modern timber framing
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traditional framing
suggested development of the cruck frame

West, *The Timber-Frame House*, p 22
the failure of an unbraced frame
the need for triangulation
building frame, (purported to be Noah building the ark), from the Bedford Hours, early C15th

box frame construction

Brunskill, *Vernacular Architecture*, p 53
English box frame house

MUAS 10,207
pseudo-dragon beam near the Castle Gate, Windsor, England

Chris How
the dragon beam
the Banqueting House, Whitehall: revised elevation by Inigo Jones, 1619

Campbell, *Vitruvius Britannicus*, I, pl 13
Banqueting House, Whitehall, London by Inigo Jones, 1619-22

James Lees-Milne, *The Age of Inigo Jones* (London 1953), pl 1
dragon beams and sub-dragon beams at Inigo Jones’s Banqueting House, Whitehall, from 1619: record drawing by John Webb in the Chatsworth Collection

this is a plan at ceiling level and does not show the common rafters, but it does show the truss principals

common rafters are presumably housed into the ends of the ceiling joists

jack rafters are housed into the hanger beams where available, but otherwise a short beam is created for them and braced back

hip rafters are analogously housed into a short beam – the dragon beam
ceiling for a French hipped roof with coyers (H) and gaussets (G)

Pierre Chabat, *Dictionnaire des Termes Employés dans la Construction*, Paris 1875, p 376
figure 2 from the treatise of Fray Lorenzo de San Nicholas, *Arte e Uso de Architectura* [The Art and Use of Architecture] (1639)
‘of the Italian or hip roof’ by Godfrey Richards

Andrea Palladio [ed Godfrey Richards], *The First Book of Architecture*, (London 1773 [1663]), p 199
Godfrey Richards’s diagram interpreted

Miles Lewis
Batty Langley’s roof frames with dragon beams, from the pages on roofs dated 16 November 1741, additional to the work as originally published

Batty Langley’s plate 5 interpreted

Miles Lewis
dragon beam

John Wood, *A series of plans for Cottages or Habitations of the Labourer* (London 1806 [?1781]), pl 1, fig 67
Thomas Hardy’s sketch of dragon beams, probably copied from a text.

Sutcliffe’s rationalised detail

G L Sutcliffe [ed], *The Modern Carpenter, Joiner and Cabinet Maker* (8 vols, London 1903), V, p 72
dragon or diagon beams at Christopher Wren’s Sheldonian Theatre, Oxford, 1664-9

‘dragon beams’ (angled struts or puncheons) within a king post truss

Joseph Moxon, *Mechanick Exercises, or the Doctrine of Handy Work* (London 1678), p 160
‘dragon beam’ in a jettied-out upper floor, as generally understood in the twentieth century

dragon beams

• 1663 Richards: a full-length diagonal beam, receiving the base of the hip rafter

• 1677 Wren/Plot: a diagonal member under ceiling joists, possibly providing bracing in the horizontal plane

• 1677 Moxon: unintelligible, but intended to be a diagonal strut in a kingpost truss

• 1740 Langley: a diagonal beam receiving the base of the hip rafter, but running in only a short distance to meet an angle brace.

• 1908 Green: a full-length diagonal beam in a jettied-out floor.
laminated timber
stud & balloon framing
trussed partition, 7 Robert Adam Street, London, c 1780

Robert Ayton
eighteenth century timber framing
nineteenth century trussed partition

Francis Price, *The British Carpenter* (London 1753), plate C
R S Burn, *Building Construction* (London 1877), p 49, fig 231
the roles of the brace and the stud in a box frame

the frame is like a truss, and the diagonals are important members

the studs merely fill in the panels in between

the diagonals are at least as large as the studs, often much larger

where a diagonal meets a stud, the diagonal is continuous and the stud is cut
principal member

discontinuous studs

stairway partition, 4 New Quebec Street, London, c 1790

Robert Ayton
butting joints; 4 New Quebec Street, London, c 1790; display at Carpenters Hall, Philadelphia

Robert Ayton’; Miles Lewis
house at the Bokrijk Museum, Belgium

Marc Laenen, no 59
'Elevation of two studd work cottages of the smallest size, with brick gables', by Nathaniel Kent, 1776

Nathaniel Kent, *Hints to Gentlemen of Landed Property* (2nd ed, London 1776), facing p 263

house at the Bokrijk Museum
'Elevation of two studd work cottages of the smallest size, with brick gables', by Nathaniel Kent, 1776

Nathaniel Kent, *Hints to Gentlemen of Landed Property* (2nd ed, London 1776), facing p 263
English barn design, 1781

