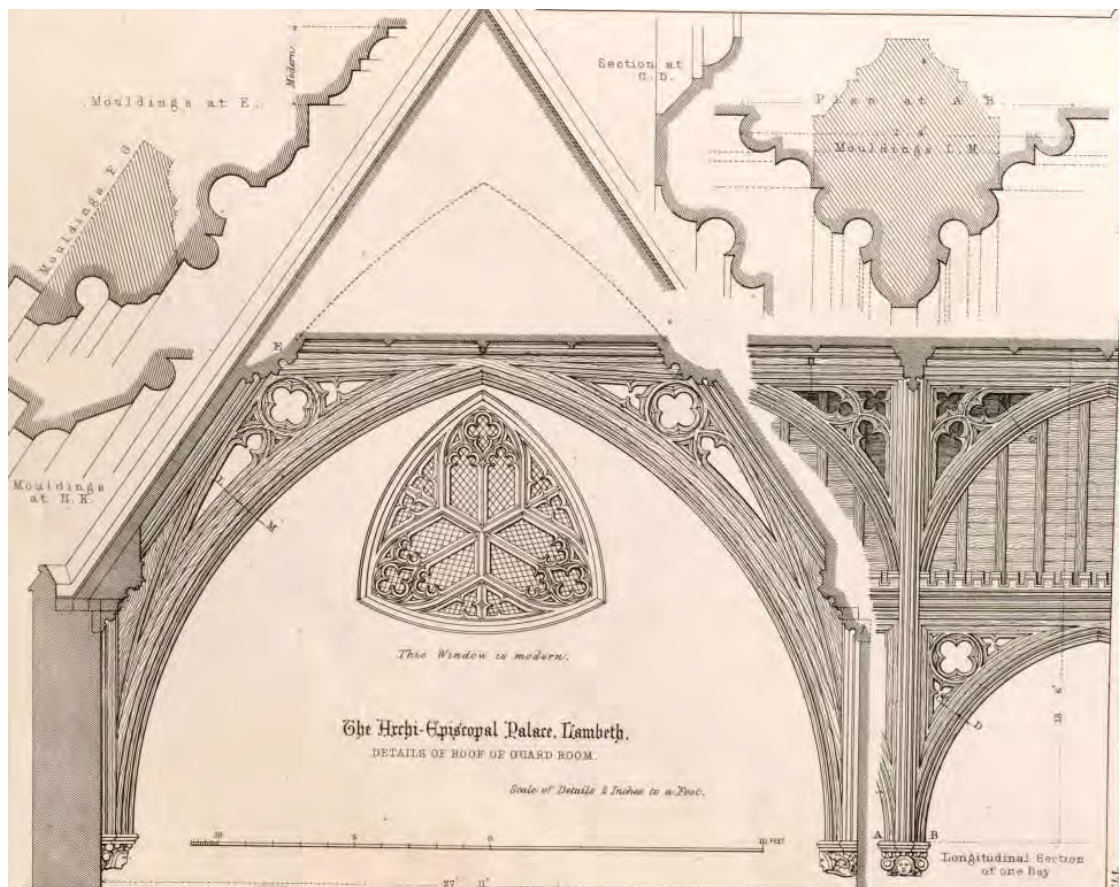


Fig. 7.16: The Guard Room, details of framing.
(Dollman & Jobbins)



Fig. 7.17: Left: Guard Room, spandrel tracery; right: Westminster Hall, spandrel tracery.



Fig. 7.18: The Guard Room, detail of framing at the springing of the arch rib and wall arcading.



Fig. 7.19: Ightham Mote, hall, 1330-42d. Top: view north towards the high end of the hall. Below: view south; mid nineteenth-century illustration by Joseph Nash.
(National Trust)

