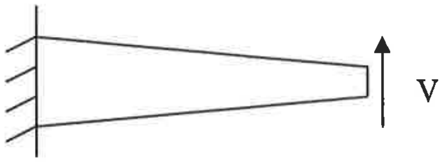
國立交通大學 103 學年度第 2 學期

博士班資格考筆試考試試題

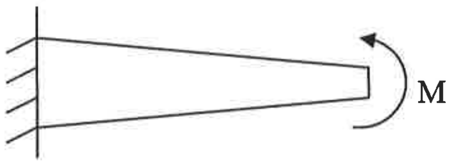
土木工程學系 結構組(甲)　科目：高等結構學　選考學生數：1　考試時間: 90min

選三題作答。若超過三題將以答題先後以前三題改題。

1. The displacements for a cantilever taper beam are shown as illustrated:

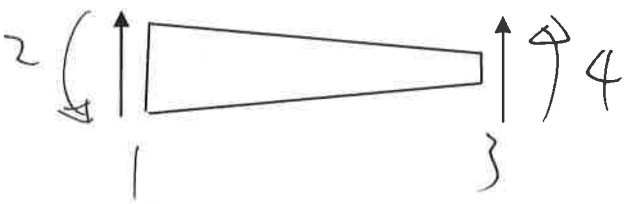


$$\delta = \frac{29VL^3}{96EI}, \theta = \frac{13ML^2}{32EI}$$



$$\delta = \frac{13ML^2}{32EI}, \theta = \frac{5ML}{8EI}$$

Determine the stiffness matrix related to the displacements as shown.



2. Truss structure as shown. EA/L is constant for all members
(a) Determine the local stiffness matrix K for each member in global coordinate.
(b) Determine the structure stiffness matrix S.
(c) Given displacement solution as

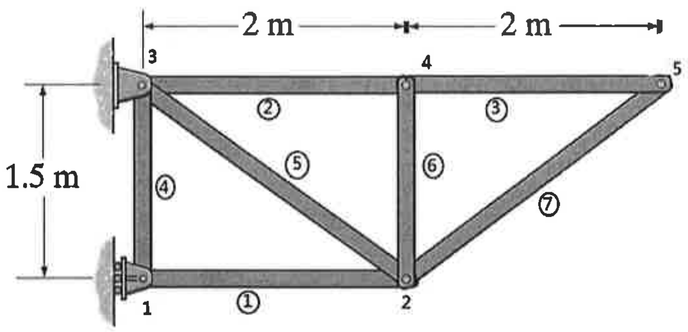
$v_1 = 0.24mm$

$u_2 = 1.22mm$ $v_2 = 2.73mm$

$u_4 = 0.78mm$ $v_4 = 3.21mm$

$u_5 = 2.62mm$ $v_5 = 3.48mm$

Find reactions at joint 3.



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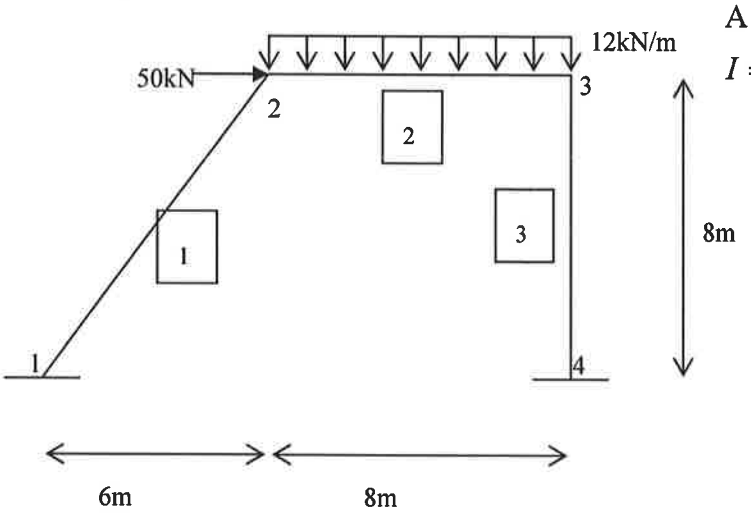
3. The displacement for joint 2 is (6.233mm,-4.7mm, -0.000388rad), and for joint 3 is (6.151mm, -0.158mm, 0.000202rad), find the member forces Q (in local coordinate) and F (in global coordinate) for member 1,2. Then check the joint equilibrium for joint 2.

