國立交通大學 106 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

1. A symmetrical structure is subjected to load P as shown in Fig. 1. The cross sectional area is A, the yielding stress is σ_y and the Young's modulus is E, for all three members. The length for member 2 is l. Calculate the limit load and determine ratio $P_{\lim}/P_{allow}$. Use the static method.

   (a) Find the internal forces of members 1 and 2 in the elastic range in terms of E, A, l if joint A is displaced by Δ. (5%)

   (b) As initial yielding occurs, calculate the yielding load P_y and the corresponding yield displacement Δ_y. (5%)

   (c) Calculate the ultimate load P_u and the corresponding displacement Δ_u when all the members yield. (5%)

   (d) If $\alpha = 60^\circ$, plot P/P_y vs. Δ/Δ_y (10%)

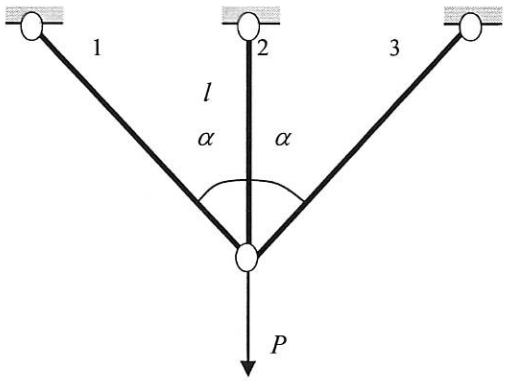

Fig. 1

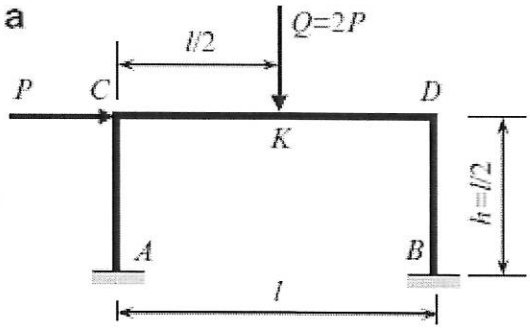

Fig. 2

2. A portal frame is illustrated in Fig. 2. If the limit moments for both the beam and column are M_y,

   (a) Find the limit load $Q_{\lim}$ if the frame fails in a beam failure mechanism. (5%)

   (b) Find the limit load $P_{\lim}$ if the frame fails in a column sidesway mechanism. (5%)

   (c) Find the governing equation if the frame fails in a combined mechanism (5%)

   (d) Plot the graph of $\frac{Q_{\lim} l}{M_y}$ vs. $\frac{P_{\lim} l}{M_y}$ for the three mechanisms if $h = l/2$. (5%)

   (e) If P=Q/2, which failure mechanism will occur first? Locate the position of the loads on the graph obtained in (d). (5%)

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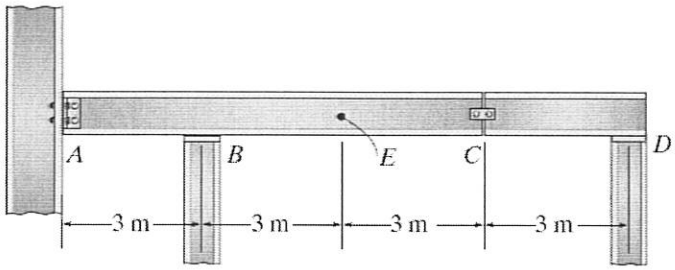
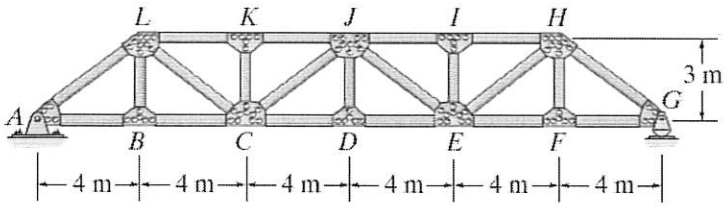
3. The beam supports a uniform dead load of 500 N/m and a single live concentrated force of 3000 N. Determine (a) the maximum negative moment at *E*, and (b) the maximum positive shear at *E*. Assume the support at *A* is a pin, *B* and *D* are rollers, and *C* is a pin. (25%)



4. Draw the influence line for the force in (a) member *EH* and (b) member *JE*. (25%)



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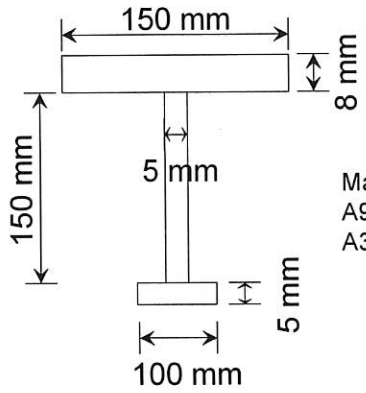
博士班資格考筆試考試試題

