The Rise and Fall of the Use of Bond Timbers in Brick Buildings in England

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INTRODUCTION

Most dictionaries define bond timber as "timber worked into a wall to tie or strengthen it longitudinally". Bond timbers can be found in buildings world wide, usually to provide against particular distortions or risks such as earthquakes, but were a feature of virtually all brick buildings in England throughout the eighteenth century and until about the middle of the nineteenth century. Initially they were inserted in the inner skin of external and party walls, but latterly were moved to the centre of walls, where they were known as chain bond, and were incorporated in internal walls too.

HISTORICAL USE

Longitudinal timbers have been built into walls as reinforcement since time immemorial. Wilcox (1981) cites instances back to the ninth century BC, in the ramparts of hill forts, and many other examples through the ages. The invariable problem with identifying the use of intra-mural timbers, as Wilcox terms them, is all that usually remains is a square or rectangular void, left when the timber has rotted away and the debris has been removed by insects. This tendency to rot was one of the factors that lead to their eventual abandonment in England.

Many of the examples of these bond timbers do not run all round the building, and hence were probably introduced to reinforce potentially weak areas, such as openings or a suspect foundation. Some are huge timbers, seeming far larger that can have been needed, as the 20 inches x 16 inches empty chases left in the 14th century Threave Castle in Kirkcudbrightshire (Wilcox 1981, p.21), continuing either side of window openings in the same line. This indicates that they were originally continuous, to provide temporary reinforcement whilst the mortar was setting, to be cut out afterwards before the window frames were fixed, as was normal practice later.

Wilcox lists examples from the fifth to the fifteenth century, in church towers, gateways, large rectangular buildings, shell keeps and in mural towers and walls – all substantial buildings with thick stone or earth walls, probably some with rubble hearting.

At that time domestic construction in England was generally on a small scale, usually framed in timber, with brick or stone flues and chimneys, and perhaps party walls, if the original 12th century

legislation in the City of London was followed. It is likely that these techniques continued in use in Britain and particularly in London, until the 17th century.

One of earliest published British references to bond timbers is in the fascinating writings of Sir Roger Pratt, included in his "General rules concerning building" dated 7 December, 1665, as transcribed and edited by R T Gunter:

> Not so to mix timber in our walls for binding them, as that the wood decaying, they must necessarily sink, viz. as when we lay thick lintels over the whole breadth of our walls, especially of the piers, which will have nought to support them; but perhaps they may be laid with advantage, about 4 or 6 inches both in their breadth and depth, etc. so to run round the whole inside of the building; for the better tying of the walls, and the equal pressing of them by the several timbers.
>
> (Gunter 1928, p. 85)

in which Sir Roger Pratt anticipates the one of the problems that eventually lead to the abandonment of bond timbers, as well as stating their purpose.

THE GREAT FIRE OF LONDON (1666)

Towards the end of the 17th century, bond timbers started to be incorporated in the inside face of the party and external brick walls of most masonry buildings in England as a matter of course, as can be seen in the interior of the unfinished wing at Boughton House dating from about 1690 (fig.1). James Campbell (1999, p.170) refers to their use as recorded in the accounts for Kensington Palace for July 1691 – "John Hayward, Carpenter, Offices in ye Woodyard, &c. For 3659 chunks of oake in ye Brickworke. For 186ft of oake bond timber in ye foundations".

Frequently bond timbers were continuous through window and door openings and were cut out later when the shell was complete and the lime mortar had hardened. By the mid 18th century, builders incorporated them in most brick buildings in England.

Why did this practice start at that time and what had changed to prompt this alteration to construction practice which would have increased both the time taken to build the walls and their cost?

Until 1667, and the Act for the rebuilding of the City of London following the Great Fire, most ordinary buildings had timber framed walls, albeit sometimes with the masonry party walls that had been a requirement in London since 1189, but had not been rigidly enforced or complied with. There were of course many brick buildings, but they were palaces and large houses, not the ordinary housing and smaller buildings for commercial use that would be found in city and town centres.

The Fire was such a catastrophic disaster that it caused a radical change in building construction, and the rebuilding Act of 1667 included a requirement that all the external walls of all buildings be made of brick or stone, and set out required thicknesses for brick party walls. Whilst this change only applied legally to the City of London, it will have influenced building construction throughout the rest of the country, particularly in the London area.

Reconstruction in brick in the City proceeded apace and it is likely that that first generation of city centre brick buildings will have suffered from the cracking and distortion that might be expected when building quickly in lime mortar, and with the unaccustomed detailing that resulted from the restrictions in the Act forbidding timber external walls. In order to avoid or at least minimise this distortion in the future, it is suggested that builders started to incorporate bond timbers into the brickwork of the superstructure, as they had been accustomed to do where there was an obviously dubious foundation or a potential weakness, and this soon developed into normal practice.