E, A, I = constant

E = 200GPa

A = 20000mm^2

$I = 1250 \times 10^6 mm^4$



4. Brief describe in the procedure of the stiffness method in frame analysis
   (a) How to consider the effect of axial force?
   (b) How to consider a hinge connection?
   (c) How to consider a semi-rigid connection?
   (d) How to consider offset connections?
   (e) How to perform a large deformation analysis?

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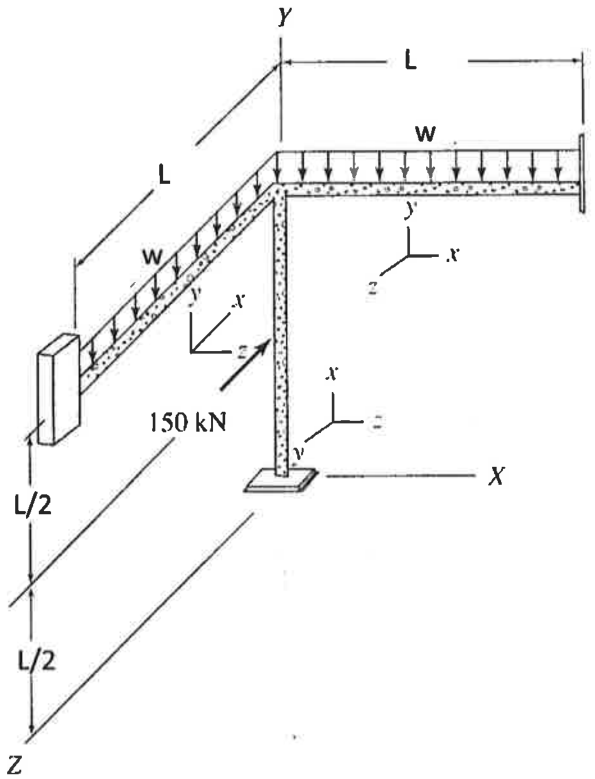
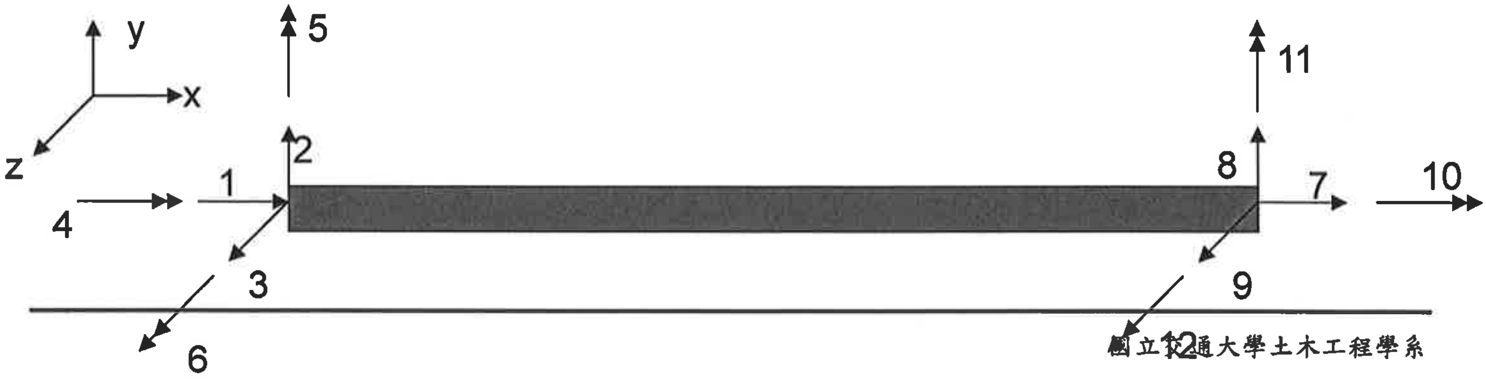
5. Assemble the global stiffness matrix of the space frame as shown. If the effect of axial deformation is neglected, what will the stiffness matrix?



