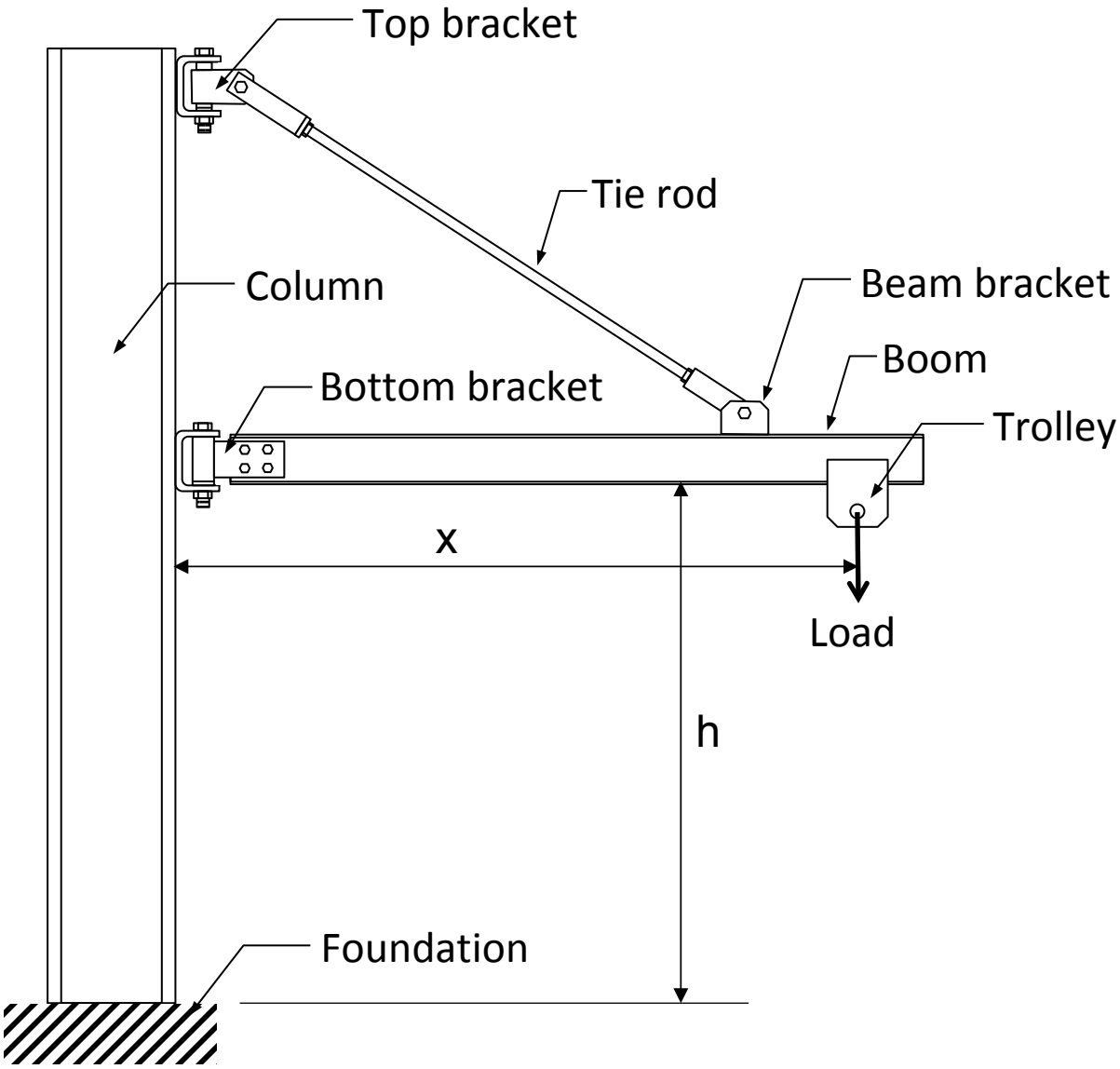
Course of Mechanical Design and Machine Elements

Homework 1, part A: Design and verification of a jib crane



The jib crane is composed of a horizontal beam (boom) over which a hoisting trolley is able to travel. The boom is supported by a vertical column and a tie-rod through brackets, which permit its rotation (±90° with respect to the position shown in the figure) about the vertical axis. The tie-rod is a round bar with threaded ends.

The following requirements must be satisfied:

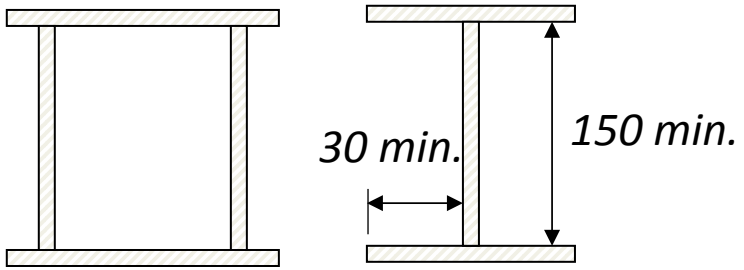
1) The hoisting capacity is 1000 kg.
2) The maximum vertical deflection under maximum load shall not exceed 40 mm.
3) The crane span is 3200 mm, the load position x can be varied between 600 mm and 3000 mm. The height h under boom is 2500 mm, while the jib crane must be installed in workshops with ceiling of minimum height equal to 3500 mm.
4) The column beam is obtained by welding four plates into a box closed cross-section. The boom is a H-beam of standard size (see catalogues). The flange and the web must be large enough to permit the motion of the trolley wheels that can be assumed with 150 mm diameter and 30 mm thickness.
5) The structure is made of construction steel with good weldability.
6) Low-weight solutions are desirable.

The brackets can be assumed to be able to transmit only forces and not moments.

As a preliminary stage of the design, it is requested to prepare the product design specification and to determine the cross-section of the beams.

Hints

- Beam cross-section geometry:



- Take a safety factor of 2.5 in the design for static strength. This accounts for the uncertainty in the material properties and the reduction in strength produced by time-varying loads. A safety factor 1.25 can be taken for the stiffness verification.
- At the beginning of the design, the cross-sections are not yet selected. Therefore, self-weight and eccentricity of the internal loadings with respect to beams axis are not known a priori. A possible solution strategy is to neglect these effects to come to a first-tentative estimation of the cross-sections. The design is then iterated to include the aforementioned effects.
- A reasonable estimation of the brackets' longitudinal size is about 300 mm.