Part 1: Matrix Method

1. Two dissimilar rods are connected together and loaded as shown Figure Q1. Using the stiffness matrix approach, calculate the displacement at the interface and the forces at the supports. E_{steel} = 200 GPa, $E_{aluminium}$ = 70 GPa.

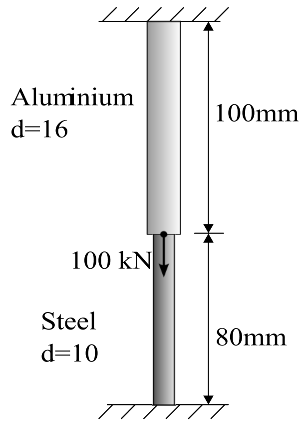

Figure Q1

2. For the pin jointed structure shown in Figure Q2. Determine the vertical and horizontal displacements at the loading point. The value of AE for each member is 200MN.

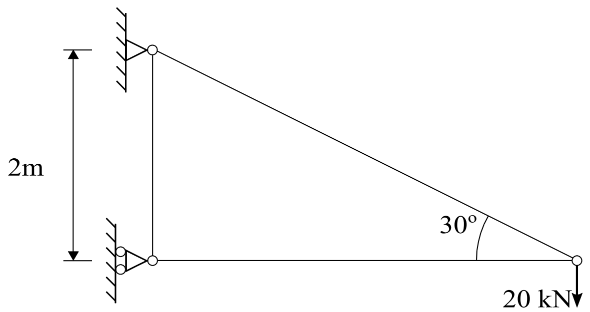

Figure Q2

The stiffness matrix of a truss element is:

$$[k_e] = \left(\frac{AE}{L}\right)\begin{bmatrix} \cos^2\theta & \cos\theta\sin\theta & -\cos^2\theta & -\cos\theta\sin\theta \\ \cos\theta\sin\theta & \sin^2\theta & -\cos\theta\sin\theta & -\sin^2\theta \\ -\cos^2\theta & -\cos\theta\sin\theta & \cos^2\theta & \cos\theta\sin\theta \\ -\cos\theta\sin\theta & -\sin^2\theta & \cos\theta\sin\theta & \sin^2\theta \end{bmatrix}$$

Part 2: Practical FE Problems

For the following cases, describe briefly the approach taken to model the problem in FE to obtain a good solution for the stresses. Sketch the geometry of the model (any symmetry?) including applied loads and boundary conditions and consider what mesh (element distribution; element type e.g. plane stress, plane strain, axisymmetric etc.) would be appropriate. Also consider any special features of the analysis.

3. A square plate of side length *L*, width *b* and thickness *t* with a central circular hole of radius *r*, is subjected to a uniaxial stress σ_0 as shown in Figure Q3. You wish to determine the stress distribution around the hole. ($t << L$)

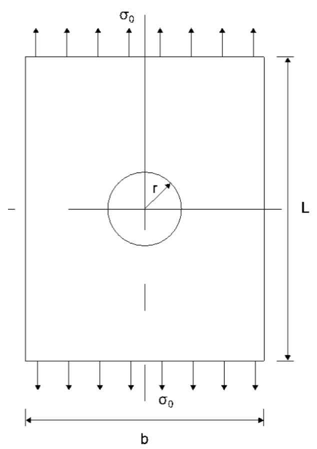

Figure Q3

4. A steel cylindrical roller of radius *r* and length *L* is pressed on a flat block of regular cross-section of the same material of depth *h*, width *w* and length *L*, by a vertical line load of magnitude *F* per unit length as shown in Figure Q4. You wish to determine the stress distribution in the block under the cylinder. (*L* is long and the loading is in-plane)

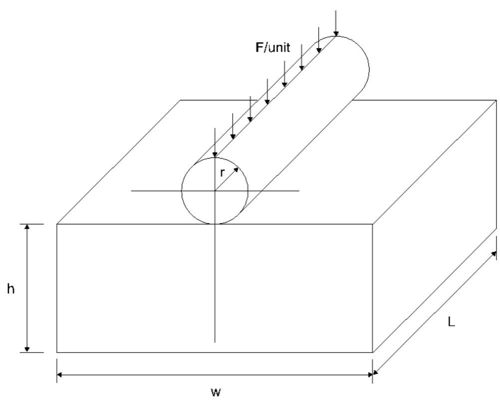

Figure Q4

5. Consider a similar situation to Q4. However, in this case the cylinder is replaced by a sphere.