The local stiffness matrix for a member of space frame is shown as follow.

$$\mathbf{k} = \frac{E}{L^3}\begin{bmatrix}
AL^2 & 0 & 0 & 0 & 0 & 0 & -AL^2 & 0 & 0 & 0 & 0 & 0 \\
0 & 12I_z & 0 & 0 & 0 & 6LI_z & 0 & -12I_z & 0 & 0 & 0 & 6LI_z \\
0 & 0 & 12I_y & 0 & -6LI_y & 0 & 0 & 0 & -12I_y & 0 & -6LI_y & 0 \\
0 & 0 & 0 & \frac{GJL^2}{E} & 0 & 0 & 0 & 0 & 0 & -\frac{GJL^2}{E} & 0 & 0 \\
0 & 0 & -6LI_y & 0 & 4L^2I_y & 0 & 0 & 0 & 6LI_y & 0 & 2L^2I_y & 0 \\
0 & 6LI_z & 0 & 0 & 0 & 4L^2I_z & 0 & -6LI_z & 0 & 0 & 0 & 2L^2I_z \\
-AL^2 & 0 & 0 & 0 & 0 & 0 & AL^2 & 0 & 0 & 0 & 0 & 0 \\
0 & -12I_z & 0 & 0 & 0 & -6LI_z & 0 & 12I_z & 0 & 0 & 0 & -6LI_z \\
0 & 0 & -12I_y & 0 & 6LI_y & 0 & 0 & 0 & 12I_y & 0 & 6LI_y & 0 \\
0 & 0 & 0 & -\frac{GJL^2}{E} & 0 & 0 & 0 & 0 & 0 & \frac{GJL^2}{E} & 0 & 0 \\
0 & 0 & -6LI_y & 0 & 2L^2I_y & 0 & 0 & 0 & 6LI_y & 0 & 4L^2I_y & 0 \\
0 & 6LI_z & 0 & 0 & 0 & 2L^2I_z & 0 & -6LI_z & 0 & 0 & 0 & 4L^2I_z
\end{bmatrix}$$



