Finite Element Methods

1. Derive the weak formulation for the boundary value problem (25%)

$$\frac{d}{dx}(p(x)\frac{d\phi}{dx})+q(x)\phi=r(x), \qquad 0\le x\le 1,$$
$$\phi(0)=\phi_0,$$
$$\frac{d\phi}{dx}\Big|_{x=1}=q_1.$$

2. In problem 1, let $p(x) = x^2$, $q(x) = 1$, by a Galerkin finite element method using linear element, produce the finite element formulations. (25%)

3. The deflection w of a uniform thin elastic plate Ω, of uniform flexural rigidity D, simply supported along its edges Γ, and subjected to unit uniform transverse load per unit area, is governed by the differential equation (25%)

$$\nabla^4 w = 1/D$$

in Ω and the boundary conditions $w = \partial^2 w/\partial n^2 = 0$ on Γ.

Obtain the weak formulation of the problem. Show that the finite element method requires C^1 continuous elements. (25%)

4. For the plate in problem 3, produce the element shape functions for a rectangular four-noded cubic element which ensures continuity of w, $\partial w/\partial x$, $\partial w/\partial y$, $\partial^2 w/\partial x\partial y$, across element boundaries. (25%)

九十六學年度第二學期成大土木系博士班資格考試(97.03)

結構動力學

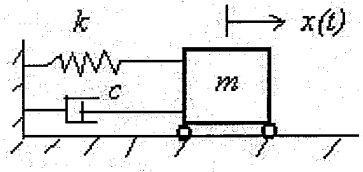
(1) Consider the free vibration of a single degree of freedom system with viscous damping as shown in Fig. 1 where *m*, *c* and *k* denote the mass, damping coefficient and spring constant of the system. The damping force is assumed to be proportional to the velocity.

(a) Derive the equation of motion. (10%)

(b) With initial conditions $x(t=0)=x_0$ and $\left.\frac{dx(t)}{dt}\right|_{t=0}=v_0$, determine the general solution for the underdamped case (10%)

(c) Define the nondimensional ratios of ξ and ω_n as $\xi=c/c_c$ and $\omega_n=\sqrt{k/m}=c_c/2m$ where c_c denotes the critical damping and $c_c=2\sqrt{km}=2m\omega_n$. Rewrite the general solution in terms of the dimensionless parameters such as ξ and ω_n. (10%)

(d) Simply draw a figure for this oscillatory motion of $x(t)$ (i.e., x versus $\omega_n t$).(10%)

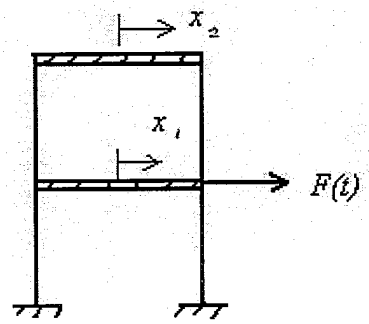


(2) Consider the two-story building as shown in Fig. 2. The equation of motion can be expressed in matrix notation as

$$\begin{bmatrix} m & 0 \\ 0 & m \end{bmatrix}\begin{Bmatrix} \ddot{x}_1(t) \\ \ddot{x}_2(t) \end{Bmatrix}+\begin{bmatrix} 2k & -k \\ -k & 2k \end{bmatrix}\begin{Bmatrix} x_1(t) \\ x_2(t) \end{Bmatrix}=\begin{Bmatrix} F\sin\omega t \\ 0 \end{Bmatrix}$$

(a) Determine the solutions of $x_1(t)$ and $x_2(t)$. (20%)

(b) Plot its frequency response curve (i.e., x_1k/F versus ω/ω_1; and x_2k/F versus ω/ω_2). (10%)



(3) A simply supported beam of total mass m has a concentrated mass M at midspan as shown in Fig. 3.

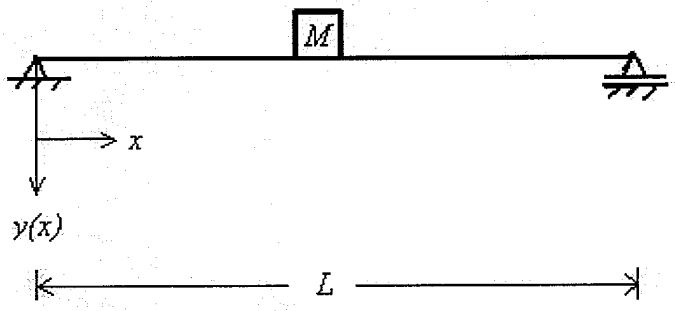
(a) Determine the effective mass of the system at midspan. (10%)

(b) Determine its fundamental frequency. (5%)

Hint: 1. the deflection of the beam due to a concentrated load at midspan is

$$y = y_{\max}\left[\frac{3x}{L} - 4\left(\frac{x}{L}\right)^3\right] \qquad (x \le 0.5L)$$

2. when a concentrated force P is applied at midspan, the deflection at midspan is $PL^3/48EI$.



