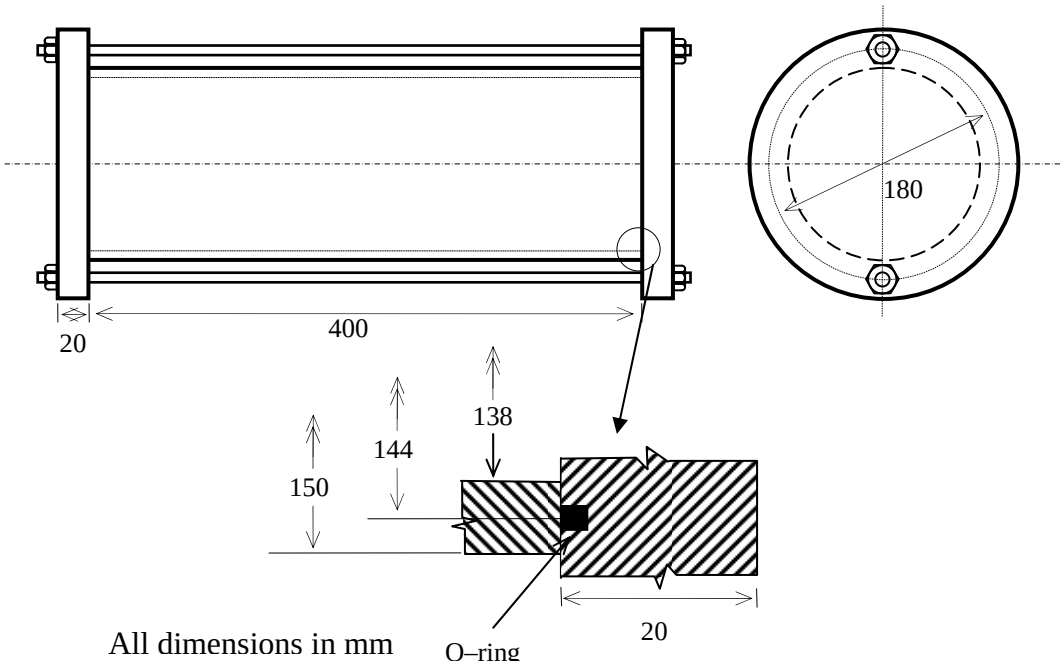
March 15, 2018

ME-351
Design Tutorial 04

1. The cylinder shown in figure is used with a gas gun setup. The cylinder has an outer diameter of 150 mm and wall thickness of 6 mm. The construction of the cylinder is as follows. There are two end plates each of diameter 210 mm and thickness 20 mm. The two plates along with the cylinder are assembled using 10 studs (M 10 x 1.5, grade **), two of which are shown in the figure. The inner surface of each end plate has a groove for placing an O-ring of 4 mm diameter to ensure sealing (consider this as a confined gasket). The sealing diameter can be taken as 144 mm as shown in figure. (The sealing diameter is the diameter beyond which the internal pressure does not act). Every time the gas gun is used, the cylinder will be pressurized to the required pressure and then immediately it is vented into a barrel for accelerating a projectile. The cylinder wall thickness is designed for a maximum operating pressure of 5 MPa with a design factor of 4.

   i) Determine the factor of safety for i) exceeding proof strength, ii) joint separation, iii) bolt failure during assembly and iv) fatigue failure assuming infinite life. The elastic modulus for all materials is 200 GPa.

   ii) In the case of an over pressure (imagine that the operator kept on pressurizing the cylinder beyond 5 MPa), which of the following is likely to happen a) the joint will leak, b) the bolts will yield or fail completely c) the cylinder will yield. (Merely giving one option without proper reasoning backed by required calculation is not enough).



P. Venkitanarayanan, P. Wahi, S. Basu, C. Chindam