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Appraisal and Repair of Timber Structures

Second edition

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Arup

Figure 2.10 Nineteenth-century framing

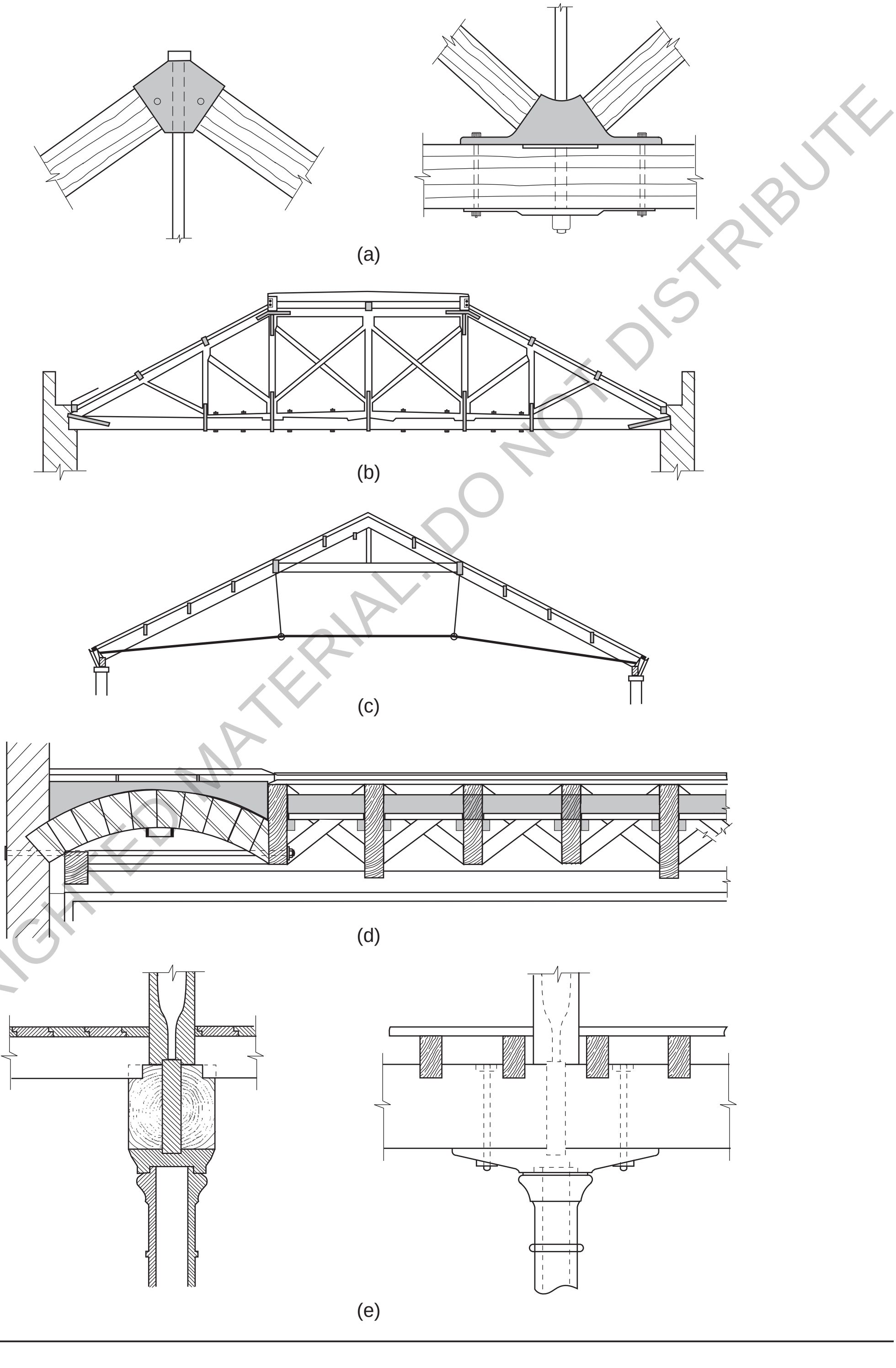
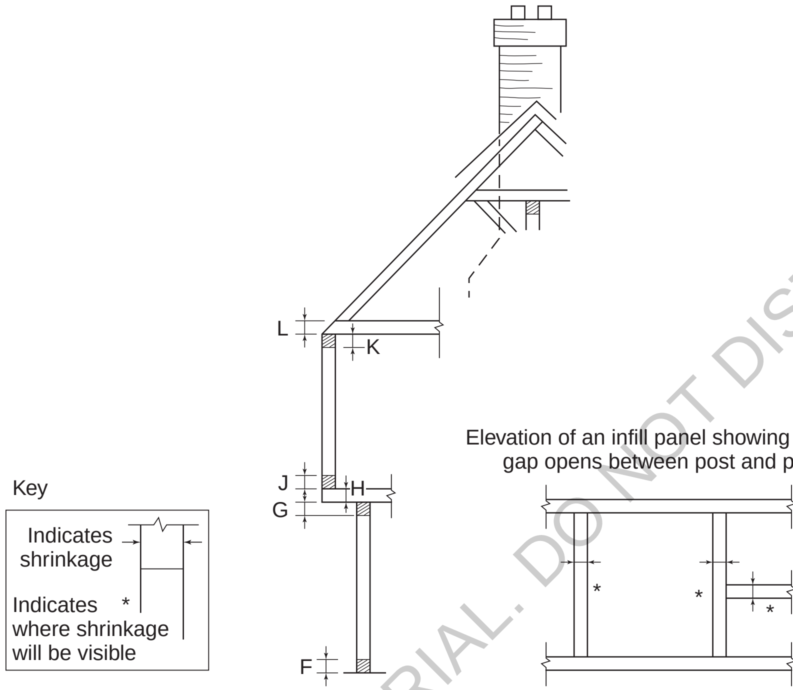


