In this case study, we analyze the PAT Center of Richard Rogers and Ove Arups & Partners structural engineering.

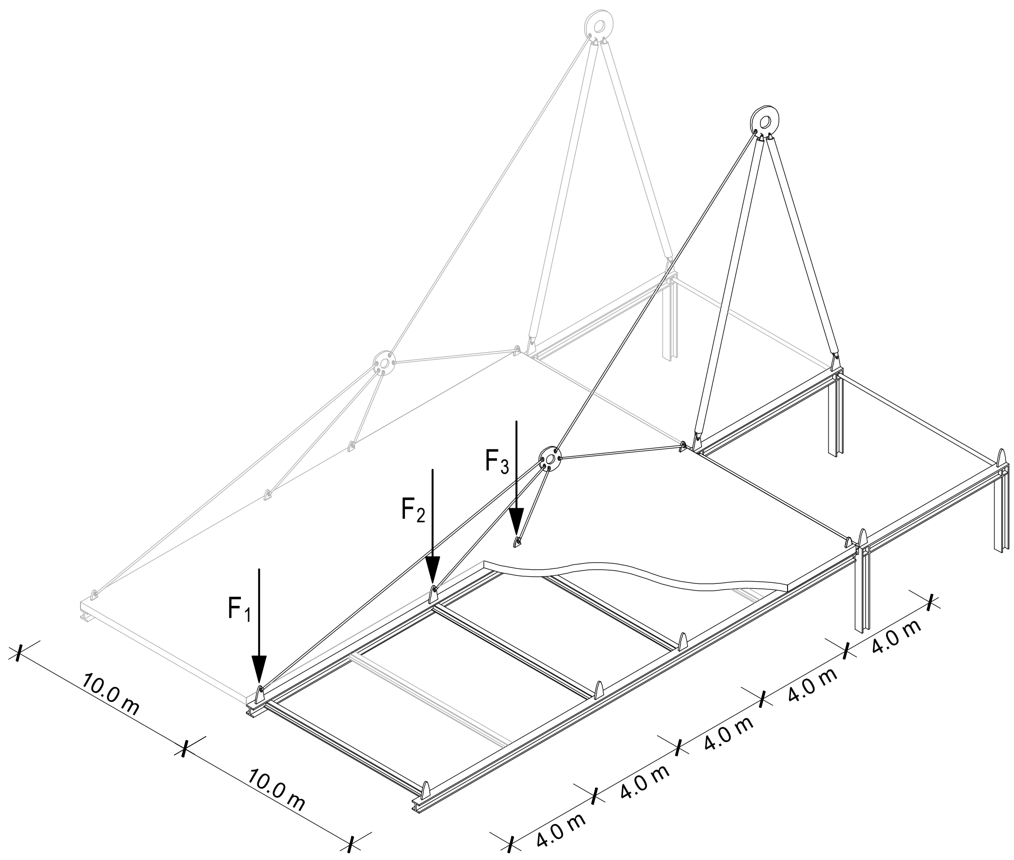
The PAT Center in Princeton, NJ, USA is a single-storey building with a floor area of 3,700 m2. Specializing in design and telecommunications, PA Technology LTD wanted the most flexible and expandable space possible as a technological center that could be adapted to unpredictable space requirements. That is why the building consists of a single large room, which can be subdivided as desired. Along the central axis, there are serially distributed pylons from which the roof is suspended.

Task 1 Calculation of the loads

The primary longitudinal beams together with the secondary cross beams carry a ceiling of prefabricated concrete elements with a thickness of 12 cm. Concrete has a volume load γ_k of 20 kN/m³. On top there is the finished roof (composed by: insulation, gravel, covers) with a surface load of $\overline{g}_k$ = 1.3 kN/m². Also it is likely to snow in Princeton in winter, so a snow load of $\overline{q}_k$ = 2 kN/m² has to be considered.

a) Calculate the total area load for the concrete elements as well as the roof structure including snow at design level and round up the value to whole kN/m².

b) Calculate the point loads F1-3 acting on the primary beam with the rounded value from 1a). In the axonometric drawing, the respective dimensions of the load-influencing zones can be recognized. Important: Two bars are neglected because their weight is not transferred directly by a rope.

