CO-CONSTRUCT

Services in Structural Framed Timber Buildings

Guidance for a defect-free interface

Compiled by Richard Hennessy, Andrew Cripps and Roderic Bunn

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BSRIA

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Buro Happold

What is Co-Construct?

Co-Construct is a network of five leading construction research and information organisations - Concrete Society, BSRIA, CIRIA, TRADA and SCI - who are working together to produce a single point of communication for construction professionals.

BSRIA covers all aspects of mechanical and electrical services in buildings, including heating, air conditioning, and ventilation. Its services to industry include information, collaborative research, consultancy, testing and certification. It also has a worldwide market research and intelligence group, and offers hire calibration and sale of instruments to the industry.

The Construction Industry Research and Information Association (CIRIA) works with the construction industry to develop and implement best practice, leading to better performance. CIRIA's independence and wide membership base makes it uniquely placed to bring together all parties with an interest in improving performance.

The Concrete Society is renowned for providing impartial information and technical reports on concrete specification and best practice. The Society operates an independent advisory service and offers networking through its regions and clubs.

The Steel Construction Institute (SCI) is an independent, international, member-based organisation with a mission to develop and promote the effective use of steel in construction. SCI promotes best practice through a wide range of training courses, publications, and a members advisory service. It also provides internet-based information resources.

TRADA provides timber information, research and consultancy for the construction industry. The fully confidential range of expert services extends from strategic planning and market analysis through to product development, technical advice, training and publications.

For links to all Co-Construct members go to www.construction.co.uk.

Services in Structural-Framed Timber Buildings

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Cover illustration: Norwich Cathedral Refectory, ©Buro Happold/Mandy Reynolds.

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Introduction

The growing awareness of environmental issues has renewed interest in timber-framed buildings. The combination of low environmental impact and timber's natural aesthetic has led to a growing number of buildings where the timber structure is an important visual feature. At the same time the pressure to build new homes and legislative demands for dramatic improvements in insulation performance are driving growth in the use of timber-panel house construction.

Both types of buildings – the structural framed and the timber panelled – raise issues of the co-ordination of building services with the timber elements. Many of these co-ordination issues are different to the equivalent challenges faced with steel or concrete buildings. This guide focuses on the construction of new buildings. Similar lessons would apply to refurbishing existing buildings.

This guide, the fifth in a series called Interface Engineering Publications (IEP), focusses on the structural category of buildings: those framed with beams, columns and trusses in a manner comparable to steel or concrete framing. A separate guide in this IEP series, *Services in Panel-framed Timber Buildings,* covers interface issues in timber-panel system buildings.

BSRIA and Buro Happold Consulting Engineers have pooled their technical knowledge to provide structural and services engineers with consistent interlocking advice. Details of the source material, relevant European and British Standards and other references for further reading are provided at the end of the publication.

It is important to remember that by their nature, individual framed structures will often require individual solutions to interface problems. Therefore this guide aims to illustrate the main areas to be considered, and then to explain how particular buildings have addressed them. The reader must use these examples to inform their thinking, and not to adopt the solutions as definitive.

For this reason much of the material in the guide is derived from two example projects: Norwich Cathedral Refectory and Sheffield Winter Gardens. In both these projects the integration of timber structure and building services formed a major aspect of design and construction.

Andrew Cripps and Richard Hennessy, Buro Happold Consulting Engineers, and Roderic Bunn, BSRIA

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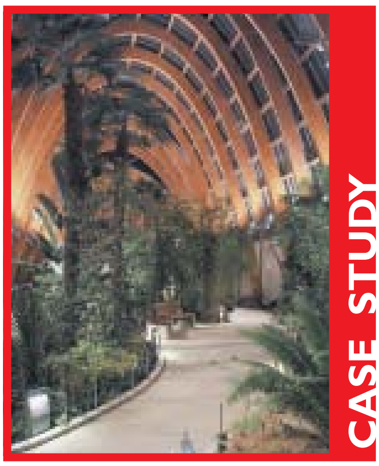

How to use this guide

Advice about the characteristics of timber structures is given in orange-tinted text boxes.

Advice about the interface issues of mechanical and electrical services with timber structures is given in the blue-tinted text boxes.

Comments marked by ■ link to the structural engineering sections listed under *also see*.

Comments marked by ■ link to the services engineering sections listed under *also see*.

