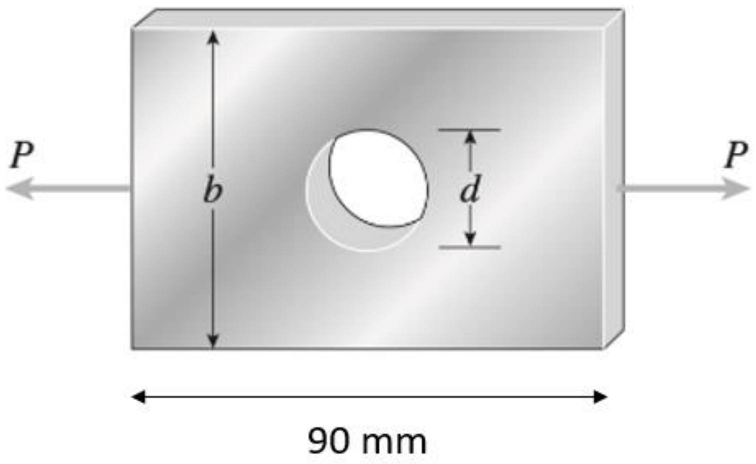
本次作業第三和第四題的相關參數為：

第三題

Young's modulus = 200 GPa

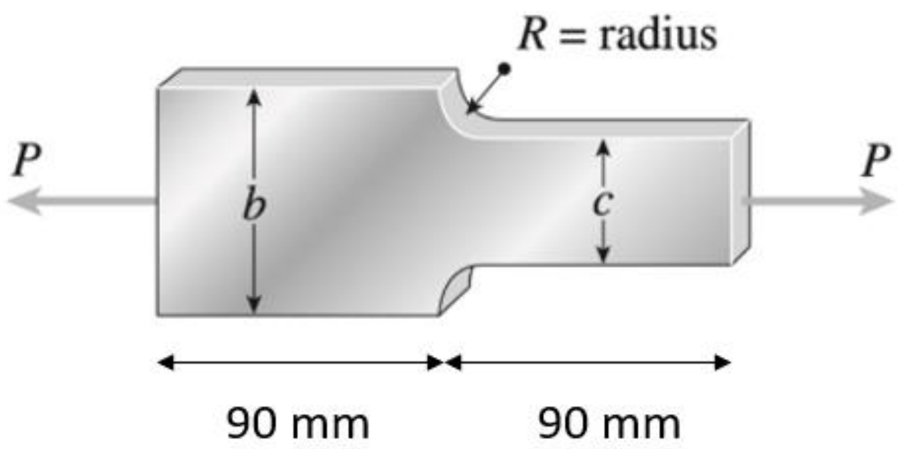
Poisson’s ratio = 0.3



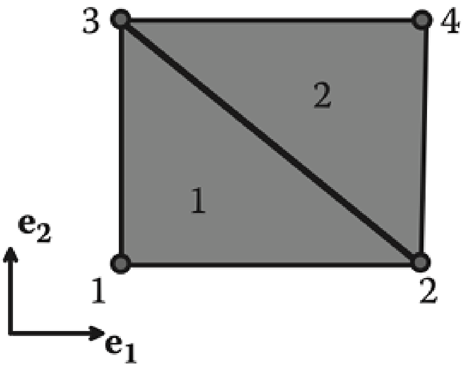
第四題

Young's modulus = 200 GPa

Poisson’s ratio = 0.3



本次作業的第 3 和第 4 題請使用 Global stiffness matrix 的 ***K*** 矩陣的方式來求解，相關原理和程式碼如下，透過(2.16)的原理將每個元素相對應的 ***K*** 矩陣一一填入至 Global stiffness matrix 的 ***K*** 矩陣，請自行切割網格並定義座標(coor、conn 等)，網格數量可不需太多，因此有誤差是很正常的



$$W = \frac{1}{2}\begin{bmatrix} u_1^{(1)} & u_2^{(1)} & u_1^{(2)} & u_2^{(2)} & u_1^{(3)} & u_2^{(3)} \end{bmatrix}\begin{bmatrix} k_{11}^{(1)} & k_{12}^{(1)} & \dots & k_{16}^{(1)} \\ k_{21}^{(1)} & k_{22}^{(1)} & & \\ \vdots & & \ddots & \\ k_{61}^{(1)} & & & k_{66}^{(1)} \end{bmatrix}\begin{bmatrix} u_1^{(1)} \\ u_2^{(1)} \\ u_1^{(2)} \\ u_2^{(2)} \\ u_1^{(3)} \\ u_2^{(3)} \end{bmatrix}$$

$$+\frac{1}{2}\begin{bmatrix} u_1^{(2)} & u_2^{(2)} & u_1^{(3)} & u_2^{(3)} & u_1^{(4)} & u_2^{(4)} \end{bmatrix}\begin{bmatrix} k_{11}^{(2)} & k_{12}^{(2)} & \dots & k_{16}^{(2)} \\ k_{21}^{(2)} & k_{22}^{(2)} & & \\ \vdots & & \ddots & \\ k_{61}^{(2)} & & & k_{66}^{(2)} \end{bmatrix}\begin{bmatrix} u_1^{(2)} \\ u_2^{(2)} \\ u_1^{(3)} \\ u_2^{(3)} \\ u_1^{(4)} \\ u_2^{(4)} \end{bmatrix} \tag{2.15}$$

(3) We could add the missing terms to each element displacement vector:

(2.16)

$$W = \frac{1}{2}\left[u_1^{(1)}\ u_2^{(1)}\ u_1^{(2)}\ u_2^{(2)}\ u_1^{(3)}\ u_2^{(3)}\ u_1^{(4)}\ u_2^{(4)}\right]\begin{bmatrix} k_{11}^{(1)} & k_{12}^{(1)} & \dots & k_{16}^{(1)} & 0 & 0 \\ k_{21}^{(1)} & k_{22}^{(1)} & & & 0 & 0 \\ \vdots & & \ddots & & 0 & 0 \\ k_{61}^{(1)} & & & k_{66}^{(1)} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} u_1^{(1)} \\ u_2^{(1)} \\ u_1^{(2)} \\ u_2^{(2)} \\ u_1^{(3)} \\ u_2^{(3)} \\ u_1^{(4)} \\ u_2^{(4)} \end{bmatrix}$$

$$+\frac{1}{2}\left[u_1^{(1)}\ u_2^{(1)}\ u_1^{(2)}\ u_2^{(2)}\ u_1^{(3)}\ u_2^{(3)}\ u_1^{(4)}\ u_2^{(4)}\right]\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & k_{11}^{(1)} & k_{12}^{(1)} & \dots & k_{16}^{(1)} \\ 0 & 0 & k_{21}^{(1)} & k_{22}^{(1)} & & \\ 0 & 0 & \vdots & & \ddots & \\ 0 & 0 & k_{61}^{(1)} & & & k_{66}^{(1)} \end{bmatrix}\begin{bmatrix} u_1^{(1)} \\ u_2^{(1)} \\ u_1^{(2)} \\ u_2^{(2)} \\ u_1^{(3)} \\ u_2^{(3)} \\ u_1^{(4)} \\ u_2^{(4)} \end{bmatrix}$$

$$= \frac{1}{2}\left[u_1^{(1)}\ u_2^{(1)}\ u_1^{(2)}\ u_2^{(2)}\ u_1^{(3)}\ u_2^{(3)}\ u_1^{(4)}\ u_2^{(4)}\right]\begin{bmatrix} k_{11}^{(1)} & k_{12}^{(1)} & k_{13}^{(1)} & k_{14}^{(1)} & k_{15}^{(1)} & k_{16}^{(1)} & 0 & 0 \\ k_{21}^{(1)} & k_{22}^{(1)} & k_{23}^{(1)} & k_{24}^{(1)} & k_{25}^{(1)} & k_{26}^{(1)} & 0 & 0 \\ k_{31}^{(1)} & k_{32}^{(1)} & k_{33}^{(1)}+k_{11}^{(2)} & k_{34}^{(1)}+k_{12}^{(2)} & k_{35}^{(1)}+k_{13}^{(2)} & k_{36}^{(1)}+k_{14}^{(2)} & k_{15}^{(2)} & k_{16}^{(2)} \\ k_{41}^{(1)} & k_{42}^{(1)} & k_{43}^{(1)}+k_{21}^{(2)} & k_{44}^{(1)}+k_{22}^{(2)} & k_{45}^{(1)}+k_{23}^{(2)} & k_{46}^{(1)}+k_{24}^{(2)} & k_{25}^{(2)} & k_{26}^{(2)} \\ k_{51}^{(1)} & k_{52}^{(1)} & k_{53}^{(1)}+k_{31}^{(2)} & k_{54}^{(1)}+k_{32}^{(2)} & k_{55}^{(1)}+k_{33}^{(2)} & k_{56}^{(1)}+k_{34}^{(2)} & k_{35}^{(2)} & k_{36}^{(2)} \\ k_{61}^{(1)} & k_{62}^{(1)} & k_{63}^{(1)}+k_{41}^{(2)} & k_{64}^{(1)}+k_{42}^{(2)} & k_{65}^{(1)}+k_{43}^{(2)} & k_{66}^{(1)}+k_{44}^{(2)} & k_{45}^{(2)} & k_{46}^{(2)} \\ 0 & 0 & k_{51}^{(2)} & k_{52}^{(2)} & k_{53}^{(2)} & k_{54}^{(2)} & k_{55}^{(2)} & k_{56}^{(2)} \\ 0 & 0 & k_{61}^{(2)} & k_{62}^{(2)} & k_{63}^{(2)} & k_{64}^{(2)} & k_{65}^{(2)} & k_{66}^{(2)} \end{bmatrix}\begin{bmatrix} u_1^{(1)} \\ u_2^{(1)} \\ u_1^{(2)} \\ u_2^{(2)} \\ u_1^{(3)} \\ u_2^{(3)} \\ u_1^{(4)} \\ u_2^{(4)} \end{bmatrix}$$

Loop 1: $a = 1$ to 3

Loop 2: $i = 1$ to 2

Loop 3: $b = 1$ to 3

Loop 4 $k = 1$ to 2

$ir = 2\left(n_a^{(j)} - 1\right) + i$

$ic = 2\left(n_b^{(j)} - 1\right) + k$

$K^{elem}_{2(a-1)+i,\,2(b-1)+k} \rightarrow K_{ir,\,ic}$

End of Loop 3

End of Loop 2

End of Loop 1

(3) *GlobStif* function

```
function kglob = GlobStif(ndime,nnode,nelem,nelnd,mate,coor,conn)
  kglob = zeros(ndim*nnode,ndim*nnode);
  for j = 1:nelem
    kel = ElemStif(j,mate,coor,conn);
    for a = 1:nelnd
      for i = 1:ndime
        for b = 1:nelnd
          for k = 1:ndime
            ir = ndime*(conn(a,j)-1)+i;
            ic = ndime*(conn(b,j)-1)+k;
            kglob(ir,ic) = kglob(ir,ic)+kel(ndime*(a-1)+i,ndime*(b-1)+k);
          end
        end
      end
    end
  end
end
```