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**Summary**

The church dates from the twelfth century and the roof of the apse at the end of the chancel was thought to have its original timber roof. The chancel and nave roofs were found to be post-medieval replacements and were not further studied. The apse roof was sampled but none of the few timbers cored subsequently dated. Careful observation of the timbers, however, revealed that the present roof had been taken down and reconstructed at least once, and some of the timbers bore circular-saw marks.

**Keywords**

Dendrochronology
Standing Building

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## Introduction

The church of St Mary Magdalene, East Ham (NGR TQ 441 839; Fig 1) is a grade I listed building. It has twelfth-century origins, with a sixteenth-century west tower. The apse and chancel roofs are much lower than the nave roof, the apse roof being separated from the chancel by a round-headed arch. A bomb fell on the church during WWII, destroying the chancel roof. The present chancel roof is a post-war construction carried out in pseudo-medieval style. The timber wall plates may be earlier. The nave roof is of tenoned purlin construction and appears to date from the seventeenth century.

The apse roof (Fig 2) is described by Hewett (1980; 35), who attributes a likely date of AD 1130-50 to it. He says it is one of the "rarest roofs in the county, and possibly in the kingdom", and that it is inexplicable that the roof has survived.

Work on the early wall paintings in the chancel was being carried out at the time of this study, and dendrochronological dating was requested in order to add to the multi-disciplinary studies being made in association with the conservation of the paintings.

## Methodology

The site was visited in February AD 2003. Oak timbers with more than 50 rings, traces of sapwood, and accessibility were the main considerations in the initial assessment. Those timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were prepared for measuring by sanding using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC. This sometimes includes samples with less than 50, but more than 40 rings, which may crossmatch with other, longer series from the same site. The software used in measuring and subsequent analysis was written by Ian Tyers (1999).

Ring sequences were plotted to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements when the samples crossmatch. Statistical comparisons were made using Student's *t*-test (Baillie and Pilcher 1973; Munro 1984). The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973). Those *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches, and give consistent matching positions.

