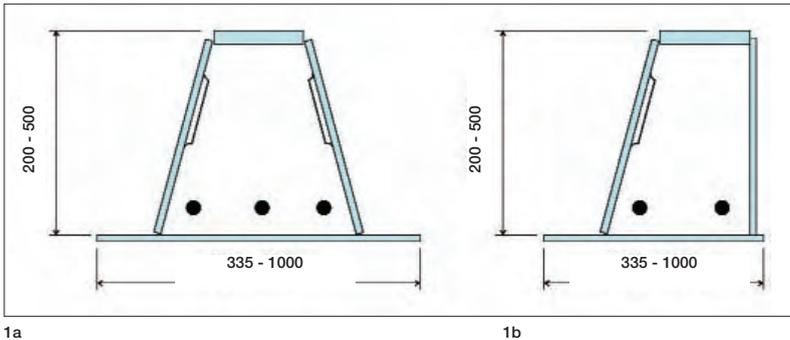


Integrated eco-floors

Phil Peacock (F) explains the advantages of using hollow steel-concrete composite beams in creating sustainable building structures



- 1 Deltabeam® profiles: a) Intermediate Beam-D Type. b) Edge Beam-DR Type
- 2 Deltabeam® integrated with the floor plate



Scandinavia is synonymous with crisp modern architecture, simple bold forms and clear lines. Functionality and building performance are generally recognised as being world class. It is no surprise that Scandinavian buildings are at the forefront of environmental standards with best in class embodied and operational energy reduction. Increasing environmental legislation is driving designers to seek ever-more sustainable and economical construction methods. A major factor in achieving sustainable construction is through well planned spatial layout that can be standardised and prefabricated as far as possible. Also speed of erection and control of risk are crucial to delivering a project to budget, time and quality.

An aspect of achieving these aims is in providing a structural layout that maximises the structural grid whilst minimising the floor depth. This allows flexible floor layouts that can be easily modified and re-serviced for future demands.

Deltabeam®, developed by Finnish company Peikko, is a hollow steel-concrete composite beam that integrates fully within a floor plate to provide a flush soffit and up to R120 inherent fire resistance. The trapezoidal profile is formed from high strength steel plate robotically welded in a single pass operation akin to assembly line car production. Once installed, Deltabeams® are designed to be filled with concrete after the floor deck has been laid. By their very design Deltabeam depth profiles can be maintained with varying load and span conditions – this flexibility can be invaluable as design amendments can be readily accommodated without variance in floor depth. The beams provide the ease of erection of a steel-frame with the noise deadening features of concrete. In addition their load-bearing capacity means that fewer columns are needed, giving wider spans. With the recent availability in the UK of long span hollowcore units, grids of 16m x 12m can be achieved carrying imposed loadings of 5kN/m² within a flush structural depth of floor plate of 525mm. Figs 1a and 1b show the range of Deltabeam profiles.

The new regulations covered in Part L of the England and Wales Building Regulations require building envelopes to have higher standards of air-tightness. Flush floor plates simplify the interface between the external envelope and floor compartments. Flush soffits makes for easy partitioning/removal and eliminate awkward acoustic detailing at separating walls associated with downstand beams. This reduces the risk of non-compliance, reduces waste and saves cost. Fig 2 shows Deltabeam integrated with several floor types.

Most building contractors aim to increase the amount of off-site manufacture to speed up the site process, reduce wet trades and subsequent drying out, improve quality and reduce risk. Deltabeam with other pre-manufactured building components can speed up on-site construction by up to 30% by having up to 50% fewer components to erect than traditional approaches. Deltabeam can be used with steel or concrete frames and with steel decking, *in situ* or precast flooring. Using precast columns with Peikko column shoe moment bases eliminates the need for tie members further reducing the piece count.

Off-site manufacture has environmental and social benefits by transferring the place of work from remote sites to production sites close to home. Working conditions and family relationships are improved along with reduced CO₂ emissions from less travel.