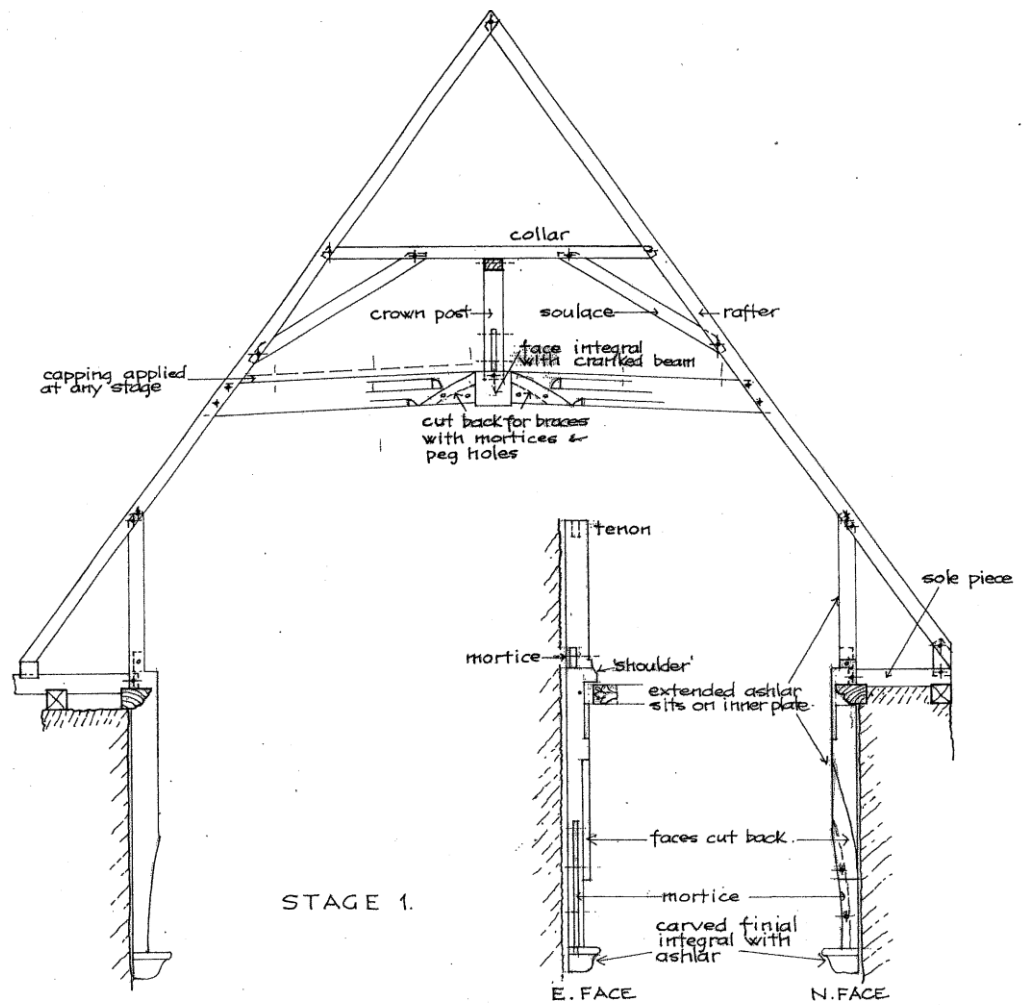


Fig. 7.20: Ightham Mote, hall, framing details at south gable, with arched-rib removed (Peter Leach)

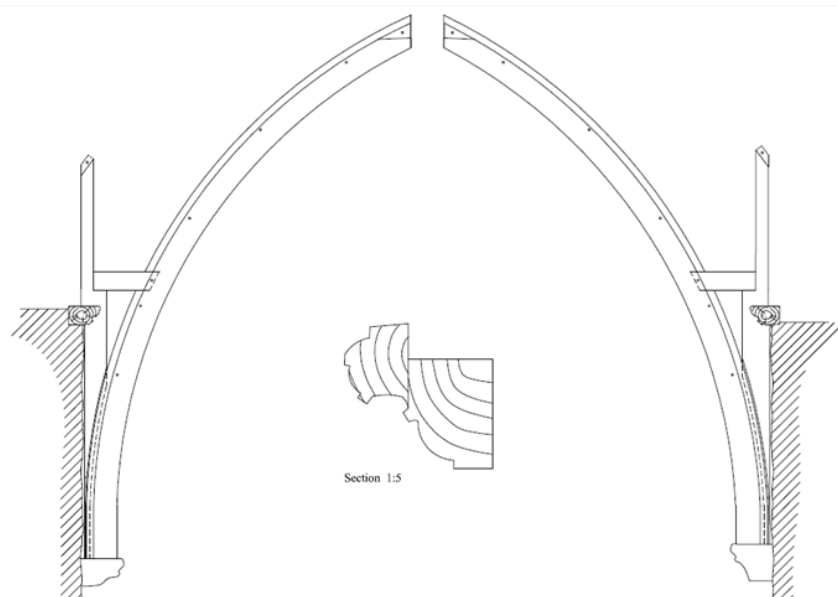


Fig. 7.21: Ightham Mote, hall, detail of arched-rib framing at south gable; note the pegging of the laminates. 'Section 1.5' is that of the rib. (Stuart Page)

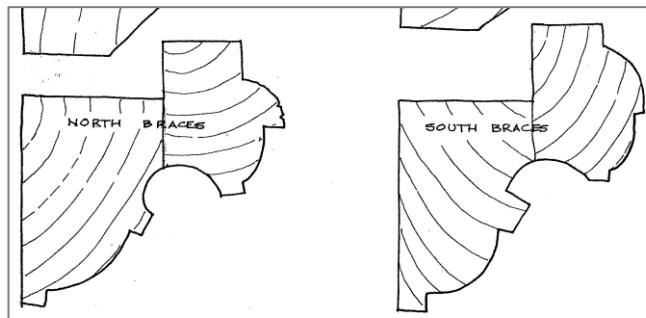
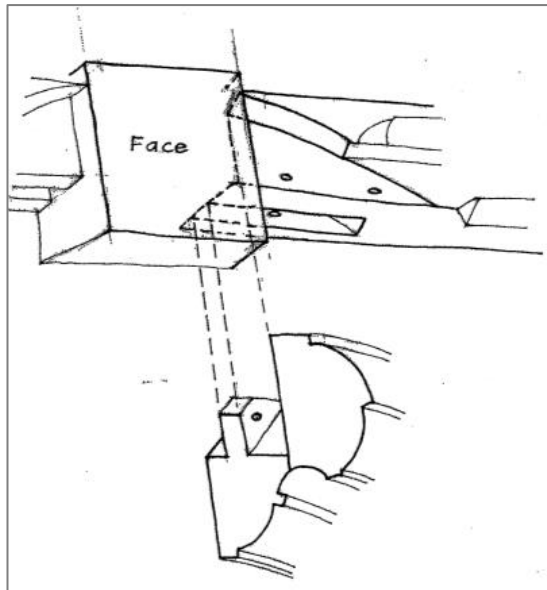


Fig. 7.22: Ightham Mote, hall, details of south gable rib framing. Top: junction with the cambered collar; below: sectional views.
(Peter Leach)