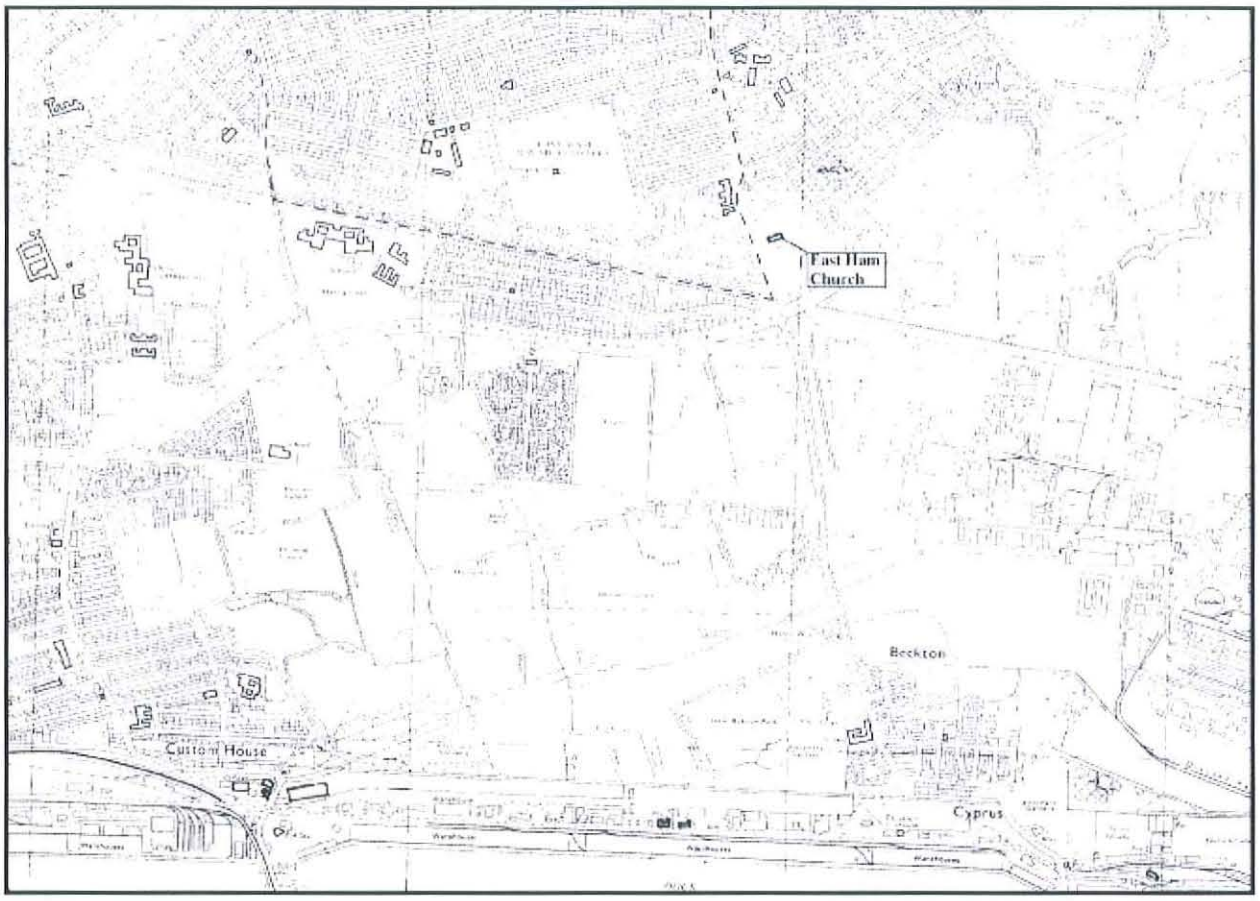


**Figure 1:** Map showing the general location of the church of St Mary Magdalene, East Ham

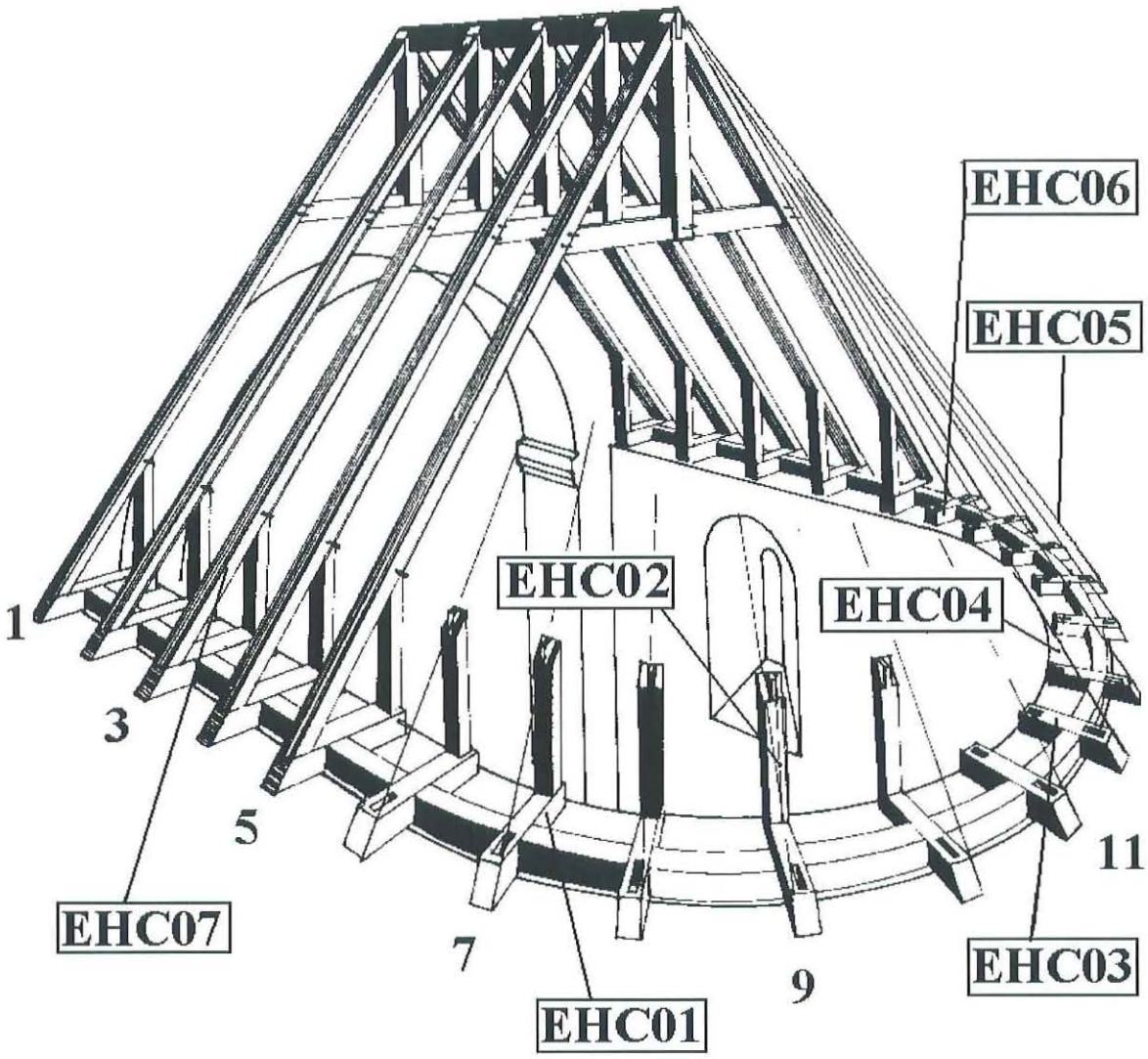


**Figure 2:** The apse roof at East Ham, showing the timbers sampled for dendrochronology. Based on an original drawing by Hewett (1980; 37)

When crossmatching between samples is found, their ring-width sequences are meaned to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established, which is then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the rings available on each sample. Interpretation of these dates then has to be undertaken to relate these findings to the construction date of the phase under investigation. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. In this instance, the sapwood estimates are based on those proposed for this area by Miles (1997), in which 95% of samples are likely to have from 9 to 41 sapwood rings. Where bark is present on the sample the exact date of felling of the tree used may be determined.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

## Results

All the timbers investigated in the apse roof were of oak (*Quercus* spp.). Sampling was limited by the lack of suitable timbers, ie timbers having sufficient numbers of rings and sapwood edges. Details of the samples taken are given in Table 1, and their locations are shown