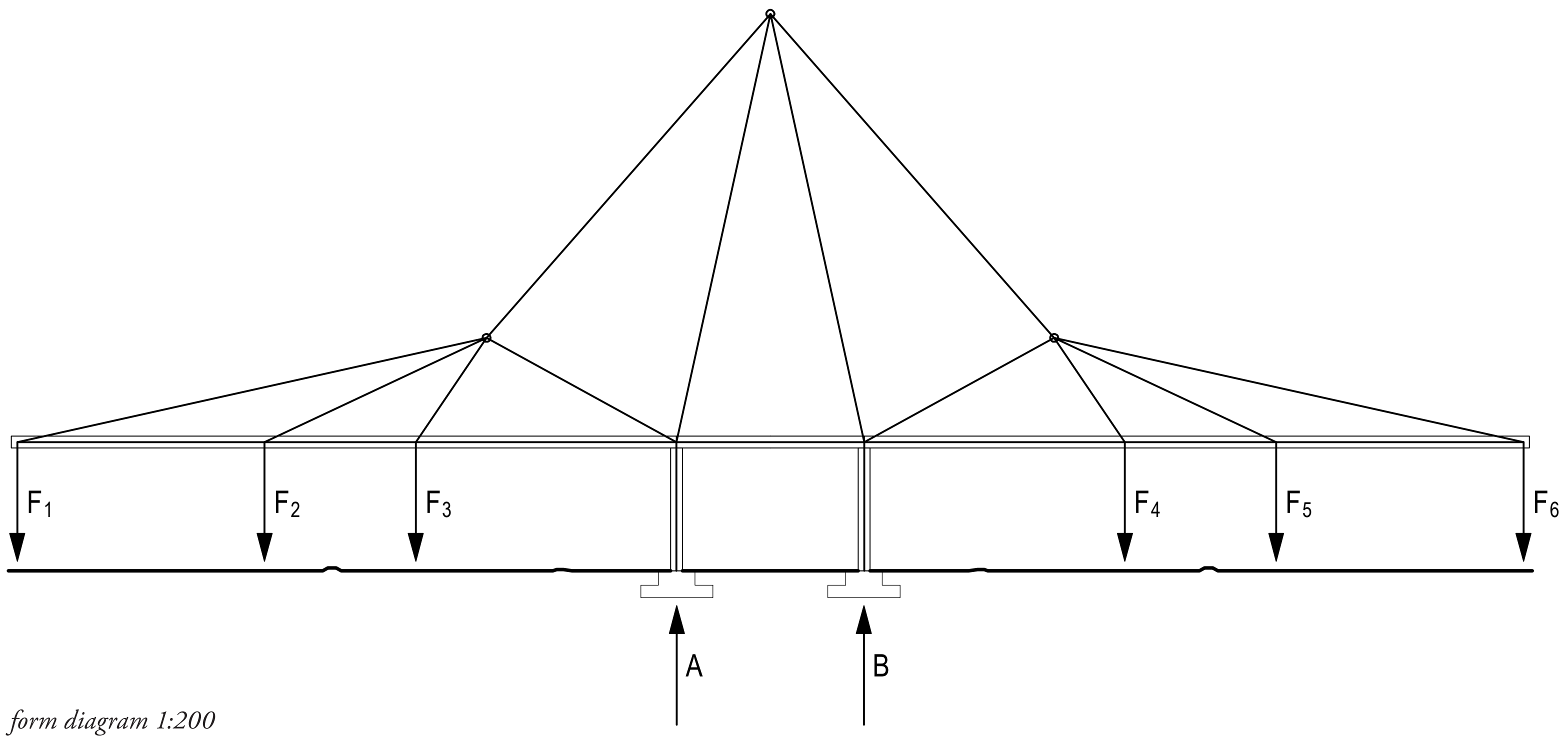


Task 2 Forces in the section

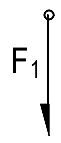
The primary structure consists of steel cables, steel tubes for the pylons and I-beams for the remaining pressure elements.