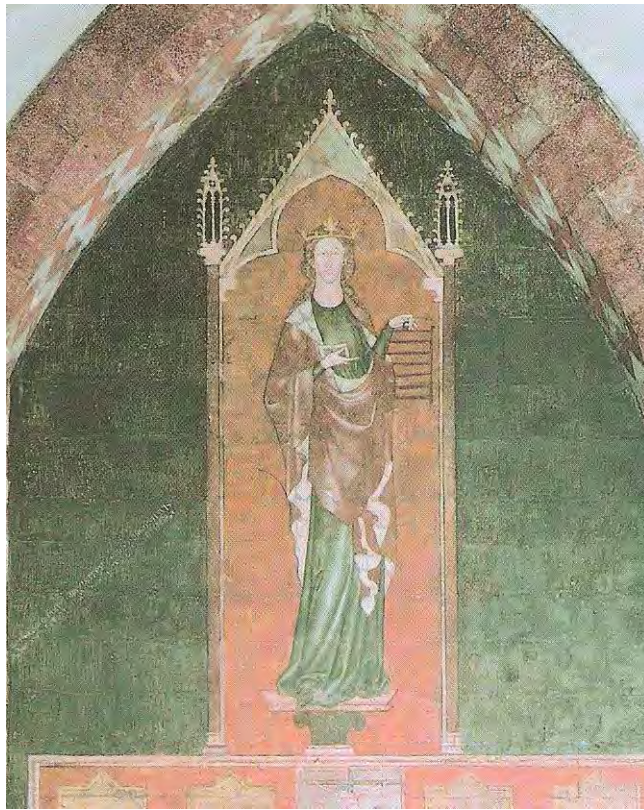


Fig 7.23: Westminster Abbey, top: wall painting, Chapel of St Faith, early fourteenth-century; below: tomb of Aymer de Valence, c. 1325. Note how the arch, gable and trefoil design is analogous to the form produced by the hammer-beam framing at Westminster Hall. A similar combination of motifs is found on the tomb of Edmund Crouchback, c. 1295-1300.
(Top: AC; below: Gardner)



Fig. 7.24: Exeter Cathedral, bishop's throne, c. 1317, detail.



Fig. 7.25: Chichester Cathedral, cusp figures on the canopy of the tomb of Bishop de Stratford, c. 1362, south transept.



Fig. 8.1: Tilney All Saints Church, Norfolk; nave, double hammer-beam roof; probably 3rd quarter of the fifteenth century.



Fig. 8.2: Type 1.1 'Lynn' type roofs. Top: King's Lynn, Norfolk, Chapel of St Nicholas, c. 1400-19; below: Mildenhall, Suffolk, St Mary's, 1420-30.



Fig. 8.3: King's Lynn, St Nicholas, details of roof showing carved spandrels of queen-post braces.

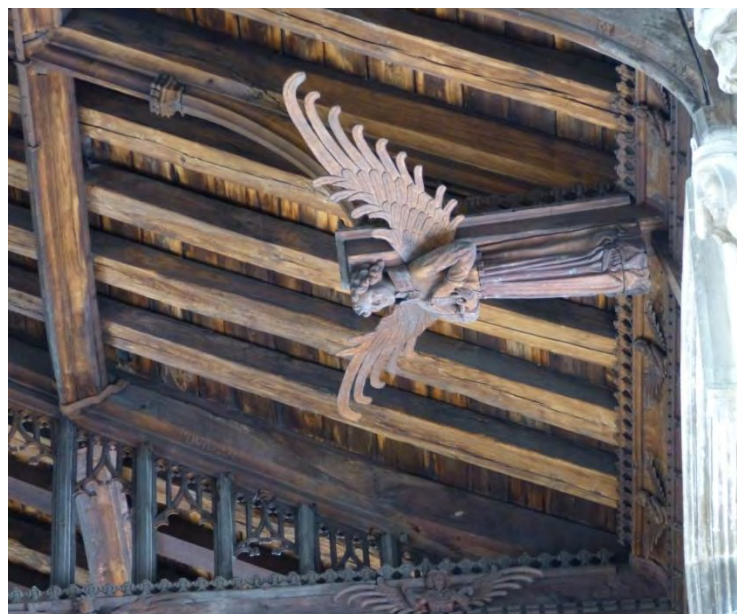


Fig. 8.4: King's Lynn, St Nicholas, detail of roof showing 'panel' hammer beam.



Fig. 8.5: Wighall, Norfolk, St Mary Magdalene, nave roof, 1419 \pm 16d.



Fig. 8.6: Wighall, St Mary Magdalene, hammer beam.



Fig. 8.7: Type 1.2 tie-beam / hammer-beam roofs. Left: Debenham Church, Suffolk, 1403 \pm 6d; right: Bildeston Church, Suffolk, c. 1420.



Fig. 8.8: Left: Debenham Church, note extant tenons on ends of hammer beams; right: Bildeston Church, replaced hammer-beam angels.



Fig. 8.9: Great Shelford Church, Cambridgeshire, nave roof, c. 1400-11; below: detail.



Fig. 8.10: Wingfield Church, Suffolk, nave roof, c. 1415.

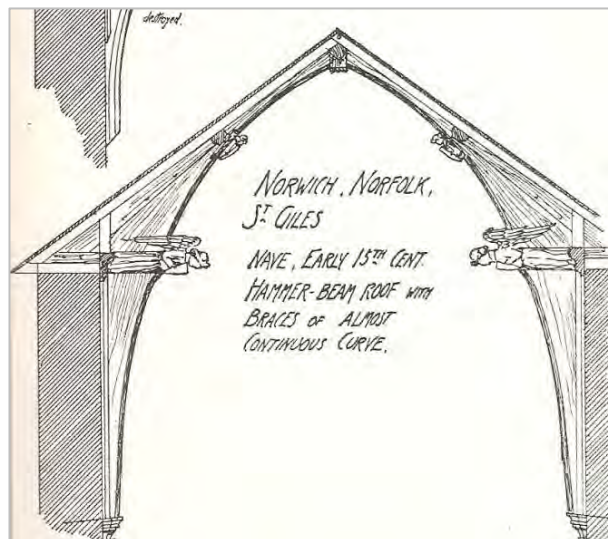


Fig. 8.11: St Giles Church, Norwich, nave roof, early fifteenth-century. Below: as drawn by F. E. Howard, 1914



Fig. 8.12: Ely Cathedral, north transept roof, 1426-27d.