(4) Interprete the analytical process of the method of modal matrix for a equation of motion of an n-degree of freedom system with viscous damping and a set of arbitrary excitation $\mathbf{F}(t)$. The equation of motion is given as

$$\mathbf{M}\ddot{\mathbf{X}} + \mathbf{C}\dot{\mathbf{X}} + \mathbf{K}\mathbf{X} = \mathbf{F} \qquad (15\%)$$

Qualifying examination (Elasticity)

1.A two dimensional rectangular plate is loaded with a uniform tensile force T lb/in. as indicated in Figure below. The plate is clamped on top and bottom edges and is traction-free along its left edge. There are no body forces.

(a) Construct an equilibrium stress field for which

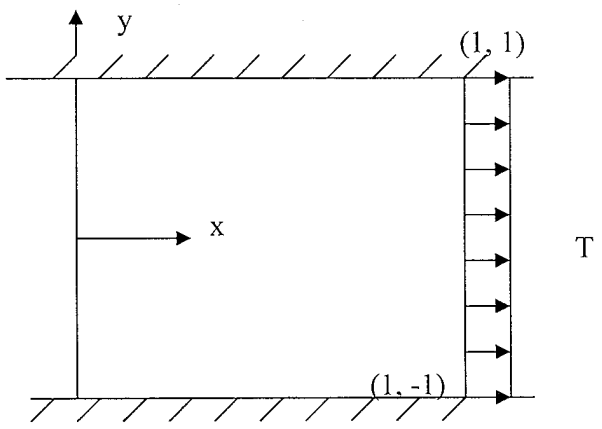
$$\tau_{yy} = c(3y^2 - 6xy^2)$$

and determine c.

(b) Construct a virtual displacement field for which

$$\delta\varepsilon_{xx} = 1 - y^2 \qquad \delta\varepsilon_{xy} = \delta\varepsilon_{yx} = -xy \qquad \delta\varepsilon_{yy} = 0$$

© Verify by actual evaluation of W_{int} and W_{ext} that the above fields satisfy the theorem of principle of virtual work.



2. The strain-displacement relations in polar coordinates are

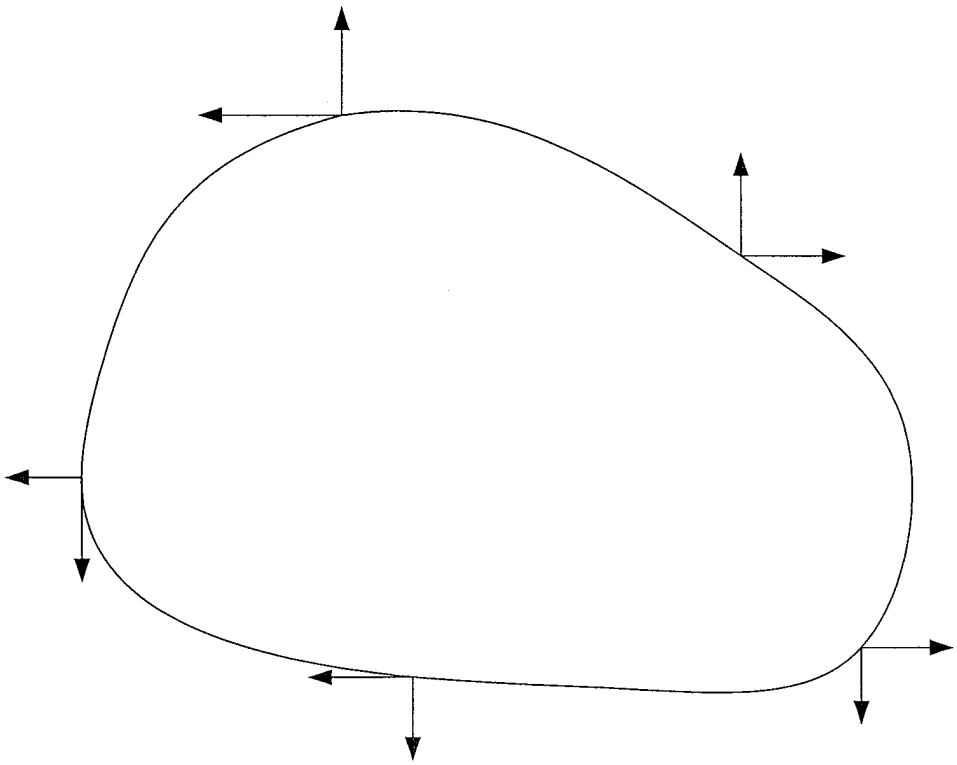
$$\varepsilon_{rr} = \partial u / \partial r$$

