

The appearance of trusses in the Low Countries

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Stone buildings of the Romanesque period might still contain original timber parts. These early wooden constructions of floors and especially carpentry are starting point of a development leading to the application of trusses in the 13th century. Thanks to dendrochronology it is possible to discover the first examples and have a closer look at the type of buildings and the regions in which these trusses emerge. Though the «package» consists of protective, supporting stone walls, the construction of timbers belongs to the craft of carpenters. As soon as we begin to find written evidence, the skill of wood-working is highly specialised already and master carpenters travelled widely in search of timber and notable commissions.¹ Mastering a craft like carpenter took years, may be decades of apprenticeship, oral training and learning by practising. Much of this mediaeval process remains a mystery because of a lack of written information and therefore becomes a degree of secrecy. Little changes in this co-operative system of working and training: comparable constructive solutions and similar materials in place and time occur. However, minor or far-reaching changes took place. Do we talk about evolution or invention as ways of change? Do internal improvements, ideas from outside, new tools, different materials or demands of other crafts cause them? Though interesting, different types of assembly-marks, the use of purlins in stead of plates, belongs to the minor changes in roof constructions,

unlike trusses. Trusses differ in size and place from the rafters they support. They are primer frames, spaced at about 2 till 5 meters interval, newcomers and successors of the earlier common rafter roof. In the Low Countries their introduction took place in the 13th century, first and most independently in the south, gradually and later, more as part of the rafter roof, in the north during the 14th century.

Continental studies of carpentry appeared in Germany in 1908 (Ostendorf), 1980 (Mennemann) and 1991 (Binding), in France in 1875 (Viollet-le-Duc) and 1927 (Deneux), as in Belgium in 1995 (Walloon provinces in Belgium, Hoffsummer). Herman Janse, an active member of the Netherlands Department for Conservation (Rijksdienst voor de Monumentenzorg, RDMZ) published his main work about roof framing in the Netherlands in 1989. Previously, in collaboration with the Belgian Luc Devliegher, Janse had presented an important article about shared timber heritage in the Low Countries (1963). Janse's elaborate typological investigation, comparable with those formulated by C. Hewett and others in Britain, can now better be dated thanks to a series of dendrochronological investigations which I have carried out for the RDMZ since 1984. In a small country like The Netherlands there are remarkable differences in the «development» and diffusion (as far as this might be considered an autonomous process) of roof construction. In this contribution I try to find a relational context and the connections with

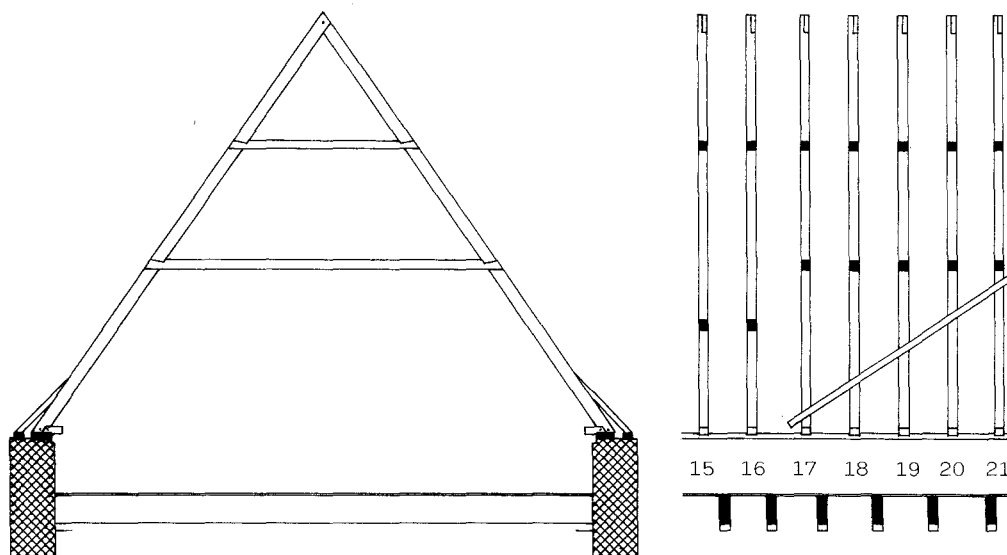


Figure 1
Drakenburg House, Oude Gracht 114 Utrecht 1291 (d). (Drawing L.M. de Klein RDMZ)

floor and wall structures for the oldest trusses in roofs.