Fig. 8.13: St Mary's Church, Bury St Edmunds, Suffolk, nave roof, c. 1430.

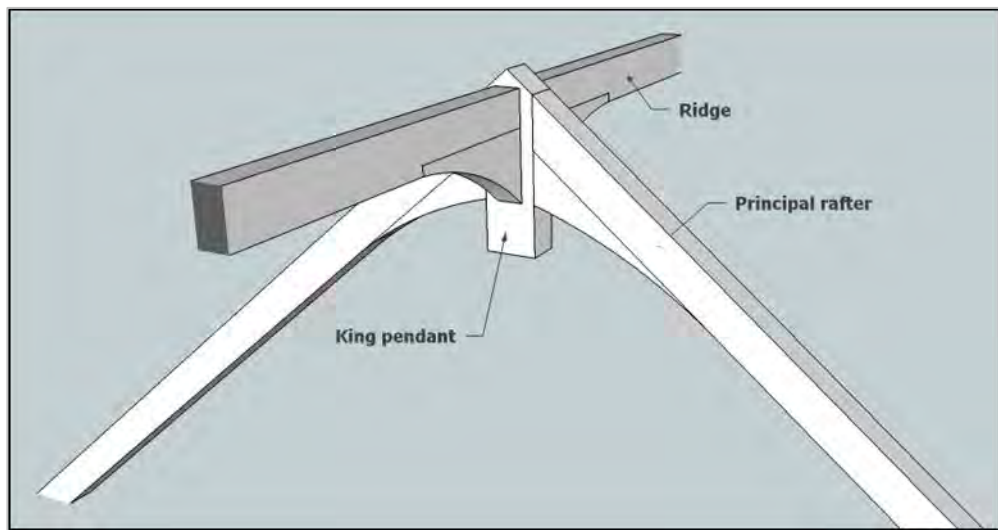


Fig. 8.14: King pendant construction.



Fig. 8.15: King pendant construction, apex framing, Ely Cathedral, north transept.



Fig. 8.16: Flared upper principals, Beeston-next-Mileham, Norfolk, nave roof.



Fig. 8.17: Flared upper principals, Great Cressingham Church, Norfolk, nave roof.

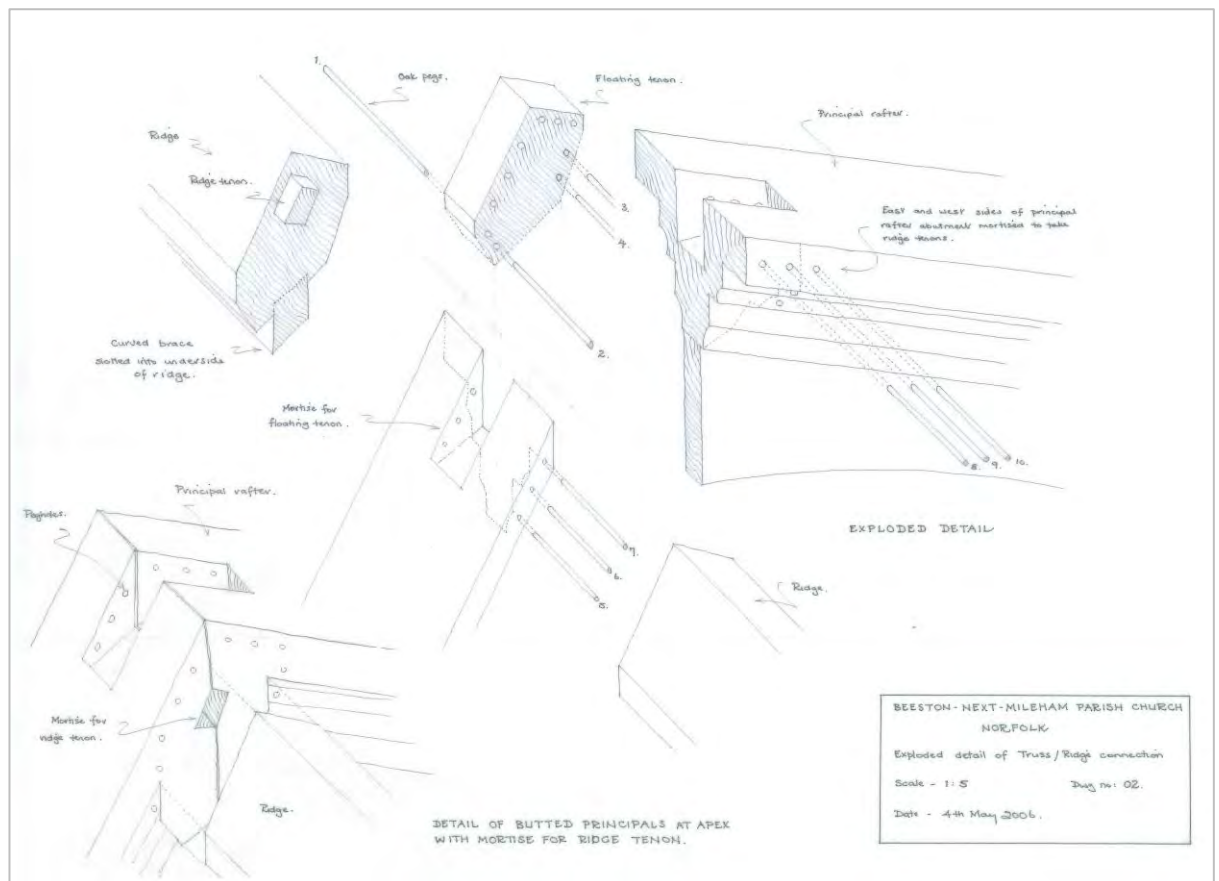


Fig. 8.18, Beeston-next-Mileham, apex framing.
(Drawing courtesy of Ruth Blackman)



Fig. 8.19: Carbrooke Church, Norfolk (fifteenth-century), detail of nave roof.