$$\varepsilon_{\theta\theta} = \frac{1}{r}\frac{\partial v}{\partial \theta} + \frac{u}{r}$$

$$\varepsilon_{r\theta} = \frac{1}{2}\left(\frac{1}{r}\frac{\partial u}{\partial \theta} + \frac{\partial v}{\partial r} - \frac{v}{r}\right)$$

for two-dimensional problems. Explain the geometric meanings of the terms $\frac{u}{r}$ **and** $\frac{v}{r}$ **appearing in strain components** $\varepsilon_{\theta\theta}$ **and** $\varepsilon_{r\theta}$**, respectively.**

3. The shape of the two-dimensional body is arbitrary as shown in the Figure. Under what kind of tractions applied on the surface of the body will the body be in a constant stresses state at any point of the body? Please give an example.



九十六學年度第二學期博士班資格考試(土壤力學)

1. 解釋名詞(20%)

   (1) Overconsolidation Ratio (OCR) (5%)

   (2) 最佳含水量(5%)

   (3) 何謂黏土的靈敏度(sensitivity)與復原性(thixotropy) (10%)

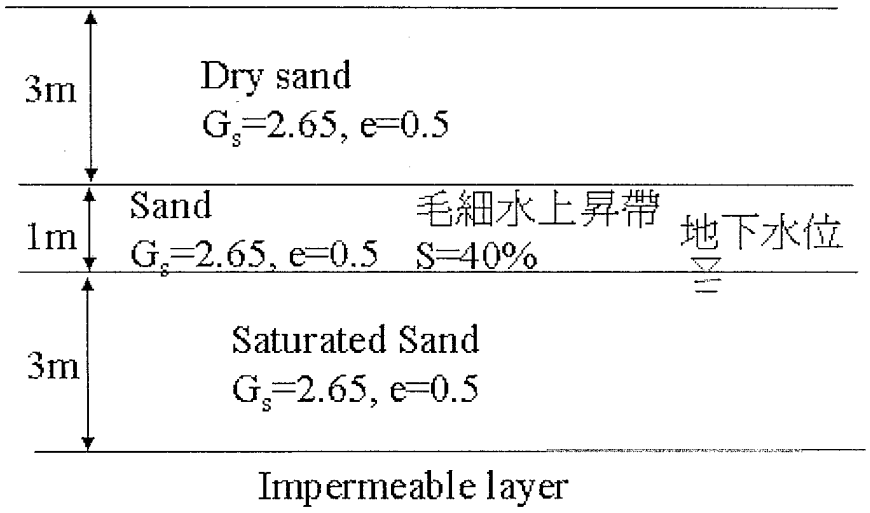
2. 何謂阿太堡限度 (Alterberg Limit)? (10%)

3. 比重計試驗是根據什麼理論進行分析?(3%)試推導比重計試驗所使用之理論公式? (7%)

4. 試述如何利用 Casagrande 所建議的方法求出黏土的預壓密應力?(5%)如何利用試驗室所得之壓密曲線獲得現地原始壓密曲線(正常壓密黏土、過壓密黏土)?(10%)

5. 試推導定水頭與變水頭試驗計算滲透係數公式(10%)

