Knowledge Transfer in Timber Engineering

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Summary

Napier University and Oregon Timber Frame Ltd have recently completed an award winning two year project in timber engineering. The project was conducted under the umbrella of a Knowledge Transfer Partnership (KTP) which is a UK government funded research programme. As a result of the project academic based research has been put into industrial practice to the mutual development of all parties involved.

The four main project areas were the implementation of a crane erect method of construction, adoption of an improved method of flitch beam fabrication, improving the system structurally through whole house engineering and improving the building envelope sustainability rating by means of developing the optimum sustainable wall detail.

1. Introduction

Oregon Timber Frame Ltd specialises in the design, manufacture and erection of structural platform timber frames for the residential market. The company manufactures over 2400 units per annum for house building companies and social housing contractors in the UK. A Knowledge Transfer Partnership (KTP), which is a UK government funded research programme, was set up between Oregon Timber Frame Ltd and Napier University. Knowledge Transfer Partnerships is Europe’s leading programme helping businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within the UK knowledge base (DTI, 2005). Each

Partnership employs one or more Associates (recently qualified people) for a project lasting one to three years, transferring the knowledge the company is seeking into the business.

Each Associate works in the company on a project which is core to the strategic development of the business, in this instance the project was to refine the whole process from design and manufacture to erection of platform timber frames, leading to overall improvement in efficiency and cost over a two year period. Detailed in the paper are four of the key project areas which have delivered success.

2. Crane Erect Method of Timber Platform Frame Construction

Traditional methods of timber frame construction are labour intensive and time consuming. The crane erect method of construction utilises on-site preparatory work and off-site fabrication of system components which results in improved time, cost and safety.

Figure 1 Crane erect of roof system

One of the major parts of the crane erect construction method is the preparatory construction of the roofing system at ground level to be lifted into position (Figure 1). To eliminate the risk of system failure during lifting a best practice erection method was developed by means of laboratory testing and 3 dimensional computer analysis (Figure 2).

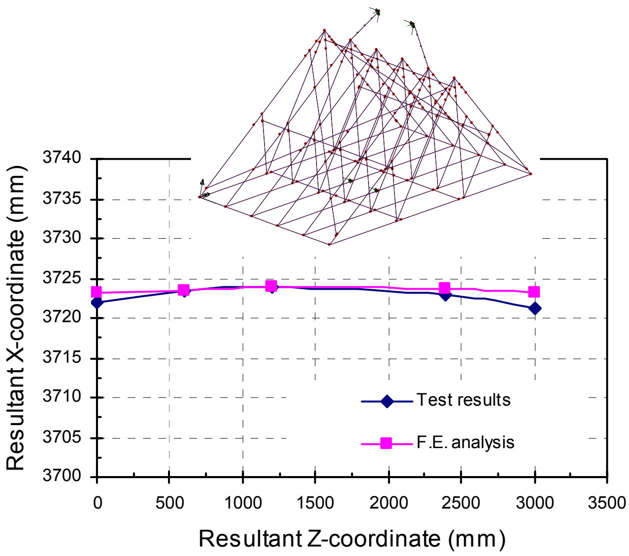
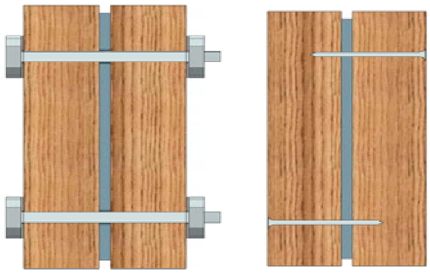


Figure 2 Laboratory testing and computer modelling of roof system

The derived method of roof lifting is simple for ease of application on site, can be altered to suit numerous different roofing configurations and also engineers out the risk of failure of the roof system with no strengthening requirements (Hairstans et al, 2004). As a result of the new procedure significant health and safety benefits have arisen, including the improved safety of site operations, potential reduced premiums for contract insurance, and reduced management time in organising operations and dealing with incidents. The operational method also reduced erection time and improved on-site logistics, and has been endorsed by house builders as an improved construction method.

3. Shot Fired Dowel Flitch Beams

In domestic dwelling design, when relatively high loads and long spans predominate and where available depth of section is restricted in some way, serviceability (deflection and vibration) is often the limiting criteria. To achieve the design criteria without the introduction of a solid steel section a flitch beam can be used.



(a) (b)

Figure 3 (a) Traditional bolted connection
(b) Shot fired nail connection

A flitch beam is a form of sandwich construction where a relatively thin steel element is sandwiched between two timber sections (Figure 3). This beam form combines the advantages of timber (ease of working, readily available resource, simple connection of ancillary components) with the strength and stiffness of structural steelwork. However, the traditional bolted connection is a time consuming method of fabrication and it also presents problems in design detailing. Bolt slippage and fabrication tolerances result in disproportionate stress transfer due to uneven strain affecting the stiffness and strength properties of the beam.