THE COMMON RAFTER ROOF

Throughout the Netherlands no evidence of timber roof construction prior to the thirteenth century has yet been found. Like elsewhere in Europe, the most basis form, the pure single rafter roof, is practically timeless: this type occurred in towns up until the fourteenth century and the countryside in the following centuries. Common rafter roofs can be found on houses in the town of Utrecht, built around 1300 with timber for rafters and collars of South-German fir with rectangular cross-section (*Abies Alba*) in addition to smaller pieces of oak for curved parts and at the bases in connection to the walls. The couples of rafters are erected on double wall plates and, at a right angle to them, on a sole-piece in which each rafter and a vertical post, the Ashley-piece, are jointed with a mortice-and-tenon. Drakenburg House (1291 d) and Te Putte House (1309 d) both merchant and warehouses situated on the Oude Gracht (Old Canal) have roofs built in this way in combination

with thick brick walls and single floor joists, Figure 1. The number of collars vary from one to three, like the roof of the (not dendrochronologically dated) Dean's chapel of St. Peter's church in the same town with two collars. There is no fundamental difference between these common rafter roofs on houses, churches or other types of buildings. Though, church roofs often have wider spans and special solutions, either for a spacial or a constructive purpose. Such a variation of the common rafter roof with curved braces for a boarded ceiling, giving the effect of a barrel vault, like St. John's in Utrecht has (1279 d), Figure 2. The spacial advantage of this type of roof construction is that the interior of the church looks higher by integrating the roof (loft). The region in which the wooden barrel-vaulted ceiling was used as a specific architectural style for churches in the Netherlands extends in the west along the sea coast.² In the oldest (church) roofs every couple of rafters had its own tie-beam, like those of Our Lady's in Maastricht (reconstructed, 1219 ± 5 d), Figure 3. In order to avoid sagging of the tie-beam, a number of hanging post is added. Though roof constructions of that type and age are rare in the Netherlands, we find them in France and Belgium dating back to the 11th

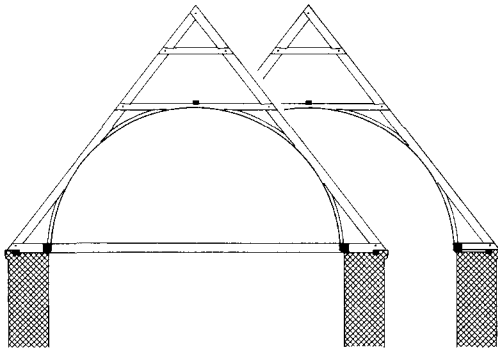


Figure 2
Nave and transept of St. John's church in Utrecht (1279 d).
(Drawing L.M. de Klein RDMZ)

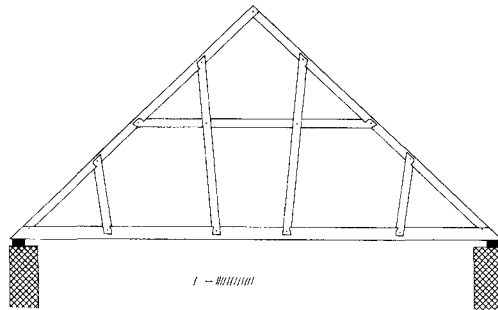


Figure 3
Our Lady's church in Maastricht, reconstructed triangle of tie-beam and a pair of rafters, 1219 ± 5 (d). (Drawing L.M. de Klein after H. Janse RDMZ)

and 12th centuries.³ In the last quarter of the 12th century, probably due to the apparent economy in the use of timber, one or may-be even a next tie-beam belonging to a pair of rafters was left out, presumably to save on wood. We find this clever solution not only in France but also in Belgium: Soignies (Saint-Vincent 1185–1200 d), Ename (Saint-Laurant 1175–1185 d) and Huy (Saint-Mort 1230–1235 d).⁴