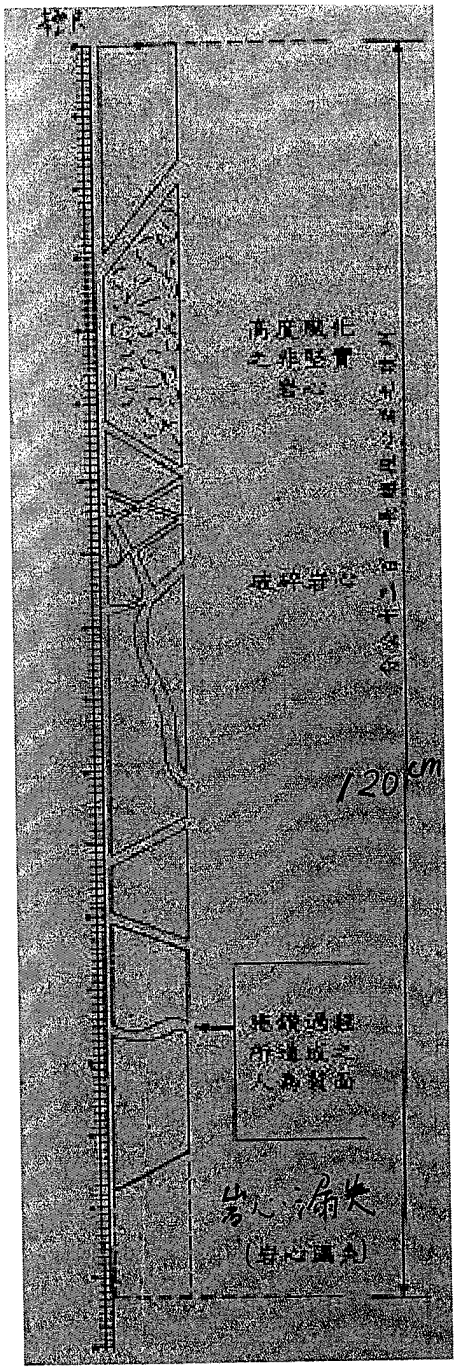
6. 下圖為一土層剖面，計算並繪出總應力、孔隙水壓力與有效應力隨深度相對應變化圖(15%)



7. 試述試驗室三軸試驗依壓密與排水條件可分為那幾類及各試驗條件?(10%)請再各舉出適用上述三軸試驗之現地工程。(10%)

九十六年度第二學期博士候選人資格
考<u>工程地質</u>試題

1. 翻譯及解釋下列名詞: (25%)
   (a) subduction zone (b) plate tectonics (c) rock mass (d) Bowen's reaction series (e) soft fillings
2. 何謂原生弱面？各列舉至少兩個原生弱面名稱。何謂次生弱面？列舉至少六個次生弱面名稱。並簡述岩石弱面對岩體之影響為何？ (25%).
3. 岩體主要有那三種分類法？試述其各考慮之因素為何？ (18%)
4. a. 礦物之主要物理性質有哪些？(至少寫出五項) b. 主要之造岩礦物（rock-forming minerals）有那些？試述之。(12%)
5. 不整合可分為哪三種？試述其三種情況之區別差異。(12%)
6. 說明岩心取樣指標(RQD)之定義及計算右圖鑽取岩心之 RQD 值。(8%)。



道路工程

(Ph.D. Qualify Exam.)

(Total 100%, 20% each)

1. Describe the reason why pavement design has gradually evolved from art to science, empiricism still plays an important role even up to the present day.
2. Brief describe the SHRP and the LTPP program.
3. Describe the difference when consider airport pavement design and highway pavement design.
4. What are the serviceability/performance concepts of pavement?
5. Briefly describe the intent of good pavement management.

國立成功大學土木工程系九十六學年度第二學期博士班資格考試

軌道工程試題

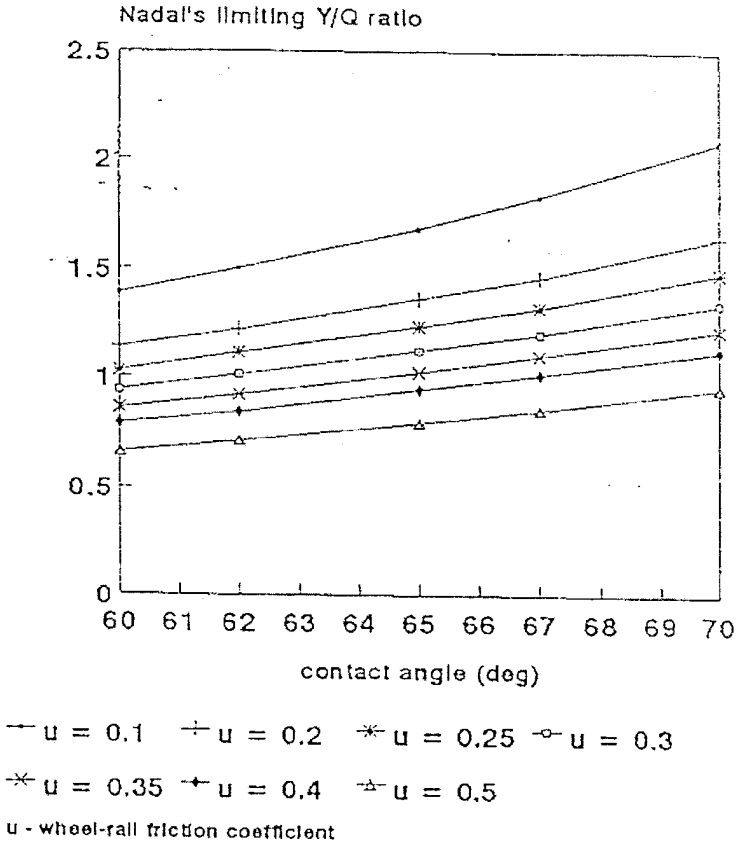
1. 請說明下段文字的內涵。(10%x3)