Fig. 8.20: Wymondham Abbey, Norfolk, nave roof, mid fifteenth-century.



Fig. 8.21: Necton Church, Norfolk, nave roof, c. 1490.



Fig. 8.22: The perfect carpentered Gothic arch? Northwold Church, Norfolk, nave, fifteenth-century. The hammer beams are non-structural; the roof is of arch-braced principal construction.



Fig 8.23: Cawston Church, Norfolk, nave looking east, c. 1450-60. Note the shadow of the, now lost, rood and the remains of a Doom.

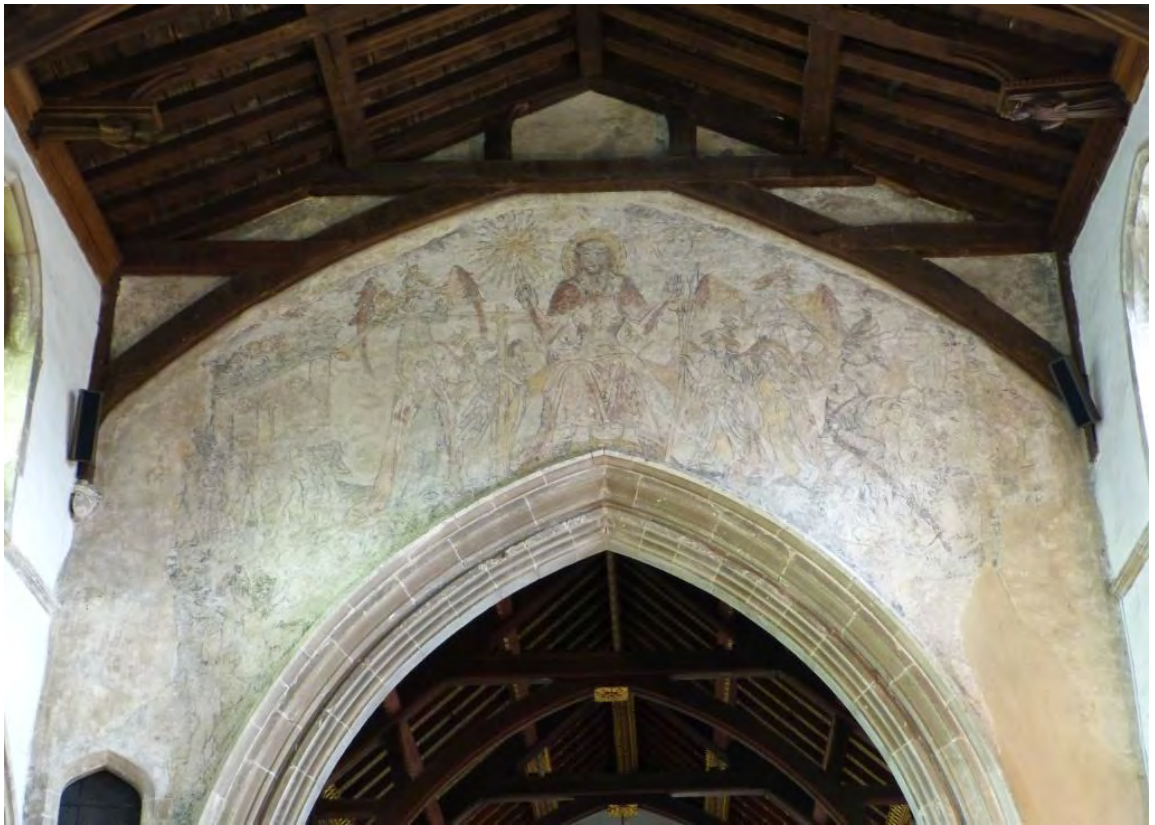


Fig. 8.24: Medieval doom paintings. Top: Great Shelford Church, probably early fifteenth-century; below: Church of St Thomas, Salisbury, fifteenth-century (much restored).



Fig. 8.25: Great Cressingham, Norfolk, nave, hammer-beam figure.



Fig 8.26: St Mary's, Bury St Edmunds, nave roof, detail of apex framing.



Fig. 8.27: St Mary's, Bury St Edmunds, detail of nave roof carving.



Fig. 8.28: St Mary's, Bury St Edmunds, angel hammer beam.



Fig. 8.29: St Mary's, Bury St Edmunds, detail of cornice.



Fig. 8.30: St Mary's, Bury St Edmunds, wall-post figures.

