Coupling Shell Elements with beam elements
Introduction

There are many applications in which shell elements are reinforced with beams.

Ribs in ships

Hang-gliders
Introduction

In some cases the beam elements can be simulated as short shell elements (this is the case of ship ribs). However, in other cases, such the hang-glider, it is preferable to include the beam elements in the simulation. This is also the case of buildings:
Numerical simulation of a building

In current class we will simulate the following building. This is a two-story building made with 4 steel frames and concrete slabs.

This example has been taken from the book:
Geometry

The steel frames are defined with the following dimensions:
Geometry

All beams are made with the same I beam cross section, which dimensions are:

The cross section orientation is the one shown in the following picture.
Geometry

Concrete slabs connect the different cross sections. They have a thickness of 15cm.

Special care has to be taken when defining these elements, in order to create them from the contour defined by the beams instead of the contour of adjacent surfaces.
Materials

The concrete slab is made of the pre-defined concrete that can be found in ANSYS Workbench.

Beams are made with structural steel.

The maximum stresses that can be applied to each material are:

- **Steel**: 250 Mpa
- **Concrete**: 30 MPa (compression) 5 MPa (tensile)

Tensile stresses in concrete can be increased adding steel reinforcements. This is not considered in current simulation.
Current simulation will be conducted with the mesh created by default by Ansys Workbench, when selecting a relevance of 100. The resulting mesh is the one shown in the following figure:
Boundary conditions

As boundary conditions we will apply a pressure load of 7.50 kN/m² over each concrete slab. We will also consider the self-weight of the structure. The base of all columns are fix supported.
We have to validate that the maximum stresses are not exceeded:

Steel: 250 Mpa
Concrete: 30 MPa (compression)
4 MPa (tensile)

We also have to validate that the maximum deformation is not exceeded. This deformation is limited to the value of:

Span/250 = 6000/250 = 24 mm
Exercise 2

Repeat the calculation if the concrete slabs are constructed as domes:
Exercise 2

The geometry of the frame cross section is, in this case:

The rest of parameters are the same than in previous simulation.

Which structure provides a better performance?
Why?