in Figure 2. Three samples were rejected as they had too few rings for further analysis. Samples EHC03 and EHC06 matched each other ($t$ = 7.3 with 65 years of overlap). They were combined into a single sequence for further analysis. Neither this sequence, nor any of the other unmatched individual series gave acceptable consistent matches when compared with the reference material. The data for the analysed series are given in Table 2.

**Table 1:** Oak (*Quercus* spp.) timbers sampled from the apse roof at the church of St Mary Magdalene, East Ham

| Sample number | Origin of core | Total no of years | Average growth rate (mm $yr^{-1}$) | Sapwood details |
|---|---|---|---|---|
| EHC01 | Sole piece 7 | 52 | 2.07 | - |
| EHC02 | Rafter 9 | <40 | unmeasured | - |
| EHC03 | Sole Piece 12 | 65 | 1.85 | - |
| EHC04 | Rafter 12 | <40 | unmeasured | - |
| EHC05 | Rafter 15 | <40 | unmeasured | - |
| EHC06 | Sole piece 18 | 66 | 1.77 | - |
| EHC07 | Rafter 3 | 67 | 1.64 | - |

## Interpretation and Discussion

Plots of the two series which crossmatched (EHC 03 and 06) strongly suggest that these two sole pieces could have come from the same parent tree. None of the few timbers sampled were dated, but a number of observations were made which suggest that this roof has been dismantled and reassembled on at least one occasion, and that new timbers have been inserted.