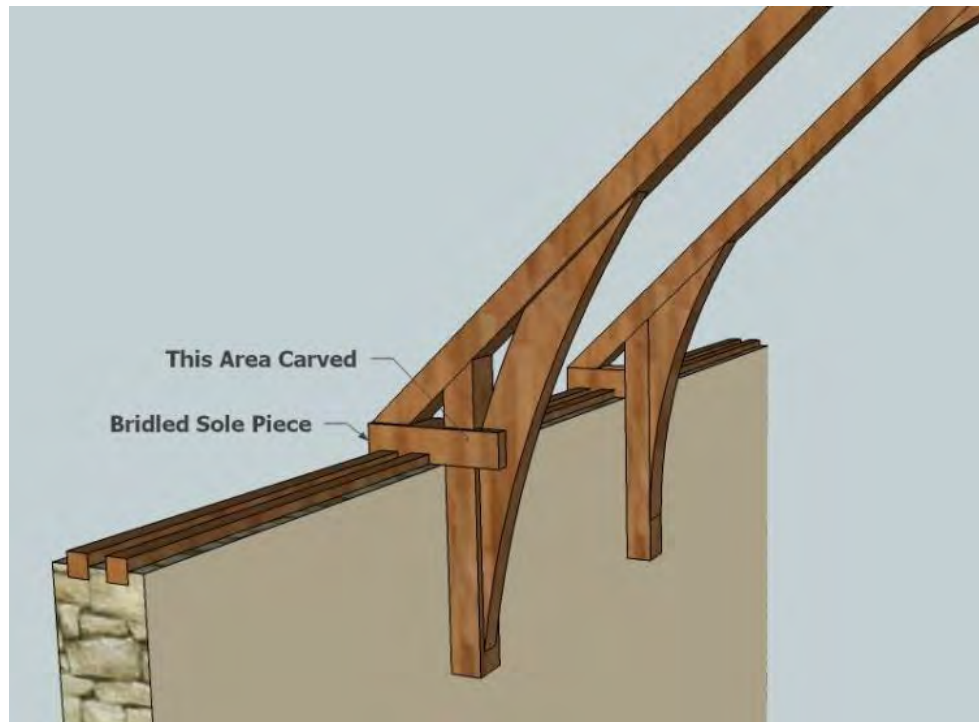


Fig. 8.31: Bridled sole piece, assumed construction at St Mary's, Bury; wall plate is hidden by cornice. Behind is conventional arch-braced principal construction.



Fig. 8.32: St Mary's, Bury St Edmunds, bridled sole-piece figures.

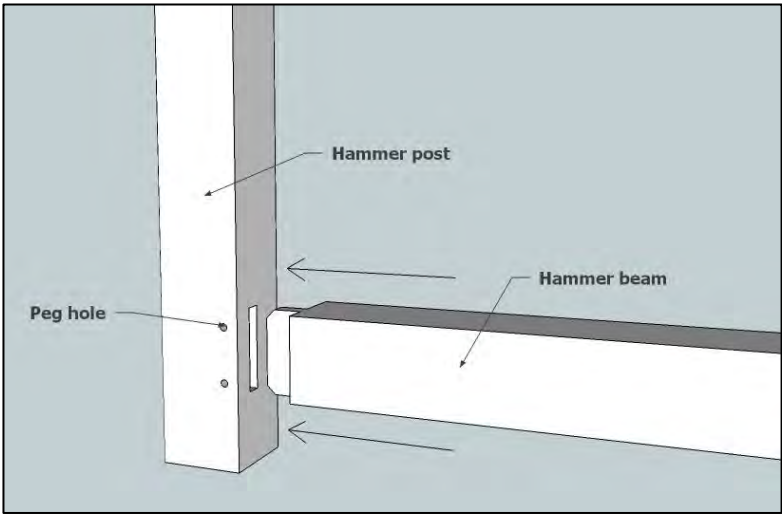
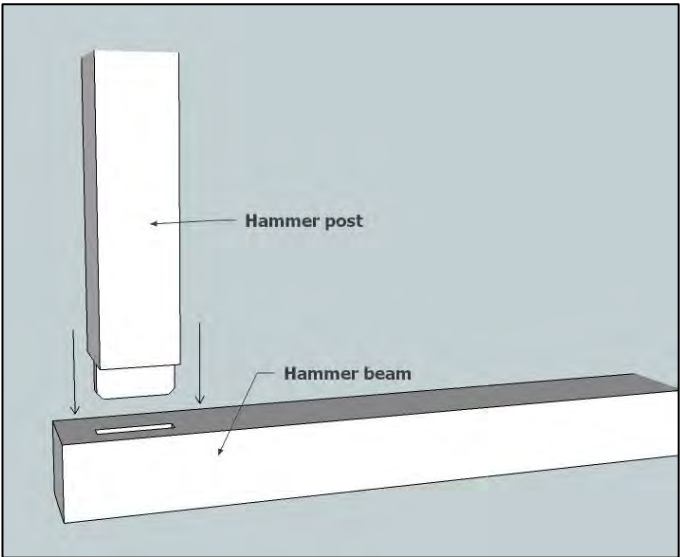


Fig. 8.33: Top: conventional hammer-beam construction; below: pendant-post construction;

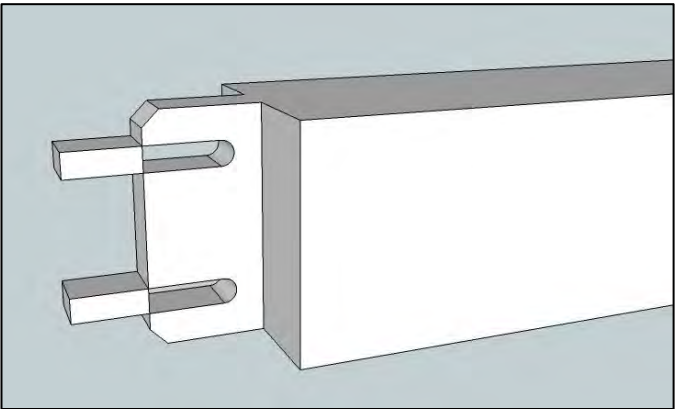


Fig. 8.34: Mortice & tenon in tension: potential shearing of tenon end-grain.