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博士班資格考筆試考試試題

土木工程學系 «組別»(甲)　　科目：高等鋼結構　　選考學生數：3　　考試時間: 90min

選三題作答，作答超過三題以解題順序前三題給分。

1. Please calculate M_y and M_P of the following section corresponding to its neutral axis.

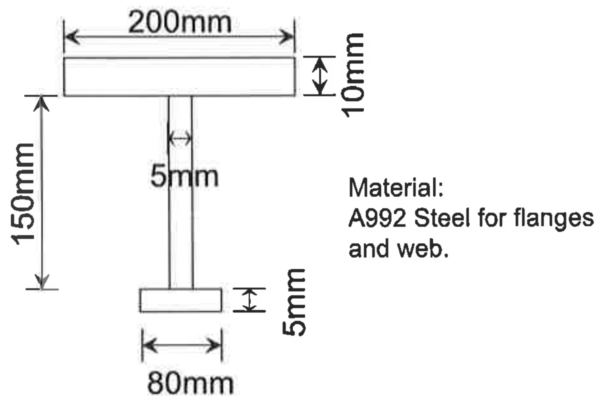
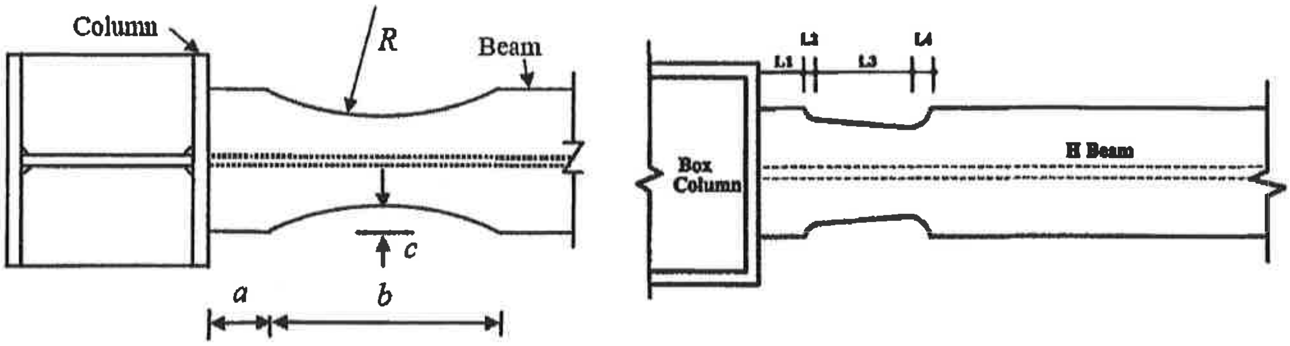


Figure 1

2. RBS connections are common in steel buildings in Taiwan.
   (1) Please describe the design philosophy of the RBS connections.
   (2) What are the advantages and disadvantages of RBS connection in Figure 2 (b)?



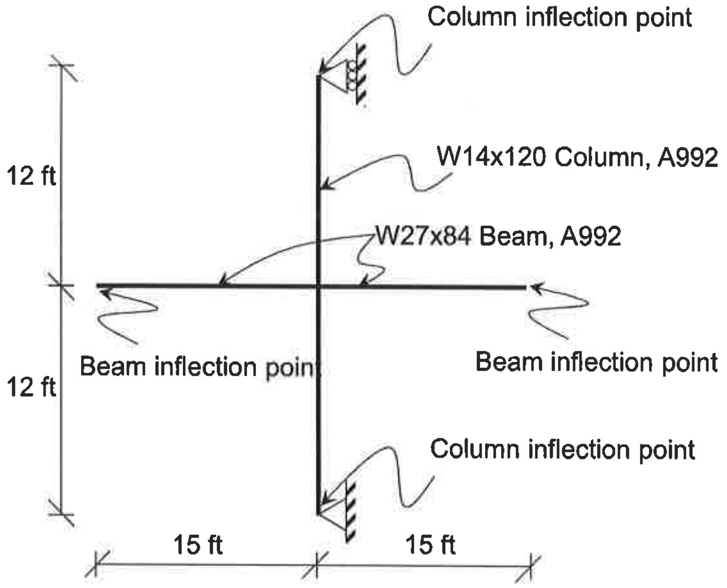
(a)　　(b)

Figure 2 RBS connections

3. A beam-column sub-assemblage of a MRF is shown in Figure 3. Use load combination: 1.2D+1.0E+L.
   (1) The shear demand of panel zone is $R_u = \frac{\Delta M}{d_b - t_f} - V_{col}$. What is the column shear V_{col} to calculate the shear demand of the panel zone?
   (2) Determine the thickness of the doubler plate in the beam-column connection. The shear capacity of panel zone can be estimated from code:

$$R_n = 0.60 F_y d_c t_w \left(1 + \frac{3 b_{cf} t_{cf}^2}{d_b d_c t_w}\right)$$

   Reduction factor φ=0.9.