A continuously welded rail length is not free to expand, only where there is a free end where the expansion will be allowed for by an expansion joint. Away from such locations variations in the rail temperature will cause variations in the longitudinal forces in the rails. The rail is installed and welded in at a specified neutral rail temperature (NRT). This is normally achieved at moderate to low rail temperatures by stretching the rail to the equivalent NRT using hydraulic tensioning equipment.

At temperatures above the NRT the rail will be in compression, and in tension at temperatures below the NRT. The NRT will therefore be chosen according to the climatic conditions, to be at some point between the maximum and minimum anticipated rail temperature, such that the combined risk of rail fracture in cold weather, and buckling in hot weather is minimized.

Following a restressing operation the NRT can vary with time and it is often the case that, where it does change, it tends to reduce. This is the redistribution of residual stresses in the head of the rail which occurs during the first few months of traffic on a new rail and results in a net longitudinal strain or compression force in the rail. This effect has been investigated in the past and was shown to be equivalent to typically 3-5°C of change in MRT, all of which occurs in the first few months of service.

2. 請解說下圖所顯示的意義。(20%)



3. 請說明下段敘述的涵義(30 %)

A simplified form exists for the P2 force by neglecting the damping and the track mass terms, which can be very useful for comparison purposes:

$$P2 = \alpha V\sqrt{km_u}$$

It will be noted that this is the same equation as presented in Paper 3 for the lateral impact forces at switches. The mechanism is of course the same, i.e. an impact by a mass on an elastic support at a discrete angular irregularity in the geometry.

In order to limit the impact forces on the track the formula for P2 has been adopted by BR as a design criterion for vehicles (P1 is not used as the vehicle characteristics have little influence). A maximum P2 + static wheel load of 340 kN is imposed for a severe irregularity of 20 mrad. This has meant that the unsprung mass has had to be reduced when newer designs have been introduced. Some example are shown in Table 1.

Vehicle	Design Speed km/hr	Axle Load kN	Uns. mass kg	P2+static kN/wheel
Class 55	160	172	3360	340
Class 86/2	160	208	2070	329
Class 43 (HST)	200	175	2300	314
Class 91 (IC225)	225	205	1700	340

4. 根據下列參考估計公式，請評估台灣高鐵與台鐵列車的噪音。並請提出解決建議方案。(20%)

$L_2 - L_1 = 30 \log_{10}(v_2/v_1)$

L_1：速度 v_1 之噪音量;　　L_2：速度 v_2 之噪音量

博士班資格考試

Spring, 2008

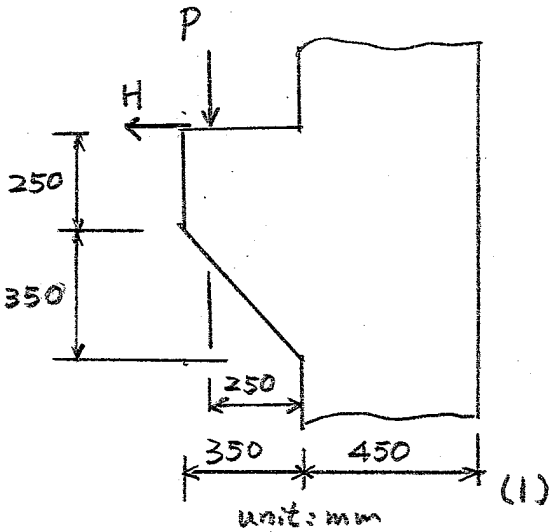
混凝土結構與材料 (Open book test)

1. A corbel is subjected to the vertical load P = 590 kN and horizontal load H = 118 kN. How do you use the strut-and-tie model to design the required reinforcement ? f_c' = 35 MPa, f_y = 420 MPa (Only list the procedure of solution) (25%)