Fig. 8.35: Tostock Church, Suffolk, nave roof, mid fifteenth-century.



Fig. 8.36: Tostock Church, nave roof, detail of pendant post framing.

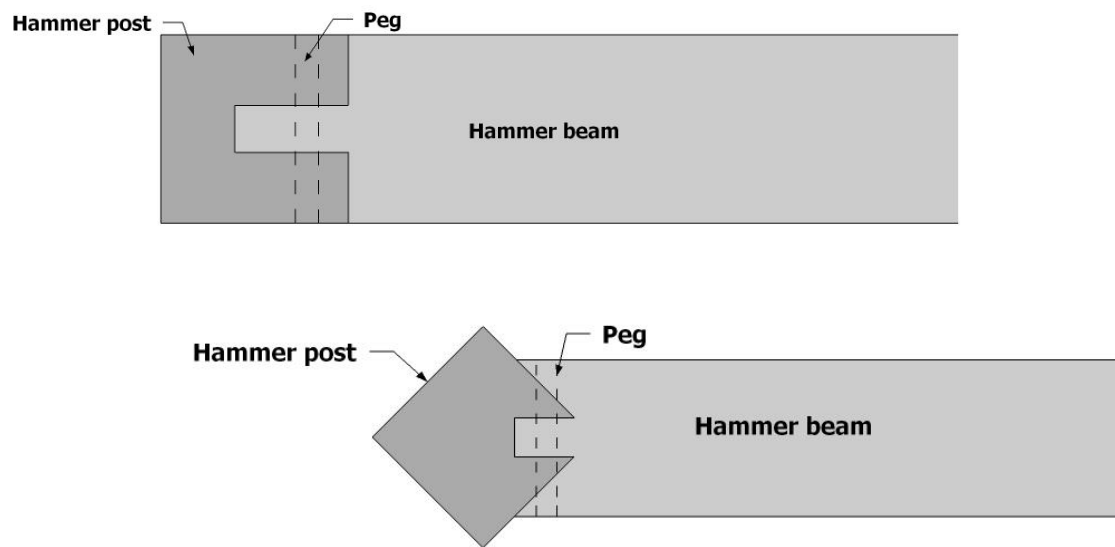


Fig. 8.37: Arris-framed hammer post (in plan). Top: Conventional pendant post arrangement; below: rotated, arris-framed pendant.



Fig. 8.38: Tostock Church, nave roof, detail of lower pendant post.



Fig. 8.39: Eltham Palace, roof of Great Hall, 1475-79.



Fig. 8.40: Eltham Palace, detail of pendant hammer post.

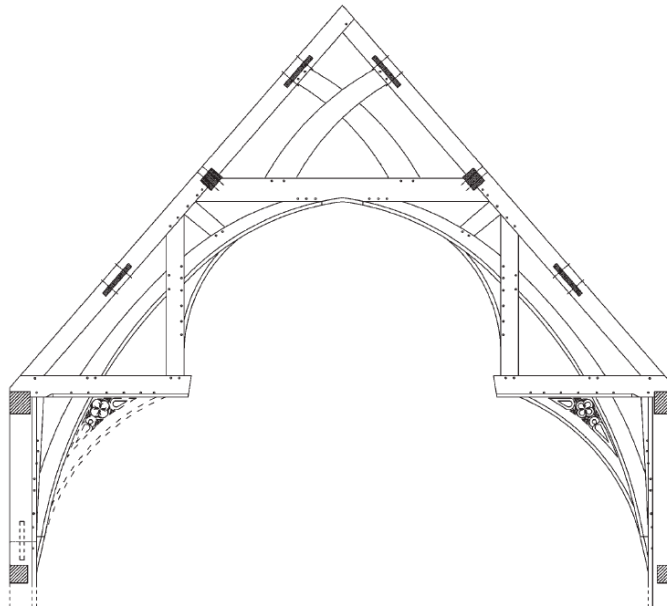


Fig. 8.41: 'Imberhorne', East Grinstead, hall framing, 1428d.
(J. Clarke)



Fig. 8.42: Bardwell Church, Suffolk, detail of nave roof, c. 1421. Note tenons to which hammer-beam angels were once fixed; note also king pendant construction at apex.



Fig. 8.43: Hammer-beam angels, Westerfield Church Suffolk, possibly early fifteenth-century.
Note also applied wall-post figures.



Fig. 8.44: Holme Hale Church Norfolk, nave, detail of roof-framing, fifteenth-century.



Fig. 8.45: Great Cressingham Church, Norfolk, nave roof, c. 1430



Fig. 8.46: Great Cressingham, nave roof, detail.



Fig. 8.47: Great Cressingham, nave roof, detail of apex framing.