Later on in the 13th century tie-beams only occur under every fourth, fifth or sixth etc. pair of rafters, Figure 4. The sole-pieces of the rafters in between are joined by a horizontally tenoned piece. These sole-pieces have the appearance of reduced tie-or foot-

beams. Though we are still talking about common rafter roofs, in this system tie-beams tend to become concentration points of forces, here often in corporation with a single hanging post. In between we find pairs of rafters with reduced tie-beams, sometimes reinforced by scissor braces. The rafters sometimes show an alternation. In the north hall of Saint John's hospital at Bruges there is a common rafter roof of oak wood (1268 d) with two collars and alternating smaller and bigger rafters, Figure 5.⁵ The smaller rafters are half as wide as the bigger one's which have a square cross-section of 18 × 18 centimetres. Though, regarding common rafter roofs in combination with single floor joists and

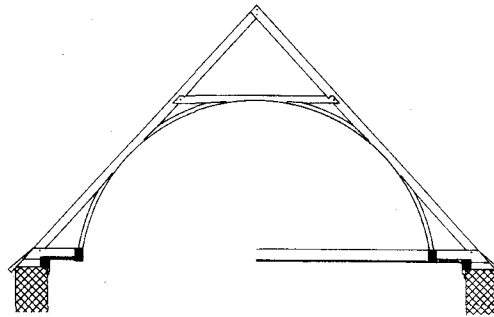


Figure 4
Oirschot, Boterkerkje, roof with barrel-vaulted ceiling of the 13th century. (Drawing L.M. de Klein RDMZ)

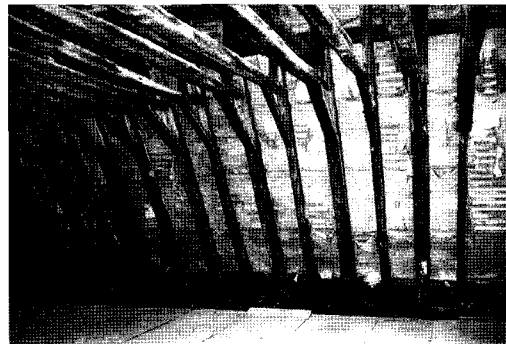


Figure 5
North hall of Saint John's hospital in Bruges, 1268 (d).
(Photo by the author 1999)

Romanesque architecture, around the year 1200 this carpentry reveals a tendency of concentrating forces in main rafters with tie-beams, finally leading to the Gothic way of constructing.

THE APPEARANCE OF TRUSSES

The oldest rafter roofs with trusses date of the 13th century. In the Netherlands they are present in the very south in two mendicant order churches at Maastricht. These are the roofs covering the choirs of the Dominican, Figure 6, and Franciscan churches, which date to 1277 (d) and 1305 (d) respectively. We find the horizontal truss beams joined with pegs to the rafters under they are placed, and bear similar number/assembly-marks. In a way these trusses can be regarded as part of the common rafter roof, a logical next step in the development of junctions with a concentration of forces. However, we do find a new element: a threefold of longitudinal plates resting on the trusses and supporting the lower row of collars. These plates concentrate the loads in the trusses, point

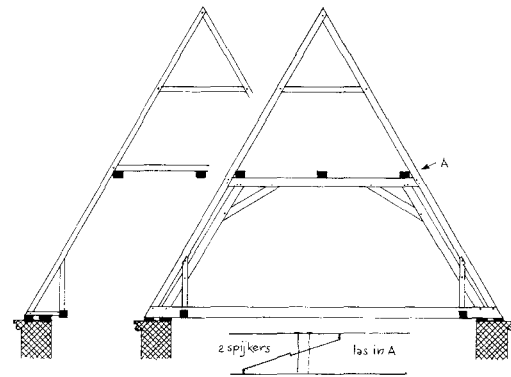


Figure 6
Choir of the Dominican's church in Maastricht, 1277 (d).
(Drawing L.M. de Klein after H. Janse RDMZ)

where the carpentry gives its weight to the sidewalls, here reinforced by buttresses (in the Gothic system).