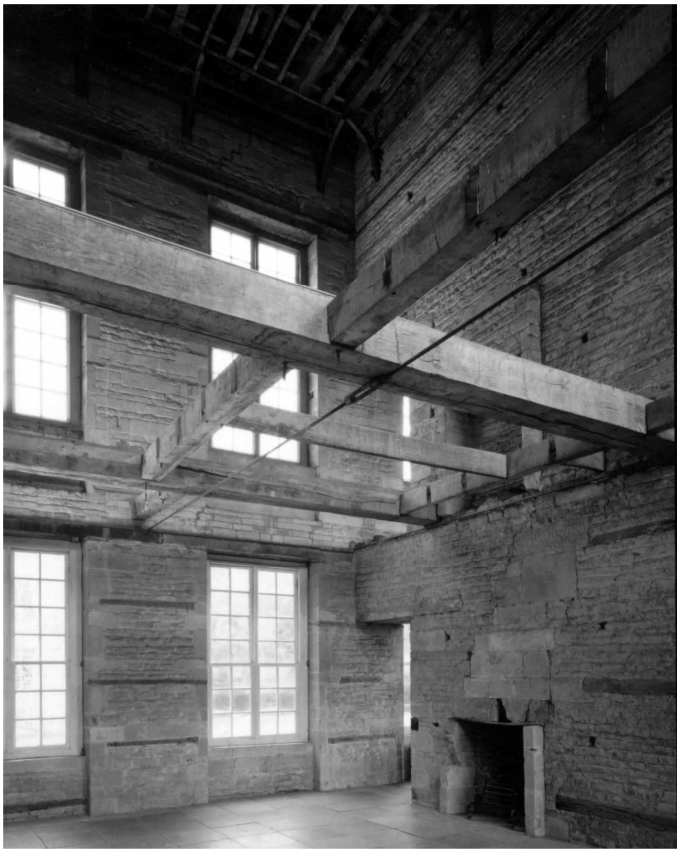


Figure 1. Interior of unfinished wing at Boughton House, showing bond timbers

EIGHTEENTH CENTURY CONSTRUCTION

An 18th century manual on carpentry – The Carpenters' Companion, (James Smith 1733), quoted in Thomas Martin's Circle of the Mechanical Arts, explains their purpose:

> I […] may venture to affirm that the carpenter's work is the chief tie and connection of a building; it is the ligament which binds the walls together.
>
> The bond-timbers, which strengthen and tie the angles of a building, and prevent its separating, is the work of the carpenter. Linteling over doors and windows, with other dischargements of weight, it is his care to perform.
>
> Bond timbers in cross walls, when settlements happen, if they are well applied, prevent the cracking of the walls, for they keep the whole together, and every part settleth alike, which would fill the building with gaps and chasms if neglected.
>
> (Martin 1820, p. 151)

And James Ayres (1998 p.116) reports the presence of bond timbers in a number of houses in Spitalfields, then a suburb of London, dating from c 1725, and quotes (p.116) Soane's specification of 1789 which instructs the builder to install: "Rough riga Memel Timber in Bonde halved, dovetailed and scarfed". He also quotes (item 92 Notes to chapter 5) Soane's documents for Tendring Hall referring to "cutt'g away Chain and Bond'g Timber in Apertures".

The legislators drafting the Acts controlling building construction in London during the eighteenth century clearly had difficulty in deciding what timbers were acceptable in party and external walls. In the Act of 1708 timber in walls was forbidden, except the ends of trusses and girders and the short templates to spread their loads, and the preamble to the Act of 1759 reiterated this prohibition. But the Act of 1763 appears to allow bond timbers in front and back walls, providing their ends are separated by at least 9 inches of solid brickwork. The first Act of 1766 reiterated the ban on "Linthaling, Bond Timbers" being laid in party walls, but later that year another Act allowed necessary bond timbers to be laid in party walls, providing there was at least 9 inches of solid brickwork between their ends and sides. In the Act of 1772 "sound square bond timbers" were permitted in front, rear and party walls, with 5 inches of solid brickwork separation. This was confirmed two years later, in the 1774 Act, although the separation was increased to $8^{1}/_{2}$ inches. It appears likely that architects, surveyors and builders were confused by this flood of legislation, with six Acts each with their own contradictory wording in a space of less than fifteen years, and probably turned the usual blind eye and carried on with their accustomed practices.

Pain's British Palladio or The Builder's General Assistant (1788) includes a cross section of a Gentleman's House showing a profusion of bond timbers in nearly every wall, many through the

full thickness of internal walls (fig.2) and all but the outer skin of external walls, and his 'Estimates of Prices under Carpenter's work' provides costs for :

Bond timber and lintels, at per foot cube, in fir	1s 10d	to	0. 2. 0
Labour to ditto, cutting off and laying, at per foot run			0. 0. $0^{1}/_{2}$
If oak bond and lintels, at per foot cube	3s	to	0. 3. 6
Labour to ditto			0. 0. $0^{3}/_{4}$

(Pain 1788, p. 9)

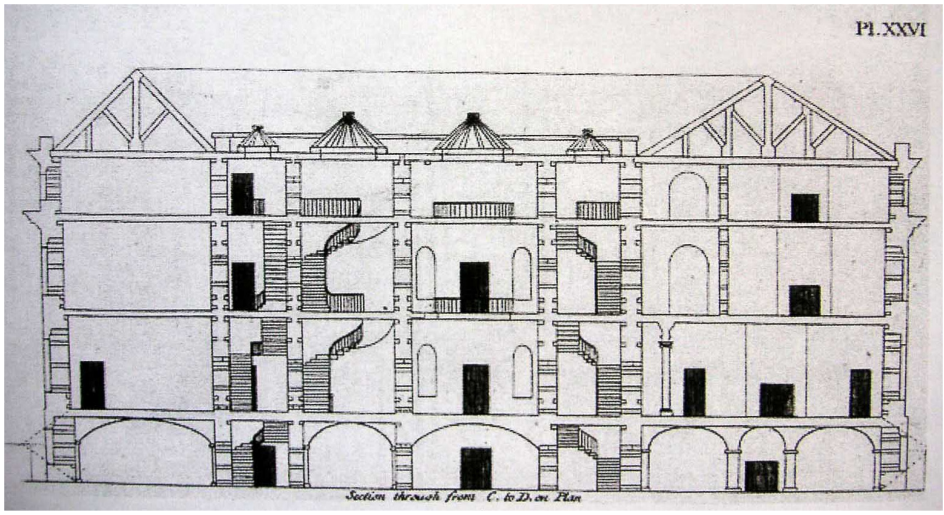


Figure 2. Plate 26 from Pain's British Palladio showing bond timbers (1788 pl. 26)

Nicholson's Carpenter and Joiner's Assistant (1797) includes a plate (fig.3) illustrating naked flooring for a house, incidentally without a stair well, with elevations of the front and party walls showing four levels or tiers of bond timbers in addition to wall plates under the floor joist ends. It is to be noted that one tier of the bond timbers in the front wall continues across the window openings, to be cut out later when the mortar is mature.