Even in northern latitudes many buildings require cooling that has been traditionally achieved through the use of air-conditioning with associated high carbon energy consumption. Exposed or partially exposed floor slab soffits can provide regulation of internal temperatures by utilising the thermal capacity of the floor mass to control ambient heat gains within a building. In the daytime the internal temperature is influenced by the external temperature, solar gain through windows and from the heat generated by the activities within the building. At night, heat is lost from the building as temperatures fall externally and the activities slow down. By purging the floor slab of heat during the night through controlled ventilation the slab can provide passive cooling during the daytime. The technique can reduce internal temperatures by 2-3°C, which is equivalent to a cooling effect of approximately 20W/m²°C. The need for air conditioning may be reduced or in some cases eliminated which will reduce capital and running costs. Exploiting thermal mass requires early consideration of the building form, fabric and orientation.

In educational and similar buildings, providing a reflective ceiling (i.e. exposed soffit, particularly in the centre of the room) provides beneficial reflection of speech that increases the audibility.

Enhanced fabric energy storage

Normally with diurnal temperature variation only a relatively thin depth of concrete 75-100mm is effective for efficient heat transfer

and storage to take place. Some precast flooring systems can be used with Deltabeam and offer improved energy CO₂ reduction and reliable thermal control. They work through increasing the surface area of concrete in contact with the heat exchanger which in turn increases the volume of fabric energy storage.

TermoDeck® developed in Scandinavia in the 1970s enhances the effectiveness of the building's thermal mass by passing fresh or heated supply air through the hollow cores of the precast slab before it enters the room. As well as transferring heat or cold to the slab energy store, the inlet air is tempered and controlled before it enters the room which improves user comfort. Fig 3 shows how the slabs are incorporated into the building and how the main supply duct would normally be situated in the corridor. Deltabeam can be manufactured with the main supply duct fitted inside its profile. No ducts and therefore no false ceilings are required in individual rooms. This allows total freedom for the interior designer to locate, or re-locate in the future, the internal wall partitions.

Underfloor tubing can be embedded within precast hollowcore units utilising high temperature water for heating and low temperature water for cooling to condition a building. The system does not require night time air-purging of the structure as the temperature-controlled water is passed through the pipes to control the energy reservoir of the structure. The water source can be heated or cooled by conventional equipment from renewable energy or from geo-thermal sources. Units respond quickly and directly to changes in water temperature which give tighter and reliable control to the internal room temperature, irrespective of ambient conditions. Compared with air systems, underfloor pipe systems emit no noise and no draughts, producing a comfortable

and productive environment.

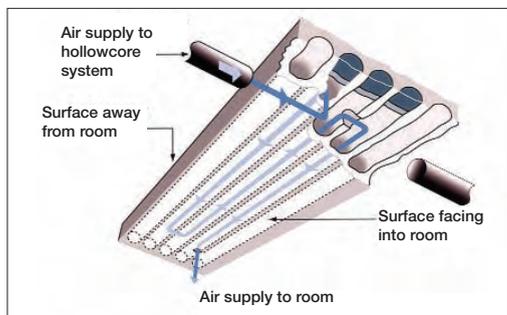
Fig 4 shows Tarmac Thermocast which comprises precast units with attractive coffered soffits embedded with a matrix of polybutylene pipes. Options for partition layouts are restricted to the pitch of the coffered slab but this disadvantage is offset by high acoustic and lighting performance which improves ambience.

Figs 5a and 5b show how Deltabeam is integrated with TermoDeck and Thermocast.