To the west of Maastricht, in Flanders (Belgium), a number of older trusses recently has been discovered.

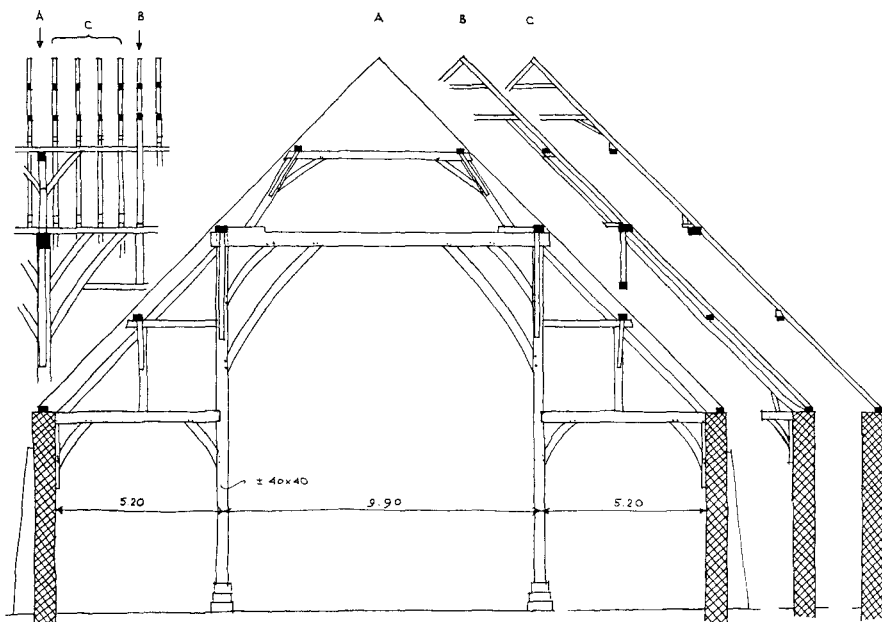


Figure 7
Lissewege (Belgium), barn of Ter Doest monastery, 1274–1294 (C14)

Several dendrochronologists attempted in vain to date the magnificent Cistercian barn of Ter Doest, near Lissewege in a polder to the north of Bruges. Here the timberwork consists of trusses on stone bases with a double bracing in both directions and a roof with single trusses, Figure 7. A closer look in the year 1998 revealed that both portal and roof trusses bear similar carved assembly-numbers, independently from the numbers on the rafters.⁶ Compared with the examples mentioned before, and trusses of a later period, this is a «modern» feature. A fairly accurate radiocarbon date places the timberwork of Ter Doest in the years between 1274 and 1294.⁷

The double barrel-vault (without a boarded ceiling) of the Bijloke hospital in Gent with a span of 16 meters reveals big trusses without tie-beams, documented and dated in 1251-1255 (d) by Patrick Hoffsummer, Figure 8.⁸ The oak wood was imported from the Meuse valley; between the trusses we find seven main rafters in alternation with smaller one's. Only the span of the former Knight Hall of the Binnenhof in The Hague counts more than 19 meters but the present construction (also without tie-beams) is a reconstruction of the mediaeval roof. Thanks to

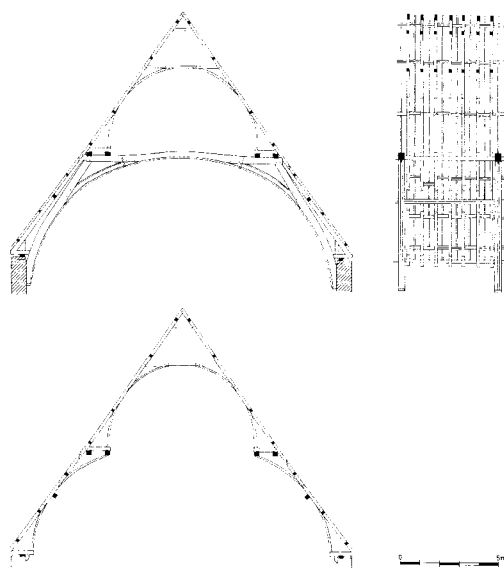


Figure 8
Gent, Bijloke hospital 1251–1255 (d). (Drawing Patrick Hoffsummer 1995)

original timbers in the flanking turrets we assume that the main roof also dated in 1288 ± 6 (d).⁹