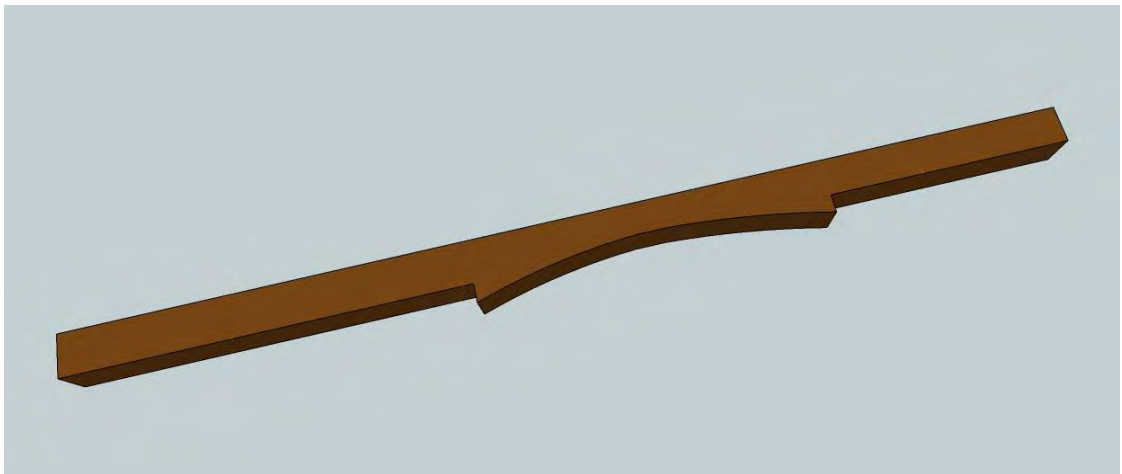


Fig. 8.48: Approximate shape of Great Cressingham principal before moulding.



Fig. 8.49: St Mary's, Mildenhall, Suffolk, north aisle roof, c. 1430; right: detail of wall-post figure.



Fig. 8.50: Eltham Palace. Photograph taken during restoration in the early C20. Note the huge amount of riveted steelwork introduced to maintain the roof's structural integrity, (from Cescinsky & Gribble)

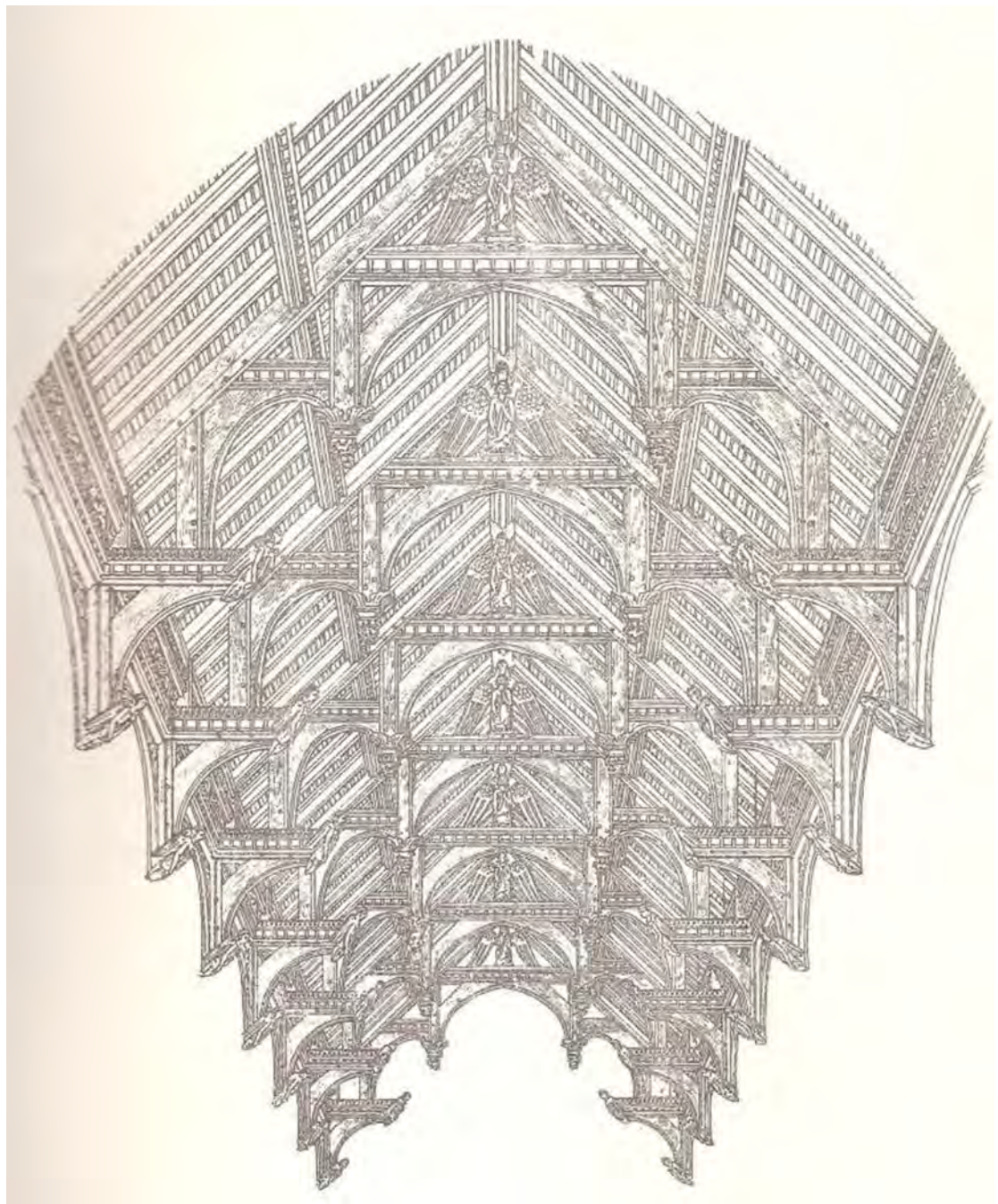


Fig. 8.51: Grundisburgh Church, Suffolk, C15
(from Brandon, *Analysis of Gothic Architecture*)




**THE GREATEST
TIMBER FRAMED ROOF
IN EUROPE**
The massive carved frames
for the Roof of the Great Hall
in the Palace of Westminster
were made in Farnham not
far from this spot,
and sent to London in the
summer of 1395.