Comments marked by ■ denote a link common to both specialisms.

Key services watchpoints

☐ Essential services engineering messages from the guide

Key structural watchpoints

☐ Essential structural messages from the guide

See also

1 **Links** to services sections
2 **Links** to structural sections
3 **Links** to common sections

Further reading to support this guide

Standards for structural and services design

Glossary for definitions of terms

The clients guide to using

Structural timber frame

The aesthetic benefits of timber are a key factor in choosing the material for structural framing. The other advantages of timber is that it has a very low environmental impact, its surface needs no paint or cladding, and it is tolerant of damp conditions not normally suited to steel or concrete. This results in an open, honest, expressed structure with no cladding or applied finishes. High quality integration of the building services is therefore very important to the finished product.

CASE STUDY

Figure 1: The Globe Theatre in London demonstrates that even historically authentic structures using traditional forms of construction require 21st Century building services. This project has smoke and security alarms and light fittings mounted discreetly onto the medieval-style timber supports. ©Buro Happold.

Key timber issues

Structural timber framing can be chosen for a variety of buildings, from the use of solid oak for historic authenticity used for The Globe Theatre in London (Figure 1) to curved forms
1 of architecture typified by the Winter Gardens project in Sheffield, and for clean and open
2 structures such as that used for the Norwich Cathedral Refectory (figure 2).

The ability to curve wood also enables the construction of unique forms of structure not possible by using other materials, an example being the gridshell construction for the visitors' centre at the Weald and Downland Open Air Museum in Sussex (figure 3).

Timber materials

The strength, appearance and durability of timber all depend on the species of tree and where it was grown. Slow growing trees from cold climates have the slowest growth rates and
3 hence denser, more durable wood.

The most durable woods used in structural timber are broad-leaved hardwoods such as oak, as used for The Globe Theatre. However, hardwoods are expensive due to their very slow growth. Softwood species are faster growing and some are durable for external use. The Sheffield Winter Gardens project used Polish larch. Low-durability softwoods such as pine are largely used for internal elements, such as joists, and for timber-panel buildings.

The second issue is whether to use solid or engineered timber. Engineered timber refers to timber which has been built up by gluing together smaller pieces of timber. The size of the raw material varies greatly:

- ☐ Sawdust and fibre-based materials are used for MDF and hardboard
- ☐ Veneers are peeled from trunks and glued together, the most common being plywood. Another type is laminated veneer lumber which uses thicker veneers, 3-4 mm thick (figure 4 overleaf)
- ☐ Chips for chipboard. Orientated strand board is made from larger chips of wood (called strands) aligned in layers (see figure 5 overleaf)
- ☐ Laminates such as glue laminated timber (often called Glulam) is made by gluing together laminates, typically 50 mm thick and several metres long (figure 6 overleaf).

Services engineering issues

Structural issues

Figure 2: The Norwich Cathedral Refectory. This shows the relationship between the timber frame and the existing Cathedral walls. ©Buro Happold/ Mandy Reynolds.

The advantage of making engineered timber from smaller items is that it allows defects to be removed. This gives greater consistency in the properties of the material, which means that higher strengths can be used in the structural design. By aligning the grain in a controlled manner, it is possible to greatly reduce shrinkage and associated deformation.

For large-scale elements, engineered timber can be considerably cheaper than solid timber. For example, a Glulam beam will be fabricated from lots of laminates from small young trees; any defects can be cut from the laminates prior to gluing. A solid timber equivalent would require a large single mature tree that does not possess any defects.

All engineered timber products are available in standard sizes. However, it is only Glulam that can also be fabricated to bespoke structural timber sections specific to a project. Frames made from other materials are fabricated from cutting and joining standard-sized elements from stock.

The majority of structural timber framing

Key structural watchpoints

- ☐ Choose timber suitable for its end use, such as internal or external use
- ☐ The structural form will determine which type of engineering timber should be used
- ☐ Obtain information from the timber supplier on shrinkage and deformation characteristics
- ☐ Exposure classes influence the strength of timber. Protected elements will be stronger and more efficient than exposed elements

Figure 3: The timber gridshell structure of the Weald and Downland Open air Museum. Note the difficulty of achieving an aesthetically-pleasing interface between the exposed timber structure and the warm-air heaters. ©Buro Happold/Mandy Reynolds.

See also

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2 Case study, page 22
3 Fire engineering, page 18

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