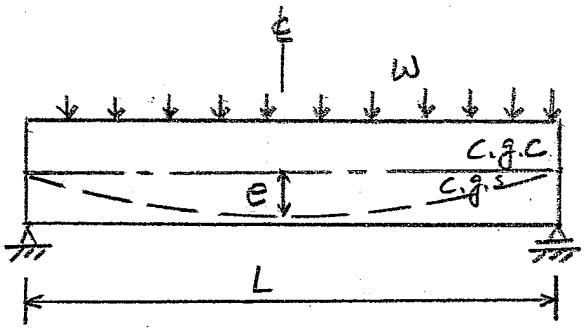
2. Use the C-line concept to find the maximum flexural stresses at top and bottom of the prestressed concrete beam. (25%)

3. The reinforced concrete one-way slab is subjected to the uniformly distributed load w and exposed to fire at the bottom side simultaneously. Find the fire endurance of this slab if the ASTM E119 standard temperature-time curve is assumed for the fire hazard. f_c' = 28 MPa, f_y = 420 MPa (Only list the procedure of solution) (25%)

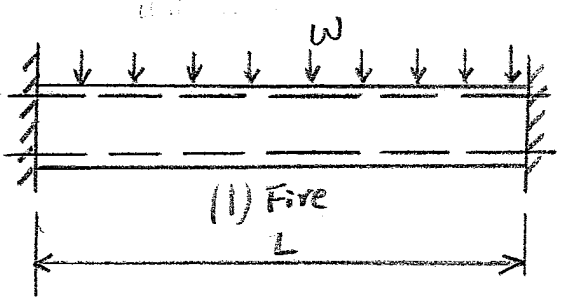
4. A squat shear wall is subjected to the constant vertical load w, uniformly distributed at the top surface, and a horizontal force H. How do you apply the softened truss model to predict the response of the load H and shear deformation of the wall ? (Only list the procedure of solution) (25%)



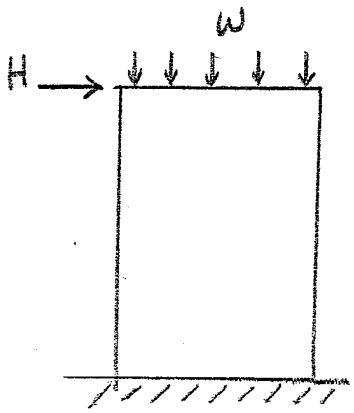
(1)



(2)



(3)