In one of the surviving, unaltered, warehouses at Cutlers Gardens, now known as Shield House, substantial internal bond timbers clearly originally continued across the window openings and were cut out later. This practice, shown to be general by contemporary references is seldom appreciated today.

Anyone concerned with alterations to buildings in London dating from the end of the 17th century to the mid 19th century will confirm that bond timbers are to be found, built into the inner skin of all external and party walls, generally one course deep and one brick wide. They are sometimes halved

at the corners, but more commonly in speculative work are just lapped and nailed, and are only interrupted for flues.

According to Cruickshank and Burton:

> In 1796 the surveyor to the Foundling Estate, Bloomsbury, then being speedily covered with speculative housing, noted his anxiety that insufficient bond timbers were being used in the speculatively built houses he had inspected. He feared that this omission would result in the houses not holding together and that they would settle with the two skins of the façade separating.
>
> (Cruickshank & Burton 1990, p. 110)

This is a surprising comment because bond timbers restrain walls longitudinally, and do nothing to remedy the lack of bond commonly found between the external half brick thick skin of (expensive) facing bricks and the backing of (cheap) place bricks.

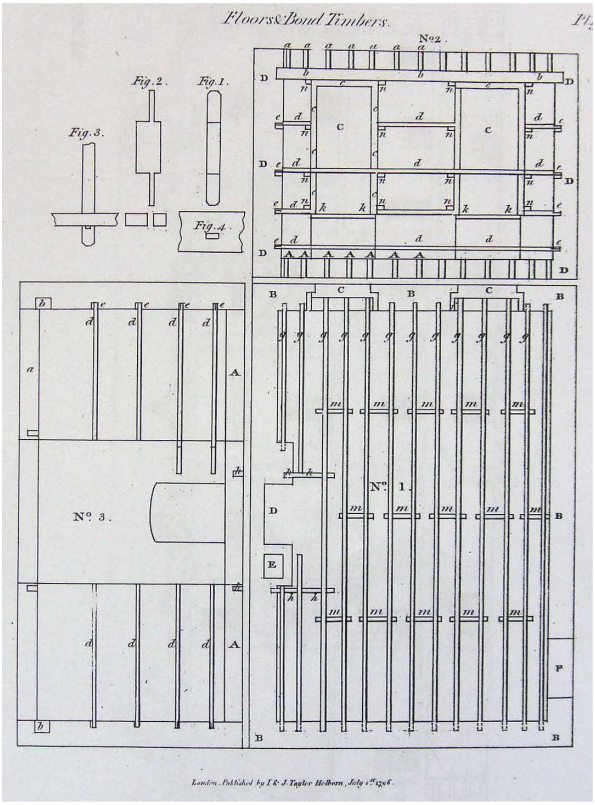


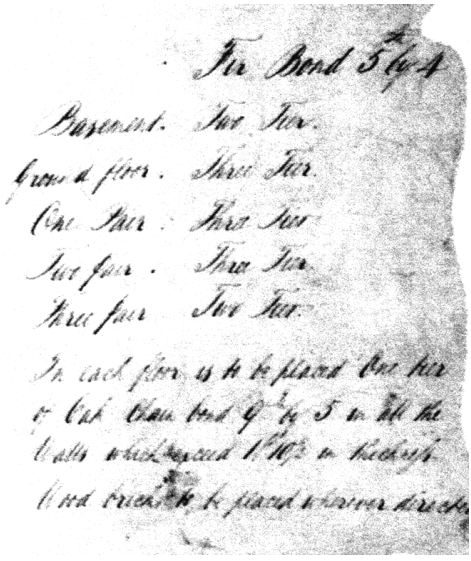
Figure 3. Plate 9 from Nicholson's Carpenter and Joiner's Assistant (1797 pl. 9)

CHAIN BOND

Towards the end of the 18th century, in more substantial buildings, bond timbers were built into the centre of walls. This had two purposes, to avoid potential disruption due to eccentricity when a bond timber in the internal face shrinks or rots, and to remove the timber to a location where it would be less liable to burn or char if a fire occurs. This chain bond was generally of a larger section, two or three courses deep and one brick wide, but of course the wall had to be at least four bricks thick.

Laing's drawings for the London Custom House held in the National Archives at Kew, of which construction started on site in 1812, provide more information about how they were detailed. One drawing specifies the timbers in the centre and face of the walls (fig.4), and one shows the chain bond on section (fig.5).

Another of the surviving Custom House drawings (fig.6) uniquely details the chain bond at one floor level in the east wing, showing timbers across window openings in the external walls, across doorways in the internal walls and even across corridors, noting that they are "to be cut out afterwards".



Fir Bond 5in by 4

Basement.	Two Tier
Ground floor	Three Tier
One Pair	Three Tier
Two Pair	Two Tier
Three Pair	Two Tier

In each floor is to be placed One tier of Oak Chain bond 9in by 5 in all the Walls which exceed 1ft 10½ in thickness.

Wood bricks to be placed wherever directed.