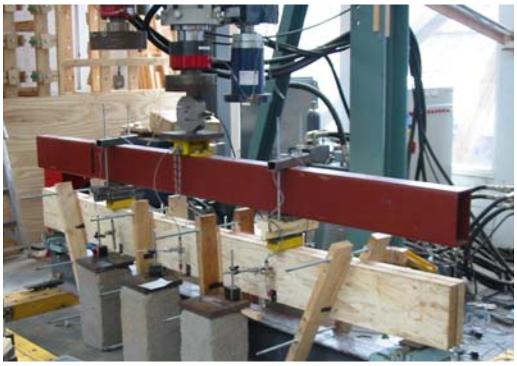


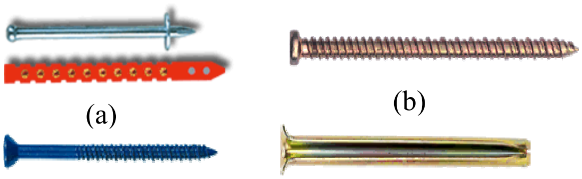
Figure 4 Laboratory testing of shot fired nailed flitch beam

Structural behaviour and performance of a shot fired dowel flitch connection was investigated as an improved method of construction which involved laboratory testing (Figure 4) and analytical work (Hairstans et al, 2006). As a result of the work carried out design and manufacturing guidance has led to product endorsement.

4. Whole House Engineering

A detailed study of standard house types was conducted with parametric designs carried out in accordance with current British Standards and new European Codes of Practice. As a result of the project the harmonisation of standard house types with new European Codes has been facilitated and recommendations have been made resulting in system improvement.

Overall system stability and robustness was regarded as a critical project area which resulted in system continuity and redundancy being highlighted as important areas in design. Continuity is required for the transmission of residual shear in walls where large openings dominate or there is the requirement of a residual shear transfer across a party-wall. With regards to redundancy both holding down and shear were investigated and in particular it was demonstrated that the racking resistance of a wall diaphragm can be governed by the specification of the foundation shear connections. A range of available shear connection methods (Figure 5) were therefore studied which has resulted in improved specification (Hairstans, et al, 2006).



(a) (b) (c) (d)

Figure 5 (a) KMN Low velocity shot fired nail;
(b)KF masonry screw anchor;
(c)MSC masonry screw anchor;
(d) EXPN express nail.

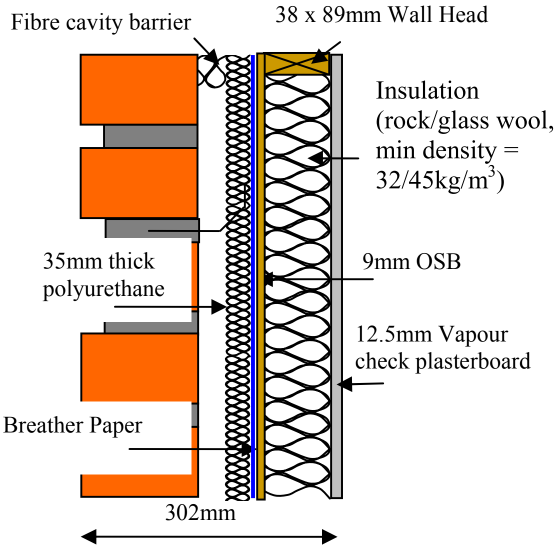


Figure 6 Optimised timber frame wall detail

5. Optimum Sustainable Wall Detail

To reach the requirements of the EU Directive on Energy Performance it is perceived a timber frame wall detail in the UK will have to attain a U-value of 0.27 W/m^{2}K. To reach this requirement a study was undertaken to derive the optimum option giving due consideration to practicality, cost, sustainability and structural performance (Hairstans et al, 2006).

The research work conducted was all encompassing with the primary function being to develop a sustainable method of achieving thermal efficiency. However, due consideration was given to other project drivers in the form of structural performance, fabrication, erection and cost therefore providing an optimised solution (Figure 6).

6. Conclusions

As a result of the project the following have been achieved:

- Implementation of Modern Methods of Construction
- Component optimisation through whole house engineering
- Harmonisation of current design procedures with new European Codes of Practice
- Value engineering procedures implemented
- Improved procurement process as a result of enhanced information
- Achieving the Government driven sustainability agenda
- An increase of £280,000 in pre-tax profit resulting from the Partnership is predicted over the next three years.

References

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