Example 2.4.1

a) A shaft is held rigidly at one end and has a twisting couple of 600 N·m applied at the other end. It can be idealised as being of length 1400 mm, composed of a 40 mm diameter copper bar 600 mm long joined to a 35 mm diameter steel bar 800 mm long. Ca1culale the maximum shear stresses in the two materials, and the angle of twist of the free end. Take the shear modulus of copper to be 40 GPa and that of steel to be 76 GPa.

(Ans: 47.7 MPa, 71.3 MPa, 4.51^o)

b) A 40 kW motor is to drive the propeller shaft of a boat at 200 r.p.m. If the shaft is to be of solid circular section, and the shear stress in it is to be limited to 70 MPa, calculate the diameter of shaft required. If a hollow shaft of outside diameter 20% greater is used, subject to the same maximum stress, calculate the percentage saving in weight of the shaft, and the percentage change in the twist of the shaft (power = torque × angular velocity).

(Ans: 51.8 mm, 49.5%, -16.7%)

c) A steel rod 20 mm diameter, 1000 mm long is rigidly held at both ends. A torque of 70 N·m is applied 250 mm from one end. Calculate the angle of twist of the mid-point of the rod. Shear modulus is 76 GPa.

(Ans: 0.42^o)