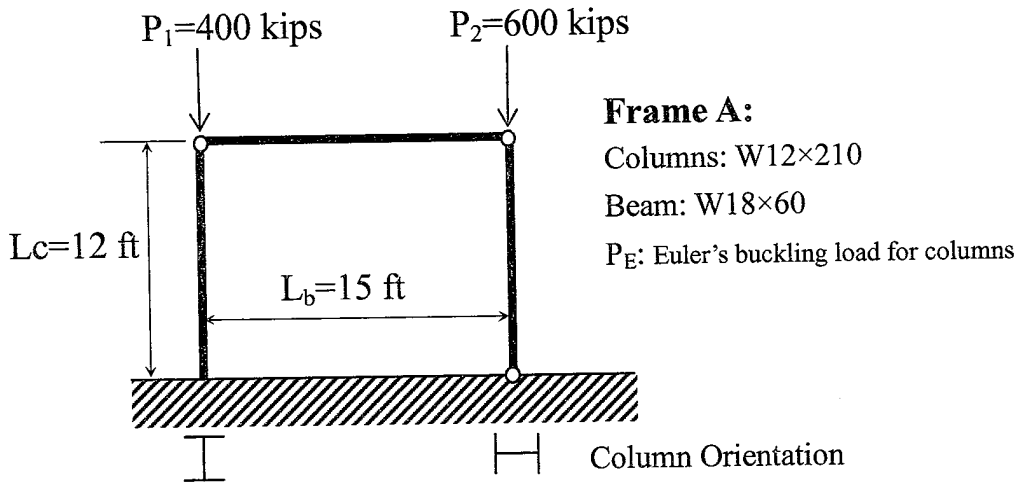


鋼鐵材料與結構　　2008.3.27

考試方式: Open AISC-LRFD manual, but close other books & notes
考試時間: 100 分鐘

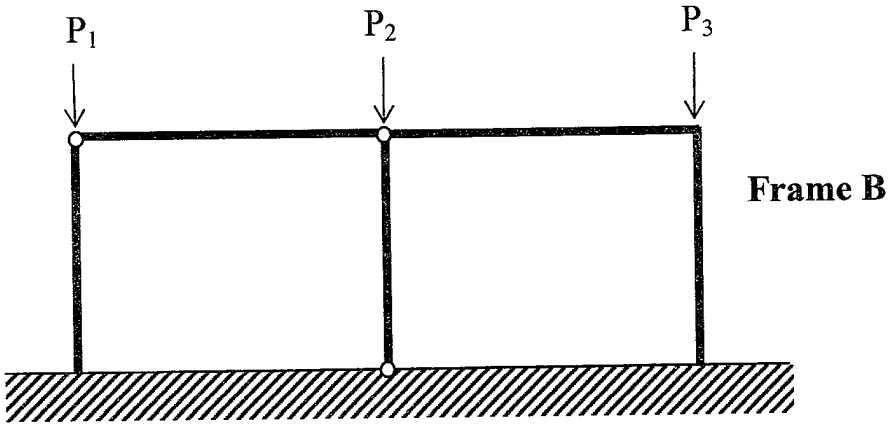
1. (40%) Please consider the following two frames:

(a) Please **derive** the formula of B_2 factor for frame A in any necessary symbol (P_1, P_2, P_E, L_b, L_c…etc.) and **compute** the exact B_2 value:



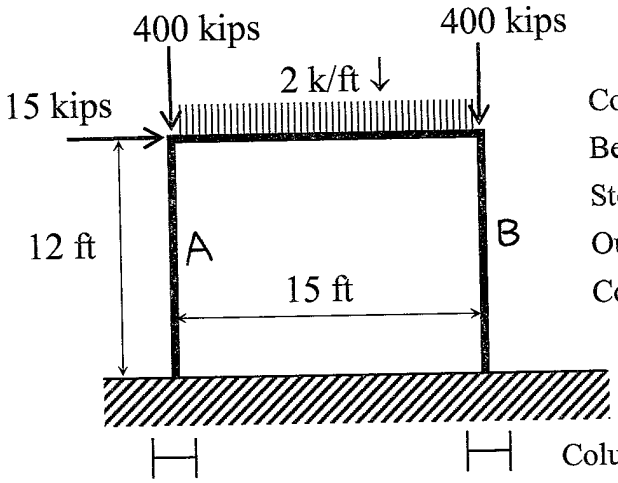
Frame A:
Columns: W12×210
Beam: W18×60
P_E: Euler's buckling load for columns

(b) Please write the formula of B_2 factor in detail for frame B in any necessary symbol (P_1, P_2, P_3, and buckling strength of columns):



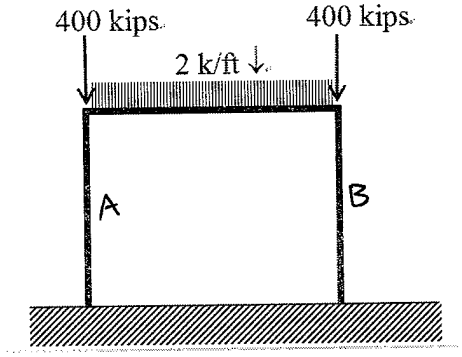
Frame B

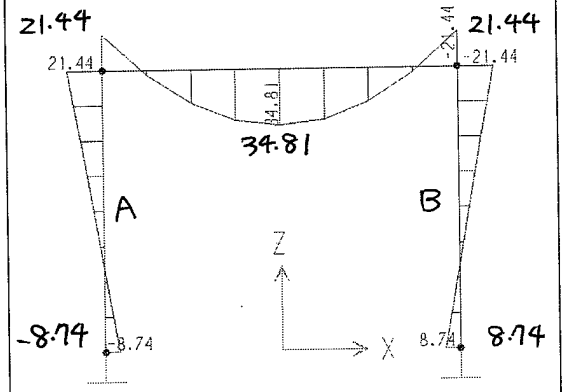
2. (60%) Please evaluate 2nd order M_u of column A & column B, and check if column A & column B meet the AISC-LRFD beam-column design interaction equations H1-1a or H1-1b:



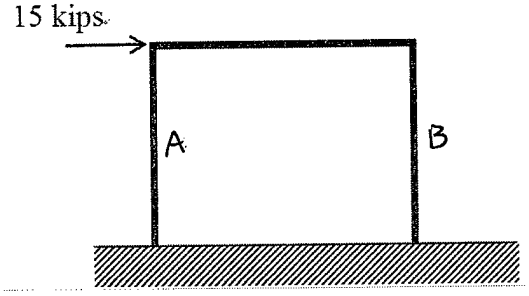
Columns: W14×132
Beam: W21×101
Steel: A992
Out of plane:
Col. A & B braced at floor level