Figure 4. Detail from drawing of London Custom House noting internal (fir) and oak chain bond with notes transcribed (No.64)

Pasley, writing in 1826, points out the perils associated by the rotting of continuous timber cills in the foundations of buildings, which has recently been suggested as the real cause of the Custom

House collapse in 1825 (Hurst 2001), rather than the piling failure on which it was blamed at the time, and writes:

> instead of using continued planking, it will be best to employ a couple of parallel longitudinal timbers for the same purpose, laid at a sufficient interval apart which, when surrounded by brickwork or masonry, are called chain timbers.
>
> The annexed figure **[fig.7]** represents a foundation secured in this manner. Two parallel chain timbers, seen in section, which may be about five inches square or thereabouts, are laid upon transverse sleepers, placed also parallel to each other at intervals of about feet apart (presumably he means a foot apart). If this arrangement be adopted, it will be evident in the event of the woodwork decaying, the base of the wall will have a sufficient and solid footing on natural ground; for the intersecting grooves of about five inches square that will be occasioned by the rotting of the timber are too small in themselves and at too great intervals to injure the stability of the brickwork. It will be understood that the chain timbers, which extend all round the building, and which, therefore must be in several pieces, are firmly connected together at the ends by scarfing or otherwise, and they are pinned down to the sleepers upon which they lie. A third chain timber may also be used, but not on the same level with the others, in which case it might weaken the wall too much, but in the centre of the wall two or three feet higher; as, for instance, at the part where the uppermost offset of the footings terminates. This third chain timber is also represented in the figure, and it will be evident that the three combined will nearly produce the same favourable effect in the first instance as a continued planking, but without being liable to any of its inconveniences.
>
> (Pasley 1826, p. 21-2)

Certainly the 9 inches wide x 6 inches high longitudinal void my practice found in the centre of the brick wall above the footings of the Duke of York's Headquarters (by John Sanders 1801-3), where a chain timber had entirely disappeared, had not lead to any 'inconvenience'.

"Chain timbers imply those which are completely buried in the wall, so that no part of them is seen after the brickwork is raised to a higher level." This definition, by Pasley (1826 p. 182), explains why chain bond comes as a surprise to most people concerned with alterations to late eighteenth and early nineteenth century buildings. Until parts of the brickwork are cut away for some purpose, it is entirely concealed.

The one place that it can be seen in cross section is in the reveals of door and window openings, following removal of the linings. The puzzle as to why a substantial timber is built into the centre of a pier only a few feet wide, is explained when it is appreciated that the chain bond was continuous through openings, and indeed even across corridors, to maintain the stability of the building under

construction and was cut out afterwards. This was apparent, also at the Duke of York's Headquarters centre block, when a 9"x 6" timber was exposed in the centre of the piers between the windows when the shutter boxes were removed, and is confirmed by the Custom House drawing reproduced above.

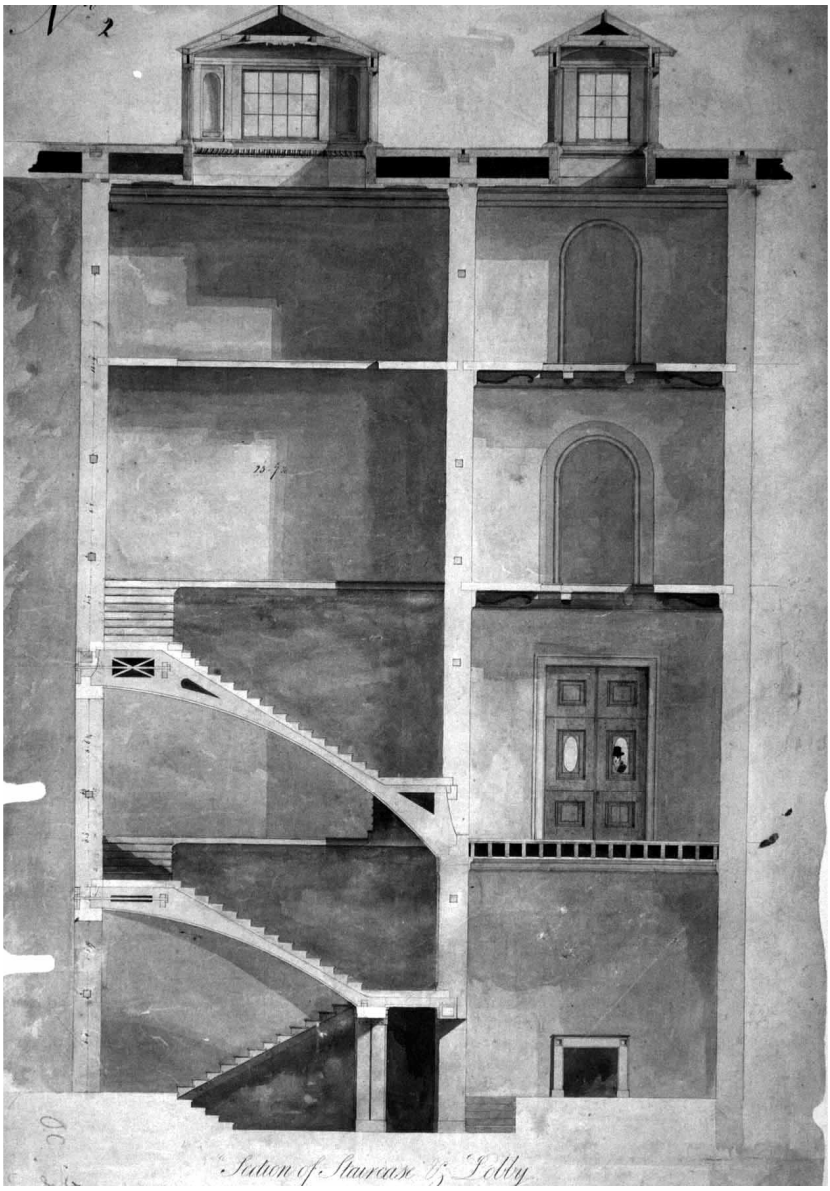


Figure 5. Section through London Custom House showing bond timbers in internal wall (No 81)