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

1. One of the earthquake-resistant steel structures is the special moment frame.
(a) Describe how the special moment frame works to resist seismic excitation; (20%)
(b) What are the criteria for a moment connection be qualified to be used on a special moment frame? (5%)
(c) Give definition for "story drift angle". (5%)
(d) Give definition for "plastic hinge rotation". (5%)
(e) AISC stipulates several prequalified moment connections. Give three examples and sketch the moment connections. (15%)

2. Please explain the energy dissipation mechanism of the following structural systems in detail: 1) concentrically-braced frame system, 2) buckling-restrained-braced frame system and 3) eccentrically-braced frame system. (20%)

3. Please calculate M_y and M_P of the following section corresponding to its neutral axis. (30%)



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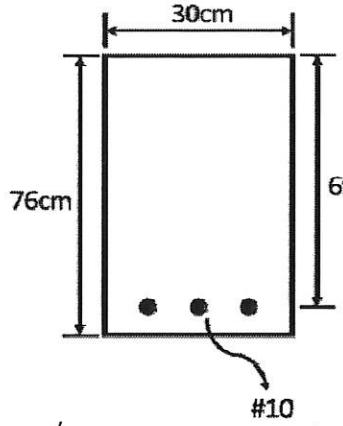
博士班資格考筆試考試試題

土木工程學系 結構組(甲)　科目：鋼筋混凝土行為　選考學生數：1　考試時間：90min

1. For a rectangular section given below



(a). What is the reinforcing bar stress f_s when applying moment $M = 6$ tf-m?

(b). What is the reinforcing bar stress f_s when applying moment $M = 13$ tf-m?

(c). Calculate the nominal flexural strength M_n

$f_c' = 280\ kgf/cm^2$, $f_y = 4200\ kgf/cm^2$, $f_r = 30\ kgf/cm^2$,

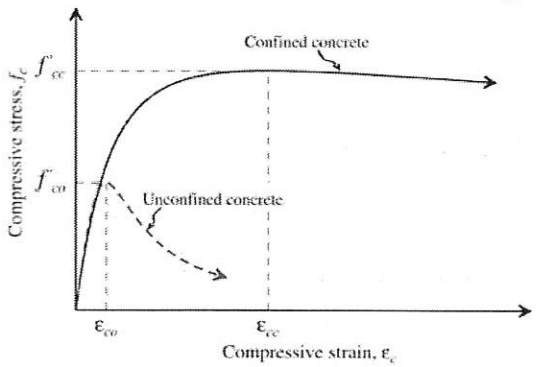
$E_s = 2.04 \times 10^6\ kgf/cm^2$

for #10 steel bars $d_b = 3.22\ cm$, $A_b = 8.143\ cm^2$

(25%)

2. Please indicate the maximum reinforcement ratio ρ_{max} and the minimum reinforcement ratio ρ_{min} with equations. Then explain the fundamental theory of ρ_{max} and ρ_{min}. (25%)

3. The following figure shows the stress-strain curves for unconfined concrete and confined concrete. In a rectangular reinforced concrete column, reinforcements will provide confinement for the concrete and affect the compressive strength of the column. Specify how the reinforcements influence the compressive strength. (25%)



4. Describe all the design variables that affect the developed length of the flexural reinforcing bars, and how the variables affect the developed length. (25%)

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博士班資格考筆試考試試題

土木工程學系 結構組(甲)　　科目：結構動力學　　選考學生數 1　　考試時間: 90min

1. (25%) A single story, single bay portal frame is given below in Fig. 1.1. The base of the right column is fixed, while the base of the left column is pinned. Fig. 1.1 (c) is the free-body diagram showing the internal forces due to a lateral displacement u (Fig. 1.1 (b)). The properties assigned are, column size: 0.50x0.50 m, E = 250,000 kN/m^2, L = 3 m and m = 25,000 kg, and damping ratio ζ = 5 %. (Assume the beam is rigid.)

(a) Determine the natural vibration period T and the damping coefficient c of the frame. (5%)

(b) Determine the maximum displacement of the roof if the frame is subjected to the 1999 Düzce NS ground motion (the acceleration spectrum is plotted in Fig. 1.2). (10%)

(c) Determine the peak base shear. (5%)

(d) Draw the bending moment diagram resulted from the peak responses obtained above. (5%)