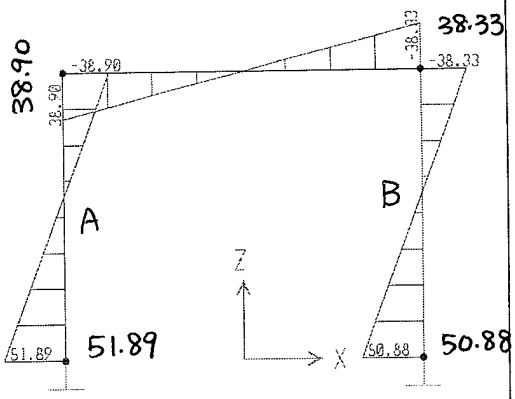
Column Orientation





1st order M_u (unit: k-ft)





1st order M_u (unit: k-ft)

Financial and Cost Concepts for Engineering & Construction

工程成本與財務　博士資格考　3/97

一. 解釋名詞及簡答 (30 分)

1. Job order cost system
2. Activity-based costing
3. Contribution margin

二. Ichiban construction company's 6 transactions in Feb. 2008 are given as follows:

1. Ichiban paid $70 labor cost for Project A.
2. Ichiban was billed $45 by a subcontractor for Project A.
3. Account receivable of $20 was collected for Project A.
4. Ichiban received $100 from client for Project A.
5. Ichiban received $60 from client for Project B.
6. Equipment depreciation of $30 recognized for Project B.

請 (1) 做分錄 (2) 過帳 (3) 做 2 月份損益表 (4) 做 2 月份資產負債表(增減多少) (30 分)

三. 現金流量表(statement of cash flows)是甚麼，其與資產負債表及損益表的關係? 並請說明如何製作。(20 分)

四. 財務比率分析的四個面向: leverage ratio, liquidity, activity, and profitability。請就其中比率與財務報表的關係，說明它們的特性與差別。(20 分)

Engineering Management Information System
Qualification, 2008

1. What is the 3-tier approach for web applications.(15%)
2. What are the differences between Structured Query Language and Query By Example? (10%)
3 Describe what update anomalies, addition anomalies, and deletion anomalies are. Give an example for each of them? (15%)
4. Table 1 contains many unsatisfactory components and characteristics. (For example, there are several multi-valued attributes, naming conventions are violated, some attributes are not atomic, and so on.)

Table 1

Attribute name	Sample value
EMP_CODE	1003
LAST_NAME	Willaker
EDUCATION	HS, BBA, MBA
DEPT_CODE	MKTG
DEPARTMENT	Marketing
DEPT_MANAGER	Jill H. Martin
JOB_CLASS	23
TITLE	Sates agent
DEPENDENTS	Gerald (spouse), Mary (daughter), John (son)
BIRTH_DATE	12/23/65
HIRE_DATE	10/14/94
TRAINING	Level I, level 2
BASE_SALARY	$32,255

4.1. Given Table 1, draw its dependency diagram. Label all transitive and/or partial dependencies. (10%)
4.2. Break up the dependency diagram you drew in problem 4.1 to produce dependency diagrams that are in 3NF. (10%) Hint: You might have to create a few new attributes. Also, make sure that the new dependency diagrams contain attributes that meet proper design criteria; that is, make sure there are no multi-valued attributes, that the naming conventions are met, and so on.
4.3. Using the results of 4.2 to draw the E-R diagram . (20%)

5. Please identify and explain the rule violations and formating errors within the DFD shown in Figure 1. (20%)

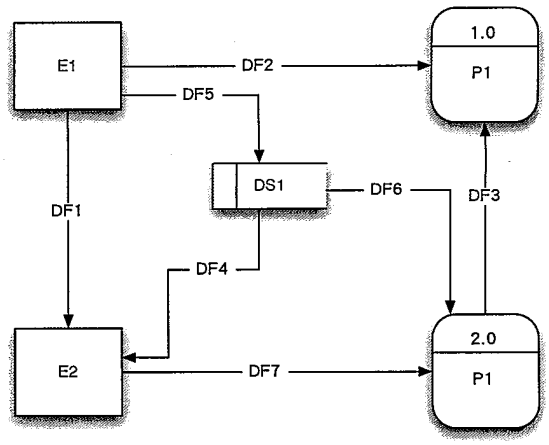


Figure 1