Figure 12.6 Effect of frame drying shrinkage on the levels of horizontal members (Reproduced from *Green Oak in Construction* (Ross *et al.*, 2007), with the permission of the authors.)



British standard of the time (CP 112 and then BS 5268, Clause 1.1 Scope), which stated:

> *It [the Code] does not cover well-tried and traditional methods of construction which have been employed successfully over a long time.*

This is an indirect statement of the 100 year rule, but it is unsatisfactory in code terms as a principle, because there are no rules to give, for instance, frame forms or span/depth ratios. The Eurocode, unsurprisingly, gives no equivalent clause. Nevertheless, during the latter part of the twentieth century, frames were sometimes submitted for approval under cover of this clause, avoiding the need for calculation.

The areas in which modern green oak frames might differ from a medieval model are

- larger floor-to-ceiling heights and longer bay lengths
- shortening of the wind braces, which are regarded as a headroom restriction
- raised ties (again for headroom)
- less steep roof slopes, increasing the rafter out-thrust
- a lightweight roof covering, increasing the possibility of uplift.

It does not follow that these frames are necessarily unstable: we are just making the point that they cannot simply be accepted as ‘traditional construction’ and might need justifying calculations. A raised

Figure 18.1.4 Canopy suspension

to apply a central point load to each beam, acting against a strut from the roof truss above (Figure 18.1.5).

Hydraulic jacks are a much better way of applying load than kentledge (if an anchor point can be arranged), since the amount of stored energy is small. Moreover, the beams could be tested one at a time, as the trimmer joists are virtually a pinned connection and provide no form of load sharing. Load tests would clearly be cheaper than strengthening.

The tests

The tests were carried out during a rare period of closure for maintenance. The test load factor was determined in accordance with the procedure described in Appendix 2. A duration-of-load factor of 1.5 was used on the dead and superimposed loads, subtracting the dead load, which was already in position. The point load necessary to increase the central bending moment by this factor is approximately 1 t. This load was applied to each beam in 0.25 t increments, and held for 1 hour. The operation was carried out safely, because the middle hanger remained in place, with the turnbuckle simply adjusted to the position of slackness. Deflection was very simply measured from the relative movement of the rod ends in the turnbuckle, using vernier callipers – just occasionally, one has this sort of luck. All the beams took the load satisfactorily, with deflections of only 3–6 mm. Residual deflection (around 1 mm) probably relates to a slight embedment of the supporting bolts.

At the time, imposed loads were classified as long-term. If the tests had been carried out after 2005, when the Eurocode was introduced, they would be reclassified as medium-term, which would have allowed a small reduction in the test load.

(In 2012, this canopy was replaced by another as part of a refurbishment).

ICE Publishing

Lawrence, Andrew and Ross, Peter
ISBN 978-0-7277-6178-1
https://doi.org/10.1680/arts.61781.168

Chapter 19
Case studies: 'repair'

19.1. Cranbrook Church, Kent – repairs to the north chapel roof

Cranbrook Church (Figure 19.1.1) is a handsome medieval building, which was rebuilt in stages up to the eve of the Reformation. The two aisles were extended to the east to form chapels either side of the chancel (Figure 19.1.2), the north chapel now accommodating the vestry and the organ. The timber roofs were largely replaced in the nineteenth century, but it is believed that they are all a close copy of the originals.

The north chapel roof

The north chapel roof is a shallow duo-pitch, supported by four principal beams with rafters canted by a central post and ridge purlin (Figure 19.1.3), and rainwater collected in gutters set against the chancel and the north parapet. These gutters are always a water risk, because of the problems of getting an adequate fall in the lead lining. During an inspection in 1989, it was found that there were leaks in the north gutter, and when this was opened up for repair it was discovered that water had reached the ends

Figure 19.1.1 View of the church from the north-east, showing the temporary cover

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Sky Believe in Better Building (Arup Associates, 2014). The tallest all-timber commercial office building in the UK. Comprising CLT floor slabs on a glulam frame, the building was completed in less than a year and demonstrated the programme savings that could be achieved with an entirely dry prefabricated form of construction. The lower acoustic and less onerous fire requirements (compared with a residential building) enabled much of the timber to be left internally exposed, adding to the programme savings