Janse and Devliegheer already compared the Bijloke roof with the construction of the middle hall of Saint John's hospital in Bruges.¹⁰ It was a great surprise to find out that the seven meters high trusses in the oldest part of this hospital date back to 1234 ± 6 , Figure 9.¹¹ The façades and sidewalls are made of natural stone and brick; they contain single and double windows covered by round arches, Figure 10. Comparing the masonry of the window arches and the timberwork there is a striking contrast between the «old-fashioned» outside of the central hall and the trussed roof at the inside. Though the south (1285 d) and north hall (1268 d) both have relatively big, pointed (Gothic) arched windows, both have (slightly) different common rafter roofs. So, it seems



Figure 9
Saint John's hospital Bruges, roof construction of the middle hall, 1234 ± 6 (d). (Photo by the author 1999)

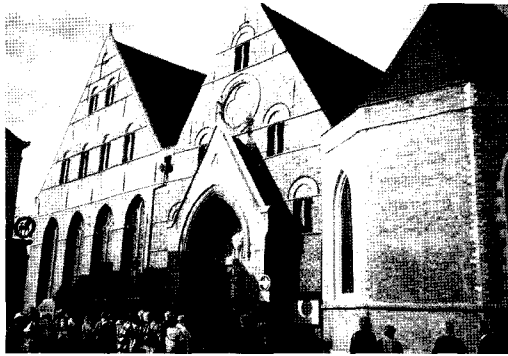


Figure 10
Saint John's hospital Bruges, front gables with south aisle (1285) on the left, middle part (1234 ± 6) with entrance under portal and to the right a chapel added to the north hall (1268). (Photo by the author 1999)

that not an architectural or stylistic reason lead to application of trusses in the central hall. This might be related to the span of the room: 12,6 meters, much more than either the north or the south hall.

For this moment the trussed roof seems to origin in Flanders: we do not find comparable early roof constructions to the south or north. A reflection on the diffusion can be traced to the north of the main rivers Meuse and Rhine. The trussed roof on the Knight hall of count Floris V in The Hague is the only example dating before 1300. The main building of the hospital of the Teutonic Knights in Utrecht, dating back to 1347 (d), has a barrel-vaulted common rafter roof without tie-beams or trusses.¹² In the episcopal capital Utrecht we find the first trussed roof on Leeuwenberg House, Oude Gracht 307 and dates to between 1319 and 1325 (d), Figure 11. It is worth mentioning here the use of both fir for long, strait parts and oak for the sole-pieces and the curved parts. As in the choirs of the mendicant order churches in Maastricht, the horizontal trussbeams are joined with pegs to the rafters under they are placed, and bear similar assembly-numbers. Only in the course of the fourteenth century carpenters in north started to number the trusses separately from the rafters. The earliest surviving instance of the separate numbering of trusses and rafters occurs in the roof of the church tower at Oudewater, dated to between 1336 and 1343 (d).¹³ In this tower we find relatively high trusses

(which seems to be an early characteristic) bearing three longitudinal plates. Other features of the 14th-century roof construction can be seen in the coupling of the principal and the wall plate via a short beam with a mortise-and-tenon in the principal; the same is done with the windbraces in the principals. The arrival of trusses brought with it the practice of adding a separate mark to the assembly-numbers on one side of the construction. This extra mark can come in the shape of a «<», a «fish», an «arrow» or an added square stripe (also called Flemish mark).