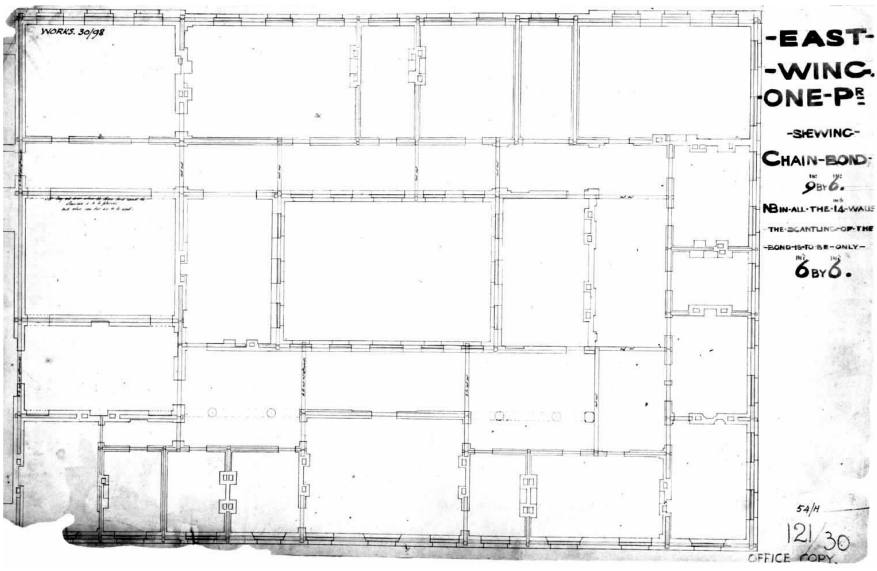


Figure 6. Floor plan of London Custom House detailing chain bond timbers in both internal and external walls, across doorways, windows and corridors – "to be cut out afterwards". (No 98)

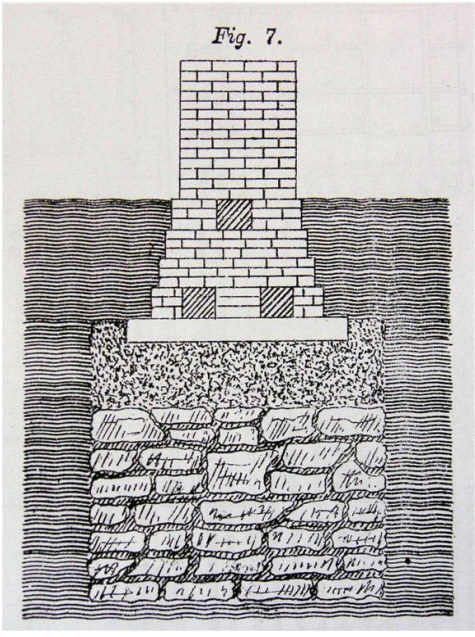


Figure 7. Chain bond timbers in foundations of buildings in Lancaster Place. (Pasley 1826 p.27)

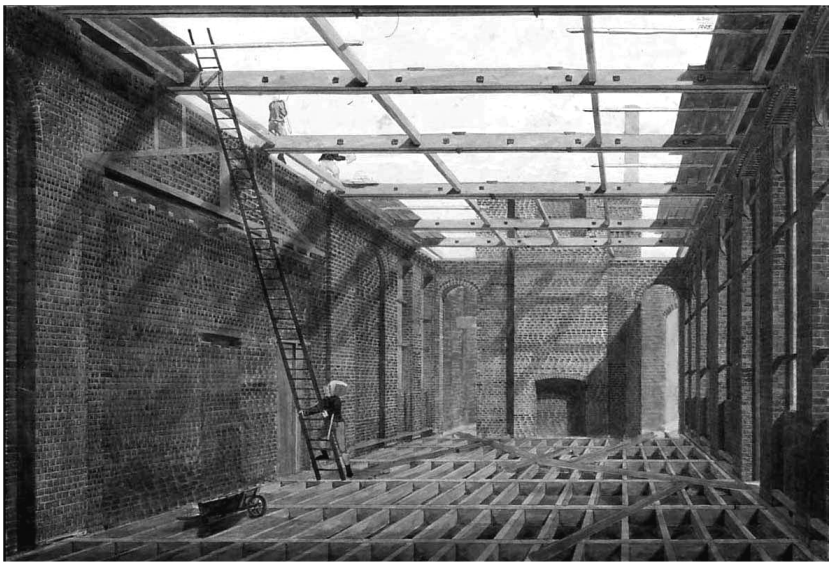


Figure 8. Drawing of construction work in the Long Ward at Chelsea Hospital c.1814, used by Sir John Soane in one of his Royal Academy Lectures, showing chain bond timbers across window openings. (14/7/5)