The existing sole pieces and ashlar pieces appear to post-date the existing rafters. At least one of the sole pieces displays circular saw marks upon its surface; and many, if not all, of them have numbers drawn on them in pencil. The numbers run in sequence starting at the south-west corner (rafter 1) and finishing at the north-west corner (rafter 23). In some cases, the ashlar pieces and/or the rafter are numbered instead of the sole pieces. These numbers are also in pencil, and the numbering sequence corresponds to the numbering of the sole pieces. Many of the horizontal battens linking the rafters were made using a mechanical saw; both circular saw marks and band saw marks are in evidence. On the rafters themselves there are no carpenter's marks present, and all that can be said about them is that they probably pre-date the existing ashlar pieces, sole pieces, and horizontal battens. The battens are held in place in shallow housings cut into the sides of the rafters. In at least one case, the setting-out lines for the housings are not scribed lines, but are again drawn in pencil. Some of the joints between the rafters and ashlar pieces have been re-pegged (there are redundant peg holes alongside the present filled peg holes), and the tenons of many of the ashlar pieces fit very poorly with the mortices in the rafters. By contrast, the joints between the collars and the rafters (and between the collars and king posts) show no obvious signs of having been reassembled; there are no redundant peg holes and the joints all seem to be close fitting. The surface appearance of the collars is very much at variance with that of the rafters (albeit the rafters themselves are of a very uneven quality). Whereas the rafters were produced by handsaw and side axe, and have smooth surfaces, the collars appear to have been made with an adze, and the timbers have a significantly cruder, rough-hewn quality. The same is also true of the majority of the king posts. Only the easternmost collar and its king post look to be of a piece with the rafters in terms of scantling, finish and quality of timber.

Two anomalous features were noted. Whereas in couples one, two, four, and five the ashlar pieces are tenoned into the underside of their rafters, in the central couple there is evidence of an alternative method whereby the ashlar pieces were halved over the sides of the rafters instead. In this couple, the northern rafter has a redundant mortice with an empty peg hole passing horizontally through it, suggesting that the present halved joint is a later alteration. The southern rafter, by contrast, employs the standard mortice and tenon joint, but includes immediately above it the sawn-off tenon of an earlier ashlar, still halved into the side of the timber. The remnant tenon is attached to the rafter with a single nail. The nail has an approximately 10mm-diameter head, and is hand-made. In the next paired-rafter couple to the east, rafter couple 4, each rafter has a tenoned ashlar piece; however in both rafters there is a second, redundant, peg hole passing horizontally through the timber a short distance above the present (pegged) mortice for the ashlar piece. Whether these holes are simply a mistake, or played some part in the former roof construction, is unclear. (Normally, of course, the mortices in a frame would have been cut before the holes for their pegs were drilled, not after).

The church underwent a large-scale restoration in the AD 1930s; and it was probably at this date that the apse roof was taken down and repaired. Although the present rafters appear to be earlier than the machine-sawn timbers in the roof frame, there seems little reason to suppose them to be eleventh century timbers. They might equally be seventeenth century timbers that were inserted when the apse was remodelled. The removal of the original Norman stone vault of the apse, and the cutting back of its stone piers to create space for the erection of wall memorials, tablets, etc,

is likely to have resulted in the need for a new roof, or at least major modifications to the original roof.

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**Table 2:** Ring width data for the samples measured

