S2: Physical design area problem (Topology, shape, and size optimization of 759-bar truss bridge)

The physical design area problem is the simultaneous optimization of topology, shape, and size of a 759-bar truss bridge with 40 nodes. Seven members and eight nodes define the lower cord of the bridge (Figure I). A rectangular physical design area with a height of 35 m and a length of 70 m is considered. The remaining nodes are divided into three groups to impose symmetry (Hasançebi and Erbatur 2002):

- 14 independent nodes on the left side of the design space area.
- 14 dependent nodes on the right side, linked to the nodes in the first group by symmetry.
- 4 independent nodes lying on the symmetry line.

These 32 nodes are connected to each other (16×31=496) and the nodes on the lower cord (32×8=256). Therefore, the overall number of members is 496+256+7=759. One topology variable is assigned per independent member, except for the members on the lower cord which must be present. Therefore, the overall number of topology, shape and size variables is 386+32+390=808. The allowable displacement of all nodes in each direction is 7 cm. The problem necessitates that the lengths of the members be within the range of 5-30 meters. A member is deactivated if its length is out of this range to handle this constraint. Design constraints are governed by AISC-ASD specifications (AISC 1989). The following values are used: F_y=248.21 MPa (36 ksi), Density=7,850 kg/m^3 and E=200 GPa (29,000 ksi)

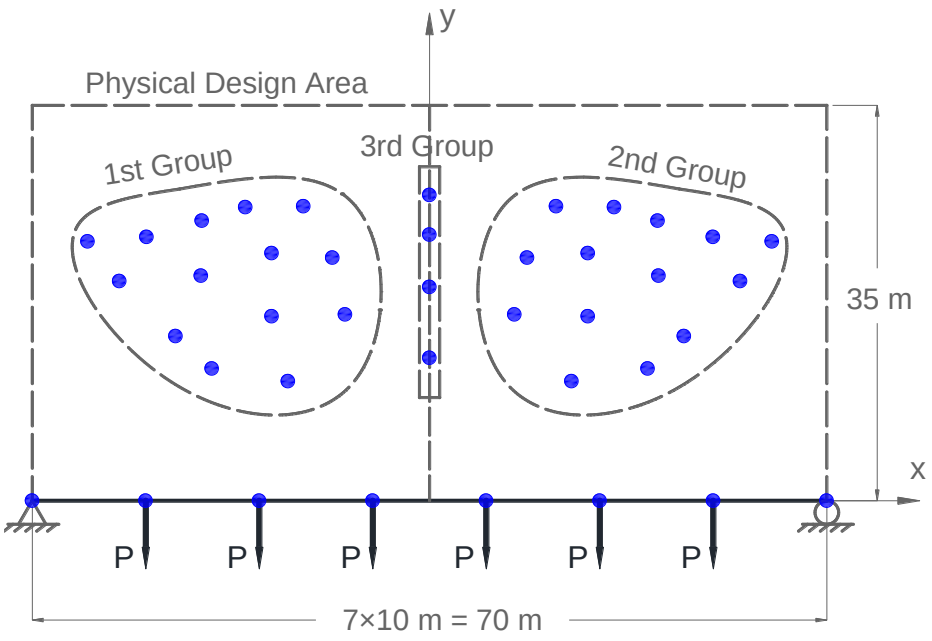

Figure I. Illustration of the 759-bar physical design problem