Though in the eastern provinces of the Netherlands the common rafter roof first seemed to be influenced by the application of a central reinforcement frame called «Stehender Stuhl», however soon by or in combination with trusses, like in the town of Deventer (and other like Zwolle, Zutphen and Arnhem). The house Bergschild 7 in Deventer shows trusses in the lower part of the roof and a central, longitudinal frame in the attic, Figure 12. During the 14th century a uniform system came into being by which the two opposite sides of a truss or rafter could be distinguished, for instance number three on one side was written as /// and the other side as //< or <<<.¹⁴ Early examples of this system can be seen in the roof of the nave of the Bethlehemkerk in Zwolle,

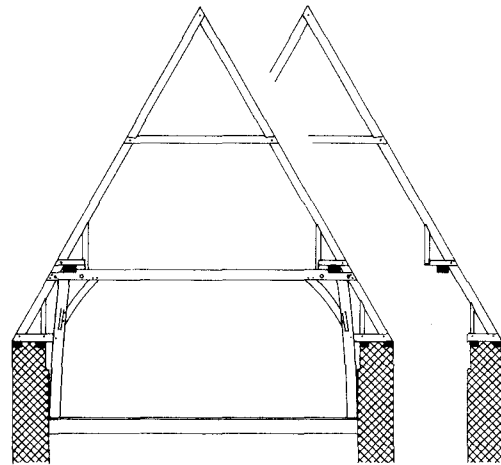


Figure 11
Roof construction with trusses in Leeuwenberg House, Oude Gracht 307 Utrecht, 1319–1325 (d). (Drawing L.M. de Klein RDMZ)

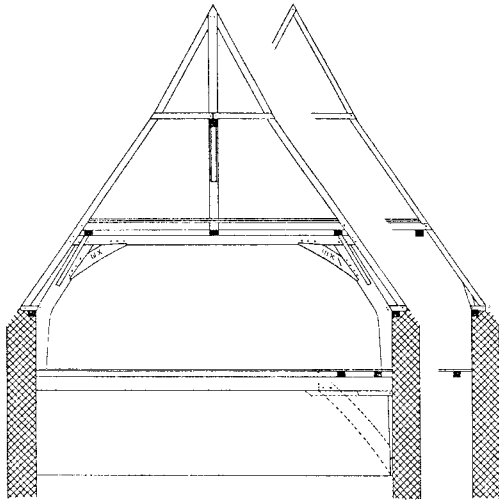


Figure 12
Bergschild 7 in Deventer, 1334 (d). (Drawing G. Berends 1971)

remained unchanged for a hundred and fifty to two hundred years. Rafters and trusses are separately numbered with broken assembly-numbers on one side. The application of trusses in common rafter roofs (of houses in towns), seems to illustrate the need of firm/stable constructions, in order to comply with the higher requirements set by mediaeval roof tiles in stead of straw.¹⁵ Both flat tiles and the so called over- and under tiles, laid with double overlap in mortar, were very heavy, but subsidised and required by the town government in order to prevent big fires.

First carpenters economised on tie-beams at the foot of roof construction. Later they left out the lower collars and the plate on the middle of the truss. Large ambitious constructions, like those of the Domkerk, have double wallplates and double plates on the lower trusses. During the 15th century next to plates we find purlins introduced into trussed roofs, in the naves of the mendicant order churches in Maastricht around 1395¹⁶ and north of the river Rhine in Utrecht in 1477.

CONCLUSION

built between 1333 and 1369, Figure 13, and in the carpentry of the choir of the Domkerk in Utrecht with double (stapled) trusses, 1386 (d). This form

The common rafter roof goes together with the single flooring, both on a distance of 60–90 centimetres.