| ring widths (0.01mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EHC01** | | | | | | | | | |
| 184 | 249 | 323 | 372 | 307 | 315 | 337 | 312 | 347 | 348 |
| 366 | 372 | 214 | 221 | 186 | 253 | 243 | 174 | 139 | 138 |
| 214 | 325 | 262 | 293 | 314 | 269 | 185 | 150 | 146 | 150 |
| 241 | 131 | 91 | 98 | 132 | 137 | 112 | 85 | 136 | 145 |
| 179 | 178 | 115 | 120 | 104 | 90 | 102 | 111 | 147 | 146 |
| 223 | 221 | | | | | | | | |
| **EHC03** | | | | | | | | | |
| 204 | 191 | 292 | 261 | 218 | 224 | 220 | 206 | 218 | 232 |
| 146 | 179 | 120 | 109 | 93 | 102 | 144 | 122 | 120 | 129 |
| 127 | 144 | 157 | 125 | 186 | 169 | 131 | 105 | 89 | 84 |
| 126 | 128 | 134 | 269 | 305 | 260 | 156 | 114 | 92 | 108 |
| 141 | 105 | 134 | 245 | 267 | 202 | 246 | 328 | 239 | 149 |
| 181 | 187 | 192 | 273 | 259 | 169 | 138 | 164 | 201 | 204 |
| 338 | 371 | 300 | 183 | 241 | | | | | |
| **EHC06** | | | | | | | | | |
| 218 | 237 | 245 | 252 | 246 | 287 | 325 | 287 | 372 | 236 |
| 176 | 216 | 135 | 148 | 113 | 148 | 186 | 161 | 146 | 131 |
| 132 | 189 | 146 | 154 | 232 | 156 | 132 | 162 | 105 | 144 |
| 164 | 160 | 184 | 307 | 261 | 214 | 143 | 130 | 93 | 109 |
| 113 | 108 | 151 | 170 | 204 | 169 | 159 | 170 | 137 | 92 |
| 148 | 163 | 150 | 192 | 158 | 118 | 85 | 169 | 174 | 160 |
| 268 | 218 | 160 | 183 | 158 | 141 | | | | |
| **EHC07** | | | | | | | | | |
| 130 | 177 | 195 | 165 | 196 | 183 | 158 | 164 | 182 | 219 |
| 311 | 261 | 270 | 227 | 244 | 265 | 172 | 146 | 160 | 189 |
| 171 | 142 | 156 | 151 | 110 | 135 | 124 | 143 | 146 | 197 |
| 141 | 108 | 154 | 129 | 134 | 123 | 131 | 115 | 103 | 103 |
| 106 | 138 | 129 | 119 | 129 | 116 | 119 | 101 | 112 | 140 |
| 212 | 147 | 244 | 217 | 162 | 256 | 195 | 214 | 185 | 212 |
| 169 | 156 | 199 | 143 | 130 | 99 | 136 | | | |

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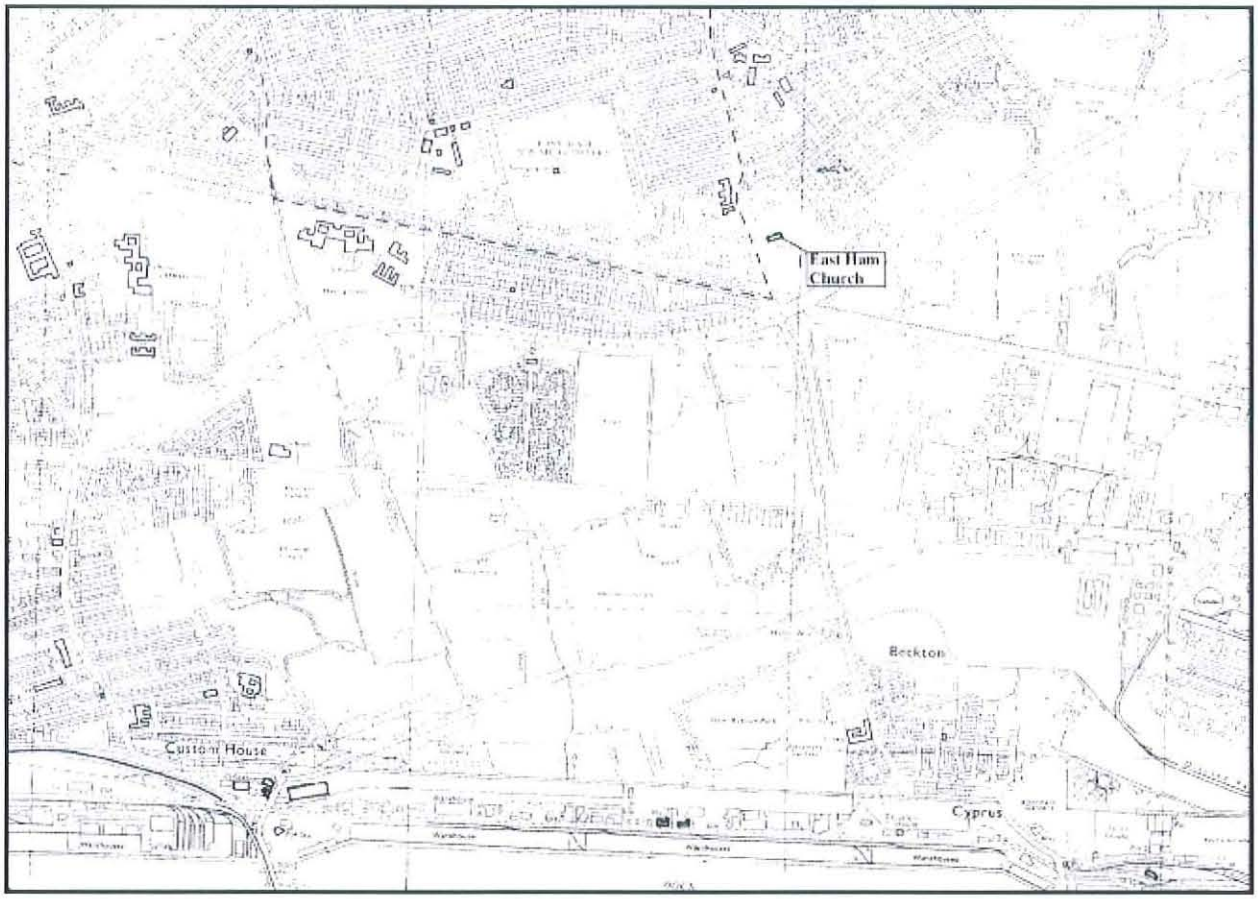