a) The cross-section of the building is shown below in the form diagram. Draw the corresponding force diagram. Use the point loads $F_{1\text{-}3}$ from 1b). Mark tension elements red and compression elements blue.

b) For the supporting elements rope, deck and pylon, indicate the position and load of the relevant segments.



form diagram 1:200



subsystem

force diagram 1cm ≙ 200kN

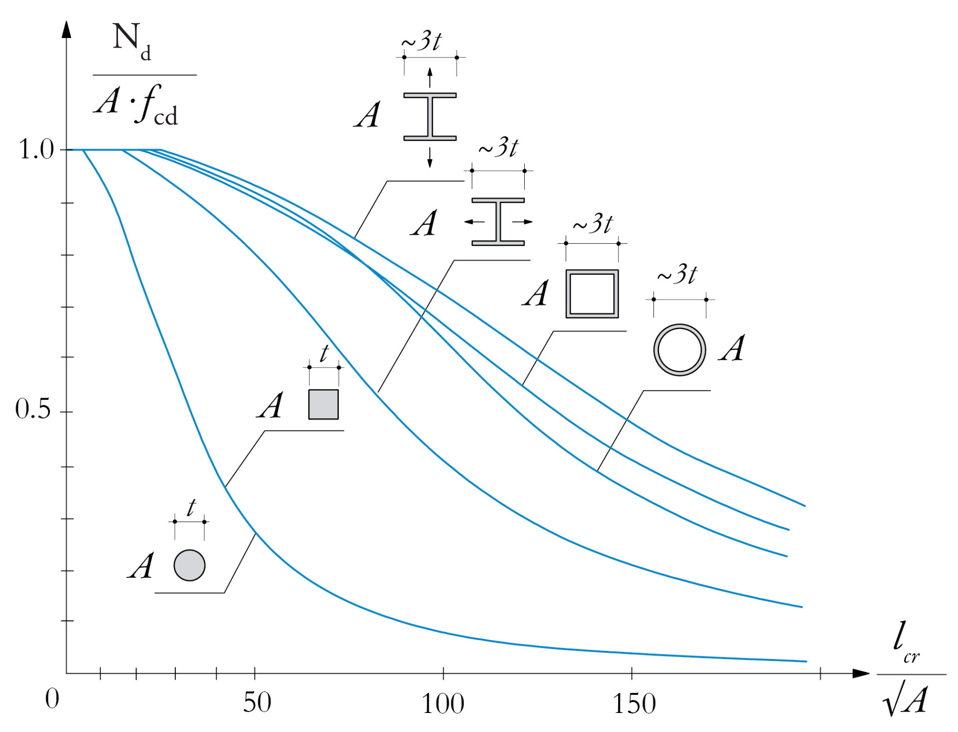
	segment	load
rope		
deck		
pylon		

Task 3 Dimensioning the main elements

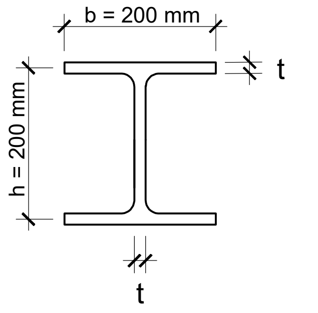
a) Check whether the rope D=100mm made of steel S355 can withstand the maximum tensile load from task 2.

b) The pylon shall be a round hollow section of S355 steel with an outer diameter D_1=160 mm and an inner diameter D_2=116 mm. Check on the basis of the diagram below whether this cross-section would buckle under the maximum compressive stress from task 2. (The respective lines in the diagram mark the critical limit of the buckling. If a point is below it, the segment will not buckle under the given load. l_{cr} means the length of the segment. How could a possible buckling be prevented?

c) The main beam is constructed with the shown steel profile made of steel S500. The flange thickness corresponds to that of the web which is 35 mm. Verify that this cross-sectional area is sufficient to absorb the maximum compressive stress of the deck as determined in task 2.



buckling diagram



section main beam