Predicting the fire performance of lightweight timber structures

In the modern sustainability-driven environment, lightweight, heavily insulated timber structures (see Figure 1) are becoming more abundant not only in the residential building sector, but also in commercial new builds such as offices and schools. In such buildings, pre-fabricated products like engineered floor joists, light gauge steel floor and wall cassettes, and structural insulated panels (SIPs) are being adopted as an alternative to the heavier traditional alternatives such as masonry, hot rolled steel, concrete and solid large section timber. Whilst much emphasis is placed on the responsible sourcing of materials, embedded carbon and post-build energy efficiency, little consideration is made regarding the consequences of resulting innovations on fire performance and safety.

Light timber alternative structures such as those formed by SIPs and engineered floor joists are a relatively new concept. However, they are becoming more prevalent in the UK. Like many new technologies, the fire performance of such systems is evaluated via standard fire tests. It is widely accepted that the standard test procedure is not a true reflection of a system's behaviour in a real fire, on a holistic scale, and hence the performance of such systems in real fires is a relative unknown.

Recognising this, BRE Global are undertaking in collaboration with Loughborough University extensive research to establish the performance of lightweight engineered timber structures in realistic fire conditions. Due for completion in 2012, the author's doctorate will address important knowledge gaps in this area through a combination of full-scale, natural fire experiments (see Figure 2) on SIP and engineered floor joist structures and numerical modelling using the TNO DIANA finite element package.

The modelling aspect of this project couples heat transfer and non linear mechanical analyses so that predictions can be made about the likely performance of a lightweight timber structure when exposed to a range of fire scenarios. By coupling the model's development with large-scale fire tests, a robust validated tool for predicting behaviour should be achieved by the end of the research programme.

Substantial progress has been made in the prediction of core temperatures in SIPs exposed to a furnace temperature regime (see Figure 3), which will be extended to natural fire exposure conditions in the near future.

Figure 1 (top) *Example of modern light timber trends*
Figure 2 (above) *Large scale test performed on engineered floor joists*

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