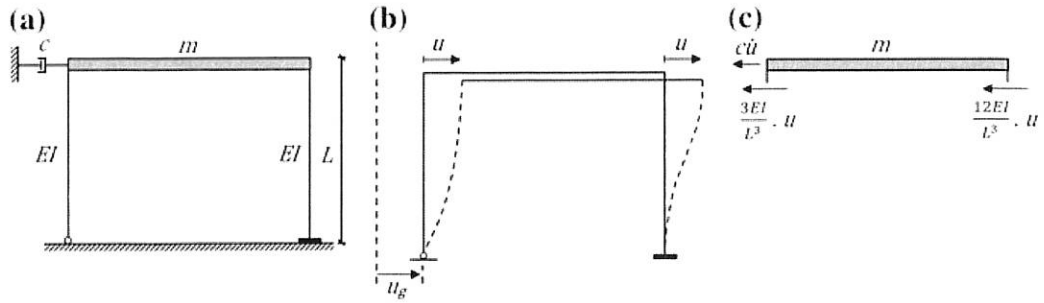

Fig. 1.1

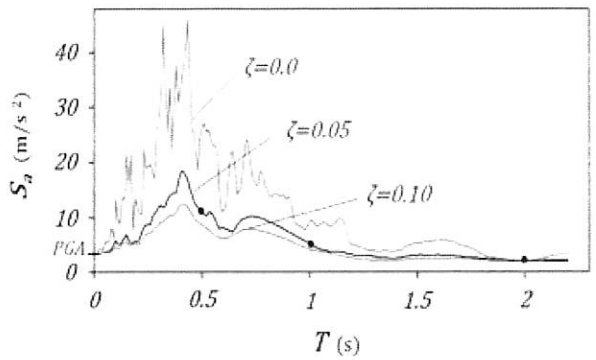

Fig. 1.2

2. (25%) A free vibration test is conducted on an empty elevated water tank such as the one in Fig. 2. A cable attached to the tank applies a lateral (horizontal) force of 100 kN and pulls the tank horizontally by 50 mm. The cable is suddenly cut and the resulting free vibration is recorded. At the end of four complete cycles, the time is 3.0 sec and the amplitude is 25 mm. (note: for lightly damped systems the damping ratio can be determined from $\zeta = \frac{1}{2\pi j} \ln \frac{u_i}{u_{i+j}}$, where u_i is the amplitude of the i-th cycle.)

From these data compute the following:

(a) lateral stiffness (5%);

(b) natural period of undamped vibration (5%);

(c) effective weight (5%);

(d) damping coefficient (5%); and

(e) number of cycles required for the displacement amplitude to decrease to 5 mm (5%).

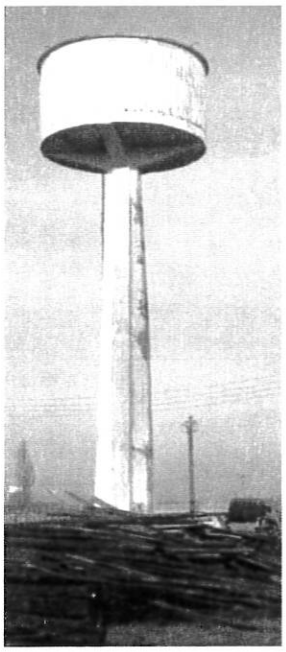

Fig. 2

3. (30%) A seismic instrument designed to measure vertical acceleration consists of a light beam AB pivoted at A through a torsional spring of constant $k_\theta = 20Nm$, as shown in Fig. 1. A small mass $m = 0.6kg$ is fixed to the beam at end B and a viscous damper attached at C to provide a damping ratio $\zeta = 0.7$. The pointer BED, pivoted to the mass at B and to the instrument casing at E.

(a) Write the equation of motion of the system in terms of the vertical deflection, u, of the mass at B. (10%)

(b) Find the undamped natural frequency of the system. (5%)

(c) If the system is calibrated to read the support acceleration correctly at an input frequency of 1Hz, what is the calibration factor κ between the reading ρ_D at D and the amplitude of the support acceleration a where $a = \kappa\rho_D$. [Note that $\rho_D = 2\rho_B$ where ρ_B is the amplitude of the mass.] (5%)

(d) If the support acceleration is $5m/s^2$ at a frequency of 10 Hz. What will be the instrument reading? (5%)

(e) Knowing that the phase angle between the measured and input signals is $\phi = \tan^{-1}\dfrac{2\zeta\beta}{1-\beta^2}$, find the time lag of the measured signal to the input for each of the two excitation frequencies: 1 Hz and 10 Hz? (5%)

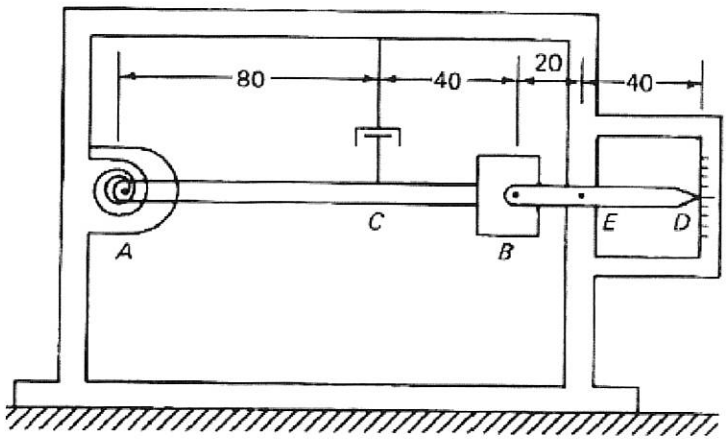

Fig.3

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4. (20%) The damping ratio of a structural system can only be obtained experimentally. Describe how you would determine the damping ratio by conducting a

(a) free vibration test (10%) and

(b) forced vibration test using the half power method (10%)