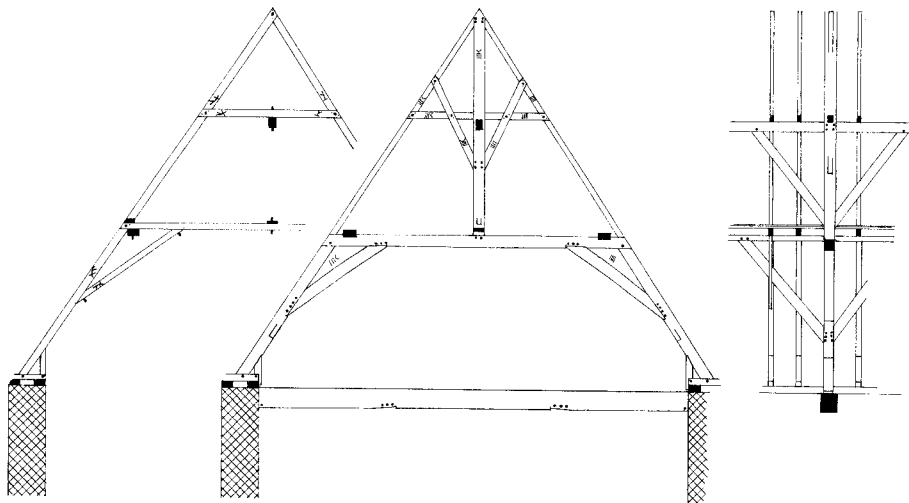


Figure 13
Roof of the nave of the Bethlehemkerk in Zwolle, built between 1333 and 1369. (Drawing by the author 1979)

However, on account of the side walls roof and floor are not directly joined in houses. The walls of these houses are thick, between 60 and 90 centimetres, and sometimes even thicker. The load that the rafters and the beams put on the walls is more or less regularly divided, and the windows are small. This is a Romanesque scheme of building. The Gothic constructional method tends to place great stress upon skeletons made of either stone or timber, applied in all types of buildings (not only churches). Regarding roof constructions, the improvement seems to start with the reduction of long tie-beams. In carpentry, this was achieved when smaller, shorter, square rafters distribute their weight via plates to the trusses which in turn were laid on piers with buttresses and which were often supported by curved braces on the inside. Gothic joisting, comprising sleepers and secondary beams, appears in the Low Countries in the last quarter of the 13th century. In the western part of the south hall of Saint John's hospital in Bruges we find this system in 1285 (d), Figure 14. Sole pieces, curved braces (corbels) and wall pieces (off the floor or on a cantilever) can support the sleepers or binders; this arrangement occurs frequently from the fourteenth century onwards. Curved braces and sole pieces reduce the tension on the sleeper, increasing the stability of the building and in combination with the wall piece, allowing a reduction in the wall thickness. The process of reducing timber in corporation with thinner walls, niches and large windows evoked concentration of forces, both in

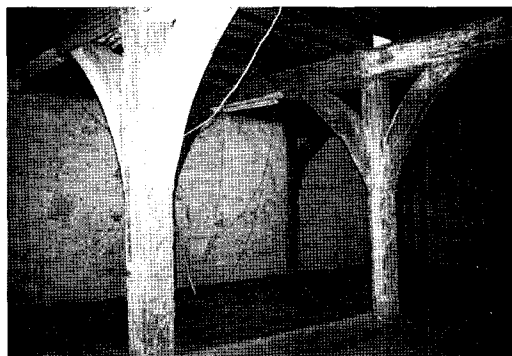


Figure 14
Floor joisting in Saint John's hospital in Bruges, 1285 (d).
(Photo by the author 1999)

masonry and carpentry. This constructive change can be linked with traditional styles from Romanesque into Gothic in the way Viollet-le-Duc has explained. Strikingly, in this process carpentry and trusses seem to be earlier than Gothic masonry, at least in Flanders where trussed roofs appear in second quarter of the 13th century.

NOTES

1. Harvey 1975, 147.
2. Janse 1989, 147 and 390.
3. Hoffsummer 1995, 76–79.
4. Hoffsummer 1995, 80.
5. Compare with Janse & Devliegher 1963, 323–324.
6. With the help of my colleague Albert Reinstra and the architect B. Delaey.
7. De Vries 2000, 76.
8. Hoffsummer 1995, 88–89.
9. De Vries 2000, 77.
10. Janse & Devliegher 1963, 353.
11. Apart from Gent, all these dendrochronological dates are worked out by RING, Nederlands Centrum voor Dendrochronologie, ROB Amersfoort, the Netherlands.
12. De Vries 1996, 228.
13. De Vries 1996, 230.
14. Janse 1989, 37.
15. De Vries 1994, 81–82.
16. De Vries 1998, 238–239.

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