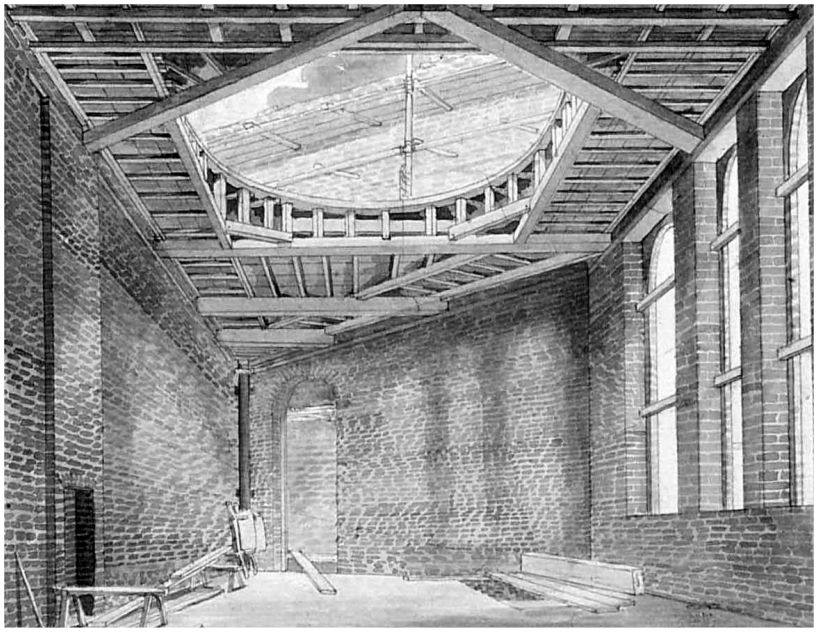


Figure 9. Progress view of Anderson & Manning' Counting House 11th October 1810 showing chain bond timbers across window openings(Vol.71/14)

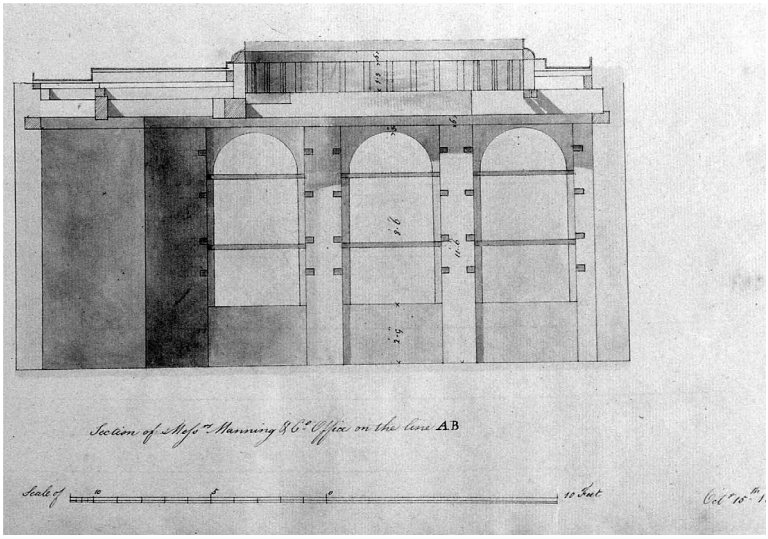


Figure 10. "Section of Messrs Manning & Co's office on the line AB" October 15th 1810 corresponding to above watercolour, showing bond timbers and wood bricks (Vol. 71/9)

Pasley also writes about buildings under construction in 1825:

> The ingenious and judicious arrangement of chain timbers adopted by Mr. Baker, for the purpose of securing the foundations of his new buildings in Lancaster Place, London, has already been described. {repeated above} In the same buildings he has introduced two lines of chain timbers in every story, from the foundations upwards, one immediately below and the other above each tier of windows, the latter of which answer the double purpose of chain timbers and of lintels. These longitudinal chain timbers, inserted into the middle of the walls, are connected with transverse timbers of the same description, introduced into all the party walls, the continuity of which is only broken by the stacks of chimneys, where it would of course be improper to use timber of any description.
>
> (Pasley 1826, p. 182)

He also points out the disadvantages of the "common arrangement" of bond timbers and wall plates, which leave an eccentric void in the wall if they should rot or if there is a fire.

And he clarifies the sequence of construction of a brick building:

> In the construction of a building it is usual to lay not only chain timbers, wall plates, and other timbers that must enter into the wall, but also the joists of single floors, and the girders and binders of framed floors, as soon as the brickwork is carried up to the level at

> which they are to be placed. The framework of partitions is also fixed at an early period. In short, the whole skeleton of the carpentry of a building keeps pace with the brickwork; and the custom is for the bricklayers to prepare the bed, as it is termed, for every timber to rest upon, after which the timber itself is raised and placed by the carpenter.
>
> (Pasley 1826, p. 233)

This is graphically shown in the fascinating drawing of construction in progress at Chelsea Hospital used by Sir John Soane (Fig. 8) to illustrate one of his lectures, which, in addition to chain bond timbers across window openings to be cut out afterwards, also pictures naked flooring carried on timber girders trussed with iron and future openings framed in timber but temporarily in filled with brickwork. Other drawings by Soane's pupils are illustrated at figures 9 & 11. Figure 10 is the section drawing associated with figure 9, but surprisingly dated a few days later.

Figure 11. Drawing by one of Sir John Soane's pupils of construction in progress at Dulwich showing bond timbers (Vol.18/22)

DISILLUSION WITH TIMBER BOND AND SUBSTITUTION OF HOOP IRON

But by 1830, disillusion is setting in, as referred to in the second edition of Tredgold's Carpentry:

> Building new timber into wall is often a cause of decay, as the lime and damp brick-work are active agents in producing putrefaction, particularly where the scrapings of roads are used instead of sand for mortar. Hence it is that bond-timbers, wall-plates, and the ends of girders, joists and lintels are so frequently found in a state of decay.
>
> (Tredgold 1829, p. 195)

and by 1836, Pasley had revised his recommendations, and of chain bond timbers. He writes:

> Sensible of the disadvantages of internal bond timbers, let into walls, flush with the surface, the most eminent British Architects have recently abandoned this construction altogether, substituting chain bond timbers instead of them, which being buried in the middle of walls, are not exposed to fire, and if they should decay, the wall will evidently be less weakened, than by a like failure of the former.