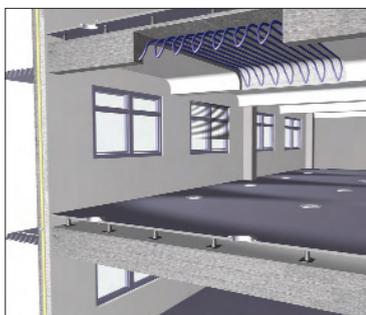
Construction benefits

- The erection time for a pre-fabricated building compared to a conventional cast *in situ* concrete building can be reduced by up to 30%.
- Factory produced hollow core slabs enable installation to take place during all weather conditions.
- In conventionally serviced buildings flush soffits allow the prefabrication of services resulting in up to 15% cost saving through reduced waste.
- Fabric energy storage can save 30-50% energy consumption and 70-90% reduction of peak cooling loads. Further substantial savings in investment, maintenance and operational costs, compared to conventional air-conditioning systems are achieved.
- Elimination of suspended ceilings can reduce building height and lower construction costs.

Further information: Peikko UK Ltd, Ridgeway, Newton Aycliffe, DL5 6SP (tel:+44 1325 318 619; fax:+44 1325 318 481; web: www.peikko.co.uk).



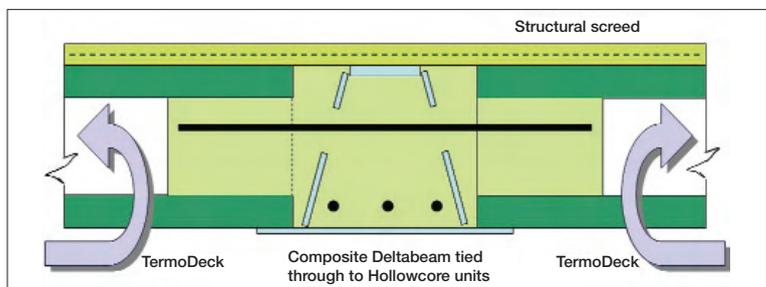
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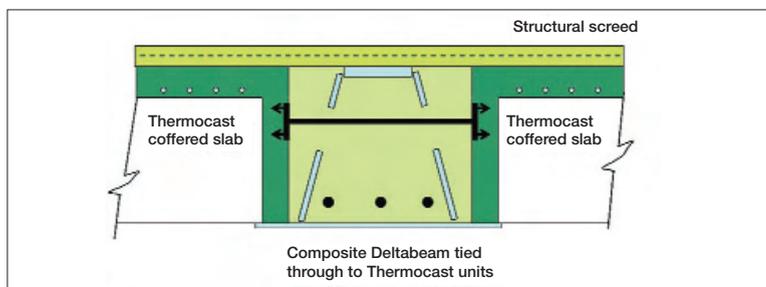
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6



5a



5b

Example

Cults Academy and Bucksburn Academy, part of 3R Aberdeen City Schools embody Scandinavian design with very high standards of sustainability expected to achieve BREEAM 'Excellent' ratings. The schools are built on a grid system with precast hollowrib floors supported on prefabricated load bearing concrete sandwich wall panels and a spine of Deltabeam composite beams. The building forms are therefore simple and rectilinear. The exterior panels incorporate rough and colourless timber cladding to counter the harshness of the concrete and large glazed surfaces in dark grey aluminium frames. Simplicity and distinctive character are achieved by using these three, quite dissimilar materials exclusively (except for a granite wall at the main entrance). Inside, the emphasis has been to bring in as much natural light as is practical and connect the indoors areas with the outdoors. The composite nature of Deltabeam allows for economy of materials, sustainability and the flat soffit enables designers to future-proof learning spaces. The contractor shows Scandinavian expertise in using Deltabeam and precast elements to full effect to achieve the client's requirements (Fig 6).

Credits

Architect: Indro Candi, Iceland
 Consulting Engineer: Buro Happold
 Contractor: Pihl UK Ltd

- 3 TermoDeck concept
- 4 Thermocast system
- 5 Deltabeam integration: a) Deltabeam with TermoDeck
 b) Deltabeam with Thermocast
- 6 Bucksburn Academy: Prefabricated sandwich wall panels supporting flush hollowcore floors with integrated Deltabeam spine