William Pain, *The Carpenter's Pocket Directory; containing the Best Methods of Framing Timber Buildings ... with the Plan and Sections of a Barn* (London 1781), plates i & iid
timber barn, 1807

timber construction in Tidewater Virginia: open mortice and tenon half lap splice

timber construction in Tidewater Virginia:
shouldered tusk and tenon joint

corner joints in Vermont, USA

St Mary's Church, Chicago, 1833

balloon frame of a 1½ storey house, USA, c 1845-1859

sills 8 x 8 [200 x 200]

stud 2 x 4 in [50 x 100]

puncheons 4 x 4 [100 x 100]

corner posts undefined

ribbon 4 x 1 or 6 x 1
[100 x 25 or 150 x 25]

W E Bell, *Carpentry Made Easy* (1859), plate 5
Bell’s balloon frame house
sills 8 x 8 [200 x 200]
stairs 2 x 4 in [50 x 100]
puncheons 4 x 4 [100 x 100]

Kent’s studd-worke cottages
stairs 3 x 5 [77 x 125]
puncheons 5 x 6 [235]

W E Bell, *Carpentry Made Easy* (1859), plate 5
Kent, *Hints to Gentlemen of Landed Property*
balloon frame of a two storey house, USA, c 1845-1859

sills 3 X 10 [75 X 250]

W E Bell, *Carpentry Made Easy* (1859), plate 5
Bell’s balloon frame 1½ storey house

- ribbon 4 x 1 [100 x 100] or 6 x 1 [150 x 25]
- stud 2 x 4 in [50 x 100]
- puncheon 4 x 4 [100 x 100]
- sill 8 x 8 [200 x 200]
- ? corner post unspecified
characteristics of the US balloon frame derived from Europe

close studding
the horizontal girt

new industrial characteristics

smaller sizes of timber
standardised sizes of timber
simplified timber joints
extensive use of nails
balloon frame,
USA

factors responsible for the balloon frame in the USA

high cost of labour
makes complicated joints and shapes impractical

efficient sawmills
make smaller and standardised timber sizes more economic than larger and more varied ones

cheap cut and wire nails
make nailed joints cheaper than traditional ones

the social acceptability of timber
makes two storey timber houses common
details of an American balloon frame
(simplified joints and skew nailing)

R S Burn, *Building Construction* (London 1877), pp 90, 91
detail of the construction of the Steam Packet Inn, Portland, Victoria, c 1840

the American balloon frame
& Haddon’s illustration of
the Australian stud frame, 1908


Robert Haddon, *Australian Architecture* (Melbourne, no date [1908]), p 327
industrial framing
House Mill, Bromley-by-Bow, Newham, London, 1776


**industrial timber Construction**

- square posts
- chamfer-stopped arrises
- spreaders
- beams (later barrups)
Portarlington Flour Mill, Australia, by Andrew McWilliams, 1857
detail of chamfer-stopped post, spreader & beam (later wedges)

Miles Lewis 1987
Crown Mills, 22 Cameron St, Launceston, by Henry Conway, completed 1898

Miles Lewis
Crown Mills: columns and cross-heads on ground and third levels

Miles Lewis
scarfed and braced joints, USA, 1859

W E Bell, *Carpentry Made Easy* (Philadelphia 1859), plate 13
general framing for a heavy barn

sawtooths & barrups
a pioneering example of the ‘shed’ principle

the Oriental Spinning and Weaving Company's cotton mill near Bombay

by William Fairbairn, and Sons, before 1863: sections

Dennys Lascelles wool Stores, Geelong, Australia

Jacob Pitman's section & roof plan

modern view of the show floor

Selenitsch, 'Geelong Wool Stores' fig 4, from Melbourne University Archives

Miles Lewis 1984
Dalgety Wool Stores, Gheringhap Street & Western Beach, Geelong: the 1901 portion

Miles Lewis 1985
Dalgety Store, 1901 building, show floor, showing cross-heads, trussed beams (barrups) and a sawtooth roof

Selenitsch, 'Geelong Wool Stores' fig 4, from Melbourne University Archives
the Crystal Palace, London, by Joseph Paxton, 1850-1
the roofing system, showing queen post barrups

Brino, *Crystal Palace*, p 43
trussed beams
(barrups)

G L Sutcliffe [ed], *The Modern Carpenter Joiner and Cabinet-Maker* (8 vols, London 1903), IV, pp 396, 387

No 8 wharf Warehouse, Walsh Bay, Sydney: detail of roof framing

Balint, *Warehouse and Woolstores*, p 73
Sunshine Harvester Works, Devonshire Road, Sunshine: view in 1906

Science Museum of Victoria
Sunshine Harvester Works, details of trussed beam and droppers

Miles Lewis 1987
Class C housing, Sewell, Chile, showing timber pillars and cross-heads

ICOMOS recommendations on Sewell, April 2006

- square timber pillars
- cross-heads
- angle braces