But:

> This construction was considered very promising at the time, but I am informed, that dry rot has resulted from it in a few years, at least where fir or even English oak have been used.

And advocates:

> four or five courses of cement bond, that is of bricks laid in pure {Roman} cement immediately over the apertures of doors and windows, strengthened by hoop iron in the joints, and continued entirely round the walls of a building at the same level.

which he says:

> will have all the advantages of chain bond, without any of the disadvantages of woodwork
>
> (Pasley 1836, p. 169)

and George Goodwin, writing in The Architectural Magazine (1838, p. 578) recommends "two courses of bricks […] in Roman cement or asphalte instead of mortar" as "an efficient substitute."

The 1842 Liverpool Building Act allowed bond timbers in external walls but not in party walls and the Liverpool Fire Prevention Act of 1843 stated emphatically:

No Bond Timber or Templates of Wood whatever are to be inserted in Party Walls, Bond may be obtained by Hoop-iron, and templates of Hardstone or the like.

This was followed by the 1844 Metropolitan Building Act which effectively forbade the use of common (internal) bond in external walls in London with the following clause:

> But no timber must be laid into any external Wall in such a Manner or of such length as to render the Part of the Wall above it wholly or in great Part dependant upon the wood for support, or so that any such wood might not be withdrawn without endangering the Safety of the superincumbent Structure, except in the Case of Breastsummers.

So only the ends of wooden joists, girders, partitions could be built into London party walls – no longitudinal timbers. Thus a 4 inches wide bond timber was clearly disallowed in a one brick thick wall, and probably in a one and a half brick wall, but would have been accepted in a two brick thick wall. Chain bond would have been acceptable, but this was generally only used in substantial buildings, not in speculative terrace housing.

The 1844 Act was so much longer and more comprehensive than the Act of 1774 which it replaced, so it is not surprising that its requirements were not entirely clear to those who had to abide by it. The Builder editorial on 9th January 1846 reported:

> doubts as to the precise meaning of many of its provisions still exist. In some, the district-surveyors are not agreed even amongst themselves, but act differently in similar cases; and considerable unpleasantness is the unavoidable result.

And a few weeks later it reported (p. 54) the conclusions of a meeting of the Society of Master Carpenters who had already drafted a petition against the Act and its "ill workings", citing:

> the useless and oppressive nature of some of the enactments: […] the prohibitions as to the use of timber, which were in many cases not only useless but equivocal and mysterious, especially as relates to party-walls, and the mode of putting in plates;

The collapse of three houses in course of construction on 12th November 1846, reported in The Builder the following week, was blamed by some of the witnesses giving evidence to the inquest on the labourer killed, on the embargo on wood bond in party walls, even though "The landlord's surveyor (Mr Blore) had expressed a wish that hoop iron should be used to tie the walls, which was extensively done." Even though he "Preferred bond timber, but iron tying does for it. Wood bond was liable to fire." And "In his opinion wood was the best bond and tie to a wall that could be possibly had." The contractor and his tradesmen shared that opinion.

The District Surveyor – Mr Donaldson – gave the reasons for the ban:

> As to the prohibition of wood, he and about twenty other surveyors were applied to, by the Lords and Commons, for their opinions on the subject, and it was decided that keeping wood out of party walls would affect a great saving from fire. If a building was examined after a fire, it would be seen that the wood was all burnt out, and only holes left in the walls. Thought an iron hoop tie was as good as a wood one. Thought more timber might be put in front walls.
>
> (The Builder 1846, p. 553)

The jury blamed the collapse on the excessive speed of construction in damp weather

> and the directions of the Act of Parliament, which compelled the builders to construct the party-walls without bond timber. At the same time, the jury hope that next year the

> erection of party-walls with, and without, bond timber will be made the subject of legislative investigation, through the evidence of practical working builders, carpenters and bricklayer, with a view to ensure a safer mode of erecting places constructed chiefly of bricks.

The Builder editorial concludes with a recommendation that:

> four or five courses of bricks all round the building be carried up in Roman cement (without which iron hoop bond is unquestionably less efficient than the old wood bond, with all its faults).

A correspondent to The Builder (p. 67) who signs himself A Builder averts that "hoop iron, of itself, will not prevent irregular settlements" being too flexible, and laying it in courses of brickwork in cement is not much better, and that the Metropolitan Buildings Act which, by prohibiting the use of wood bond or plate has been the cause of so many failures.

Insecurity in the front wall of the building in Great George Street undergoing alterations for the Institution of Civil Engineers is attributed to "the slight bond timbers across the windows so that the whole front was in a dangerous state". (The Builder 1847 p. 114)

Two months later The Builder editorial (23rd January 1847 p. 33) describes reports of problems with the walls of Covent Garden Theatre, where "The whole of the wood bond in the lower part of the walls of the theatre had decayed entirely, and […] had left the building in an evidently insecure state". These are likely to be the walls of Smirke's 1808-9 reconstruction, at that time less than 40 years old. As this left chases in the faces of the walls 9 inches x 6 inches or even larger, insecurity is not surprising. Later the editor advocates chain bond, where, being in the centre of the wall, "decay seldom takes place" – clearly he had not spoken to Pasley – and goes on to recommend the substitution of hoop iron in courses of brickwork laid in [Roman] cement mortar, however he immediately contradicts himself by saying :

> Bond timbers are valuable in new work by distributing the various weights, and preventing irregular settlements. The front and back walls of ordinary dwelling houses, consisting for the most part of slight piers, indifferently executed in too many cases, are more likely to remain sound and unshaken when bond timbers pass through openings (afterwards to be cut out) and so hold the whole together, until the work gets its bearing and consolidates this.
>
> An equivalent for this is not provided by hoop iron alone; a cement bond is necessary; but unluckily the additional cost of this, small as it is, is sufficient to prevent the use of it, and

> in so many cases where wood bond is prohibited, the stability of the structure is made to suffer.
>
> (The Builder 1847, p. 33)

The restrictions on the use of bond and other timbers in the 1844 Metropolitan Building Act were confirmed by the 1855 Act.