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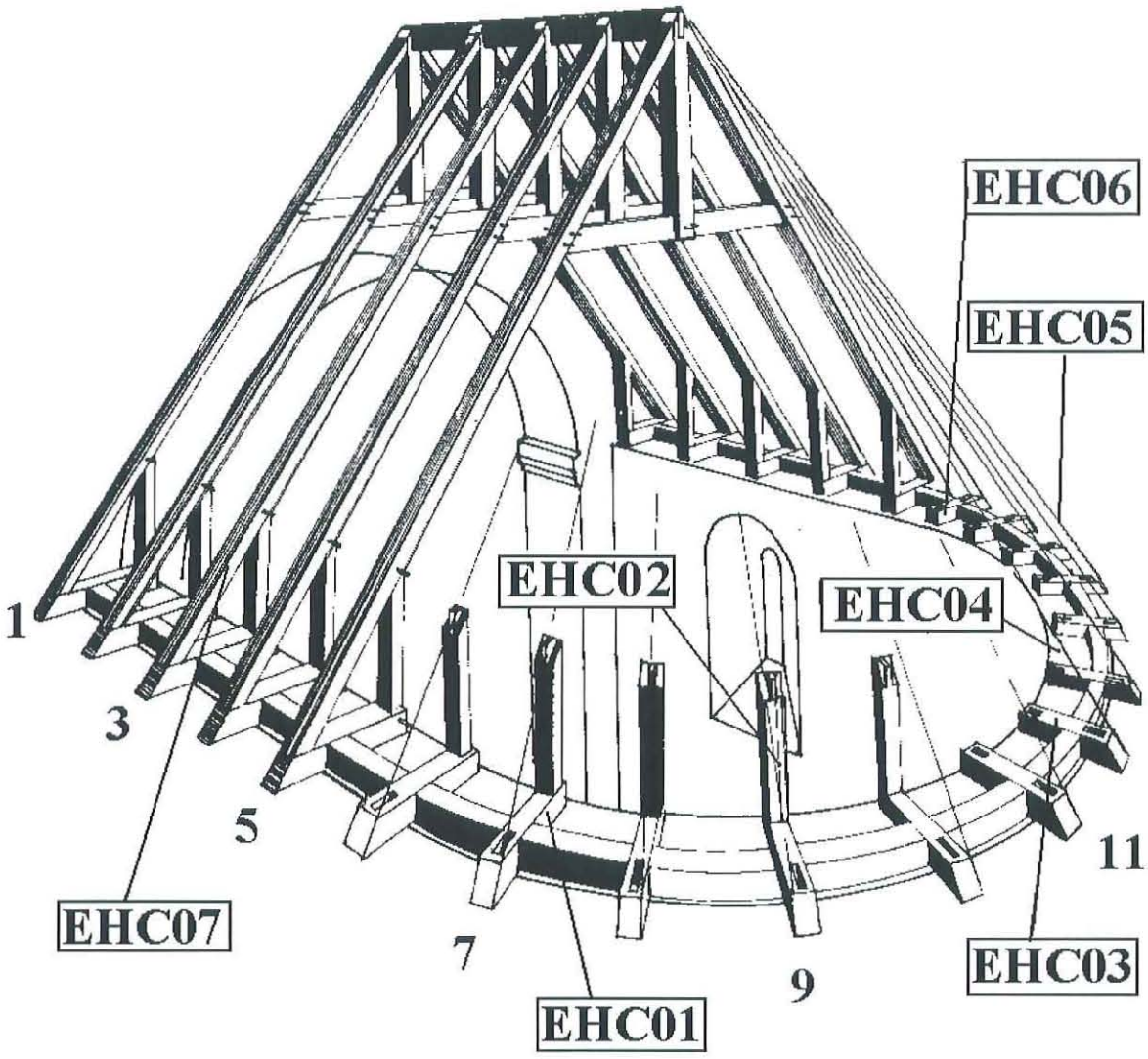


