Large-scale fire test of unprotected cellular beam acting in membrane action

Introduction

• This paper describes a full scale fire test performed recently at the University of Ulster on a composite floor for analysing the possibility of tensile membrane action to develop when the unprotected steel beams in the central part of the floor are made of cellular beams.

• This test was realised in the scope of the project FICEB+ (Fire Resistance of Long Span Cellular Beams Made of Rolled Profiles) ; a project funded by the European Research Fund for Coal and Steel.
FICEB+ - Partnership
Introduction
Cellular Beam fabrication

25th February 2010
Global dimensions of the compartment

15 m

9 m
Bearing structure
Fire protection
Steel sheeting and reinforcement
Reinforcement
## Design Loads

<table>
<thead>
<tr>
<th>Description</th>
<th>Characteristics kN/m²</th>
<th>Load Factor</th>
<th>Design Load kN/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partition</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Services &amp; Finishes</td>
<td>0.5</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Live Load</td>
<td>3.5</td>
<td>0.5</td>
<td>1.75</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>3.25</strong></td>
</tr>
</tbody>
</table>

The loads used within the structure are the same as those which are commonly used in the design of office buildings.
Assuming the design for an office, the fire load density would be 511 MJ/m² according to Table E.2 of EN 1991-1-2.

For the test, a fire load of 40 kg of wood/m² was used, which corresponds finally to a fire load of about 700 MJ/m².
Fire Loads
Temperature in the compartment

Temperature in the Middle of Compartment

- Measured Temperatures - Middle of Compartment
- Ozone-model Ulg 40 kg wood /m² (like in the test)
- Ozone-model Ulg 31.9 kg wood /m² (Nov. 2009)

Temperature (deg C)

Time (min)
Shape of the beam after the fire
Shape of the beam and connection
Safir Finite element prediction (made before the test)

**Diagram:**
- Unprotected cellular Beam

**File Information:**
- Diamond 2009.a.5 for SAFIR
- FILE: UsterH1
- NODES: 2031
- BEAMS: 260
- TRUSSES: 0
- SHELLS: 1664
- SOILS: 0

**Plot Options:**
- BEAMS PLOT
- SHELLS PLOT
- IMPOSED DOF PLOT

**Files:**
- prot1.tem
- prot2.tem
- prot3.tem
- unpr1.tem
- slab_side.tsh
- slab_center.tsh

**Date:** 12-03-2010

**FRACOF**
Thermal Modelling

double tee section

upper tee section
FEM Stresses
SAFIR Results Vs Test Results

Deflection - Beam 5

- Centre
- Predictive Ulg - double tee
- Predictive Ulg - simple tee

Deflection (mm)

Time (min)

Before Web Post Buckling
After Web Post Buckling