Innovative Steel-Concrete Composite Beam for Sustainable Slim Floor Construction

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The presentation deals with an innovative type of composite beam developed in Northern Europe during the 1990’s. The beam is typically used in precast residential, administrative or industrial buildings in combination with precast concrete slabs. The beam uses a novel type of shear connection that offers an excellent structural performance together with several other practical benefits. The structural performance of the beam has been validated by extensive research in Europe and North America. The research enabled to develop optimized design guidelines for the beam that are approved relevant authorities in several countries (including the UAE). As of today, the beam has been used in almost 10 000 projects around the world.
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Jan Bujnak is a Research and Development manager at Peikko Group, where he is responsible for the research and technical design of anchorage and reinforcement products. He obtained a PhD from Polytech Clermont-Ferrand (France) in 2007 and co-authored scientific publications dealing mainly with shear, punching shear and anchorage in reinforced concrete structures. Jan Bujnak is participating in development and testing of building products, European Technical Approvals and CE marking of building products as well in design tool development (software and technical manuals.)
Learning Objectives

1. Benefits of composite construction
2. Benefits of pre-fabricated structures
3. Design principles for prefabricated composite slim floors
Composite steel concrete construction

- Steel → tension
- Concrete → compression
Benefits

• Flexible open space
• Architectural freedom
• Additional room height
• Lower heating and cooling costs
• Easy and space-saving technical installations
• Fast and safe to erect
• Integrated fireproofing
• Prefabricated product → construction time is reduced and delays due to weather are minimized
• Unique in 3D-design, each beam fits perfectly to the structure
• Together with BIM (Building Information Modeling) this process helps identify conflicts early on in the design stage
• DELTABEAM® only requires little or no propping
• Faster than any other system on the market → Saves easily a week per floor compared to conventional structures
• Requires only a small crew
Deltabeam

- BOTTOM PLATE
- LEDGES
- WEB Holes
- AIR HOLES
- CASTING HOLE
- TOP PLATE
- FIRE REBAR
- BOTTOM PLATE
Deltabeam

- Pre-cast slabs
- Semi pre-cast or in-situ cast slabs
Structural behavior

**Erection stage** – steel beam without propping

- Bending
- Shear
- Torsion

EN 1993-1-1

$$\sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau_{xy}^2 + 3\tau^3} \leq f_{yd}$$
Structural behavior

**Execution stage** – composite beam

- **Bending**
- Horizontal shear
- Vertical shear

EN 1994-1-1  6.2.1.4
Structural behavior

**Execution stage** – composite beam

- Bending
- **Horizontal shear**
- Vertical shear

Push out test (Annex B EN 1994-1-1) ➔ $\delta_{\text{ult}}>6\text{mm}$
Structural behavior

**Execution stage** – composite beam
- Bending
- Horizontal shear
- **Vertical shear**

$$V_{Rd} = V_{Rd,sy} + V_{Rd,a} \leq V_{Rd,max} + V_{Rd,a}$$

- $V_{Rd,max}$ - concrete strut
- $V_{Rd,a}$ - shear thru openings EN 1993-1-1
- $V_{Rd,sy}$ - vertical capacity of posts EN 1993-1-1
Structural behavior

**Fire situation**

Bending
Horizontal shear
Vertical shear
Approvals

Czech: 204/C5/2006/060-025293 / 060-025292
Finland: VTT Certificate (fi, en)
Finland: VTT-RTH-03040-07 (fi, en)
Germany: Z-26.2-49
Hungary: ATB-15/2015
Poland: AT-15-8053/2014
Russia: POCC F1.AB28.H18000
Slovakia: TO - 08/0021
UAE: TAC-No-145-2015
UK: BBA No 05/4204

Design
Manufacturing
Construction
Conclusions

• DELTABEAM composite floor offers efficiency in:
  – Concept
  – Design
  – Manufacturing
  – Project management

SUSTAINABILITY