W14x120	W27x84
$d \times b_f \times t_w \times t_f =$	$d \times b_f \times t_w \times t_f =$
14.5x14.7x0.59x0.94	26.7x10x0.46x0.64
(unit: inch)	(unit: inch)
$I_x = 1380$ in^4	$I_x = 2850$ in^4
$S_x = 190$ in^3	$S_x = 213$ in^3
$r_x = 6.24$ in	$r_x = 10.7$ in
$Z_x = 212$ in^3	$Z_x = 244$ in^3
$I_y = 495$ in^4	$I_y = 106$ in^4
$S_y = 67.5$ in^3	$S_y = 21.2$ in^3
$r_y = 3.74$ in	$r_y = 2.07$ in
$Z_y = 102$ in^3	$Z_y = 33.2$ in^3

The loads in the column face:
Earthquake Load: $M_{E,left} = 0.4M_P$, $M_{E,right} = 0.45M_P$
Gravity Load: $M_{D,left} = 0.25M_P$, $M_{D,right} = 0.2M_P$
$M_{L,left} = 0.15M_P$, $M_{L,right} = 0.1M_P$

Figure 3

4. There are various configurations for CBF. Please give 4 different configurations and list at least 3 advantages and 3 disadvantages for each configuration.

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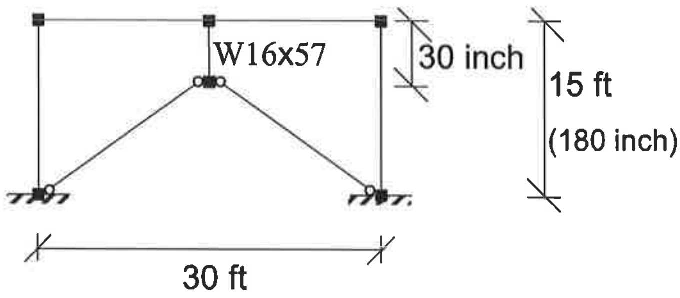
博士班資格考筆試考試試題

土木工程學系 «組別»(甲)　　科目：高等鋼結構　　選考學生數：3　　考試時間: 90min

5. An EBF structure is shown in Figure 4.

(1) Please draw the mechanism of the EBF, and **specifically** identify the location of the plastic hinges.

(2) What is the energy dissipation mechanism of the link? Please derive the code equation used to determine the mechanism.



Link: W16x57
$d \times b_f \times t_w \times t_f =$
16.4x7.12x0.43x0.715
(unit: inch)

$I_x = 758$ in^4
$S_x = 92.2$ in^3
$Z_x = 105$ in^3

$I_y = 43.1$ in^4
$S_y = 12.1$ in^3
$Z_y = 18.9$ in^3

Figure 4

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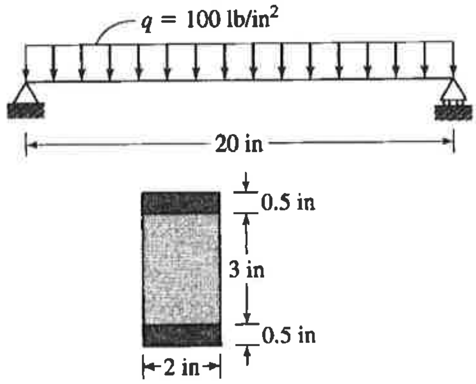
土木工程學系 結構組(甲)　科目：高等材料力學　選考學生數：2　考試時間: 90min

1. Stress components at a point are known, except for the component σ_{yy},

$$\boldsymbol{\sigma} = \begin{bmatrix} 2 & 0 & 2 \\ 0 & \sigma_{yy} & 4 \\ 2 & 4 & 0 \end{bmatrix}$$

Determine (a) σ_{yy} so that there will be a traction-free plane through the point; (b) the unit normals; (c) the principal stresses. (30%)

2. Consider a simply supported three-layer beam with the outer layers made of steel ($E = 30\times10^6\ psi$) and the inner layer made of aluminum ($E = 10\times10^6\ psi$). Determine the maximum stresses in both materials. (40%)



3. The torsion solution for a cylinder of equilateral triangular section is derivable from the stress function:

$$\Phi = k\left(x + \sqrt{3}y - \frac{2h}{3}\right)\left(x - \sqrt{3}y - \frac{2h}{3}\right)\left(x + \frac{h}{3}\right)$$

Find expressions for (a) the maximum and minimum shear stresses, and (b) the twisting angle. (30%)