The advice prefacing Skyring's Builders' prices – "Precautions for the better security of buildings" - also changed. In 1838 the author wrote:

> let the plates be strong and in one length to the front and back, and returned as far as convenient, with stout lintols to all the openings, as much depends on them: do not be too saving of the bond, which must be of the width and thickness of the bricks;

But by 1862 the words in italics had changed to:

> Let the work be well bonded; for which purpose iron hooping, with about four courses of brickwork in cement may be used in brick walls with great advantage:

But not everyone was convinced that timber bond was a bad thing. In the discussion following Edwin Nash's paper to the RIBA in 1867, C F Hayward said:

> in making out the list of failures, he would refer to the use of bond timber, which was most fatal to all permanency in construction. If any quantity of wooden plates and bond timber were used in the walls of any building, it must eventually tumble down of its own accord, if not otherwise destroyed from any of the other causes, and in cases of fire it was particularly dangerous.
>
> (Nash, 1867, p. 192)

To which the author responded:

> The remarks as to the advisability of keeping wood bond out of walls have little force, because wood bond is the very bone and muscle of a weak building.

Similar words to those used by James Smith in 1733, but at a time when wood bond was really on its way out, and now followed by:

> I say of a weak building, where nevertheless it is most objectionable, on account of its shrinkage and perishable nature.

So after all he agreed with Mr Hayward, though clearly regretted it's passing.

It really does appear that at the middle of the 19th century, wood bond was agreed to still be the best way of ensuring the stability of external walls, even though forbidden in London, but its shortcomings were reluctantly recognised. The alternative – hoop iron bond in cement courses – was too expensive and was agreed to be less effective in serving the purpose. Some writers advocated the use of courses of brickwork laid in Roman cement mortar without mention of hoop iron as a substitute for bond timbers, as discussed in Hurst (2002).

Nevertheless, my experience of working on buildings in London, mostly in terraces, shows that after 1850 wood bond is the exception rather than the rule. Hoop iron bond is found in more substantial non domestic buildings, such as Finsbury Barracks (by J J Jennings 1857), the buildings which became the Normandie Hotel, Knightsbridge (1876), Jones Bros' first building, off Holloway Road (c.1870), but never in my experience in Roman or Portland cement mortar. However the Specification dated 1890 for T & F T Verity's new building at 96/97 Piccadilly included "Provide 100 cwts Hoop iron bond well tarred & sanded, lapped at the joints & build in cement."

Only four of the 42 buildings in Donaldson's Specifications (1859) incorporate bond timbers, and those date from the 1820s & 30s, whereas nearly half of those 42 buildings incorporate hoop iron bond, but those of course are substantial buildings by leading architects, and fig.12, taken when the former buildings at the east end of Poultry in the City of London, dating from c1870, were being demolished, illustrates the amount of hoop iron bond projecting from the front wall which had been built into a party wall.

It is interesting to note that Barry's specification for the New Houses of Parliament, before 1846, (printed in Donaldson) included a clause (p. 433) reading "No bond timbers or wood bricks, or any other timbers, are to be laid in the walls.", and also a long clause (p. 431) describing where "well pitched and sanded" hoop iron was to be built into the walls, and providing for 680,000 yards run, "one third to be laid diagonally in short lengths."

The practice of using any sort of bond, timber or hoop iron fell into disuse by the end of the nineteenth century, and many buildings were built without bond, such as the J J Stevenson's terrace of nineteen large houses in Buckingham Palace Road, built speculatively by Willett between 1890 & 96, where my practice saw no sign of any form of bond in the course of extensive alterations.

It is suggested that the generally smaller scale of speculative terrace housing in the closing years of Victoria's reign and the early years of the twentieth century coupled with better mortars was the reason for the omission of bond, for by that time larger and commercial buildings had structural frames.

Figure 12. Back of front wall of buildings c1870 in Poultry, London in course of demolition showing quantity of hoop iron bond connecting front & party walls

ACKNOWLEDGMENTS

Figure 1 is reproduced by kind permission of the Duke of Buccleuch and Queensberry, KT.

Figures 4, 5 & 6 are reproduced with the consent of the National Archives. They are in Works 30 and relate to the London Custom House.

Figures 8, 9, 10 & 11 are reproduced by courtesy of the Trustees of Sir John Soane's Museum.

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An Act for widening certain streets …, 1759, (33 Geo.2. Ch.30)

An Act for the better regulating of Buildings; to prevent Mischiefs that may happen by fire within the Weekly Bills of Mortality, an other places therein mentioned, 1763, (4 Geo.3 Ch.14)

An Act to explain, amend, and render more effectual, the Powers of an Act made in the Thirty third Year of the Reign of His late Majesty, intituled, An Act for widening certain streets …, 1766, (6 Geo.3. Ch.27)

An Act to explain, amend, and render more effectual, an Act made in the Fourth Year of His present Majesty's Reign, or the better regulating of Buildings, and to prevent Mischiefs that may happen by Fire, .., 1766, (6 Geo.3. Ch.37)

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