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|---|---|---|---|---|---|---|---|---|---|
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| 366 | 372 | 214 | 221 | 186 | 253 | 243 | 174 | 139 | 138 |
| 214 | 325 | 262 | 293 | 314 | 269 | 185 | 150 | 146 | 150 |
| 241 | 131 | 91 | 98 | 132 | 137 | 112 | 85 | 136 | 145 |
| 179 | 178 | 115 | 120 | 104 | 90 | 102 | 111 | 147 | 146 |
| 223 | 221 | | | | | | | | |
| **EHC03** | | | | | | | | | |
| 204 | 191 | 292 | 261 | 218 | 224 | 220 | 206 | 218 | 232 |
| 146 | 179 | 120 | 109 | 93 | 102 | 144 | 122 | 120 | 129 |
| 127 | 144 | 157 | 125 | 186 | 169 | 131 | 105 | 89 | 84 |
| 126 | 128 | 134 | 269 | 305 | 260 | 156 | 114 | 92 | 108 |
| 141 | 105 | 134 | 245 | 267 | 202 | 246 | 328 | 239 | 149 |
| 181 | 187 | 192 | 273 | 259 | 169 | 138 | 164 | 201 | 204 |
| 338 | 371 | 300 | 183 | 241 | | | | | |
| **EHC06** | | | | | | | | | |
| 218 | 237 | 245 | 252 | 246 | 287 | 325 | 287 | 372 | 236 |
| 176 | 216 | 135 | 148 | 113 | 148 | 186 | 161 | 146 | 131 |
| 132 | 189 | 146 | 154 | 232 | 156 | 132 | 162 | 105 | 144 |
| 164 | 160 | 184 | 307 | 261 | 214 | 143 | 130 | 93 | 109 |
| 113 | 108 | 151 | 170 | 204 | 169 | 159 | 170 | 137 | 92 |
| 148 | 163 | 150 | 192 | 158 | 118 | 85 | 169 | 174 | 160 |
| 268 | 218 | 160 | 183 | 158 | 141 | | | | |
| **EHC07** | | | | | | | | | |
| 130 | 177 | 195 | 165 | 196 | 183 | 158 | 164 | 182 | 219 |
| 311 | 261 | 270 | 227 | 244 | 265 | 172 | 146 | 160 | 189 |
| 171 | 142 | 156 | 151 | 110 | 135 | 124 | 143 | 146 | 197 |
| 141 | 108 | 154 | 129 | 134 | 123 | 131 | 115 | 103 | 103 |
| 106 | 138 | 129 | 119 | 129 | 116 | 119 | 101 | 112 | 140 |
| 212 | 147 | 244 | 217 | 162 | 256 | 195 | 214 | 185 | 212 |
| 169 | 156 | 199 | 143 | 130 | 99 | 136 | | | |