Qualifying Examination (Finite Element Method)

1. Consider the boundary value problem

$$\frac{d^2u}{dx^2} = 3 \quad 0 \le x \le 2$$

$$u(0) = 2 \quad u(2) = 0.5$$

By using two linear elements of equal length calculate the approximate value of u.(25%)

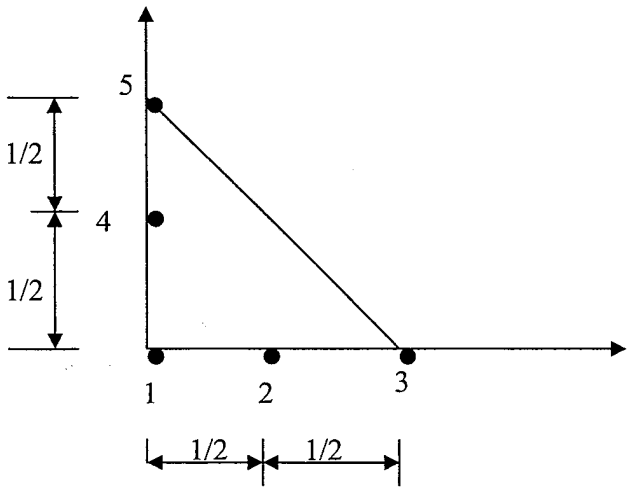
2. Deduce the boundary value problem equivalent to minimizing the functional

$$J[\phi] = \int_1^3 \{-(\phi')^2 - 4\phi\} dx + 12\phi(3)$$

where

$$\phi(1) = 1 \quad (25\%)$$

3. Discuss the properties of the following shape functions for the five-noded triangular element shown in the figure.(25%)



$$N_1 = 1 - 3x - 3y + 2(x+y)^2$$
$$N_2 = 4x(1 - x - y)$$
$$N_3 = x(-1 + 2(x+y))$$
$$N_4 = y(-1 + 2(x+y))$$
$$N_5 = 4y(1 - x - y)$$

4. Determine corresponding variational problem for the following two-dimensional boundary value problem

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = -1 \quad \text{within D}$$

where D is the triangular region bounded by the lines x=0, y=0 and y=1-x and

$$u = 0 \ \ on \ \ x = 0,$$
$$u = 0 \ \ on \ \ y = 0, \qquad (25\%)$$
$$\frac{\partial u}{\partial n} = 0 \ \ on \ \ y = 1 - x$$

1. 使用一個振動器能產生固定頻率之 Sin 形狀外力，用此振動器及數個加速度計放置在建築物中，如何測量出建築物之自然頻率，請說明。若建築物之自然頻率為 1Hz，理論上若使用 FSin(2π ft)之力(F=force magnitude, f=force frequency=2Hz)，運轉一陣子後，能否量到此 1Hz 之建築物之自然頻率，請說明原因。25%

2. Please find (1) the mass and stiffness matrices (Fig.2a); (2) Find the natural frequencies and mode shapes; (3) If the damping ratio is equal to 0.1, please find the displacements of the system under the loads as shown in Fig.2b; (4) If the response- spectrum figure is shown in Fig.2c. Please solve this problem by using the response-spectrum analysis. (50%)

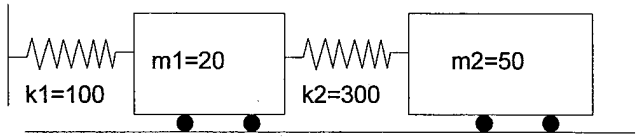


Fig.2a

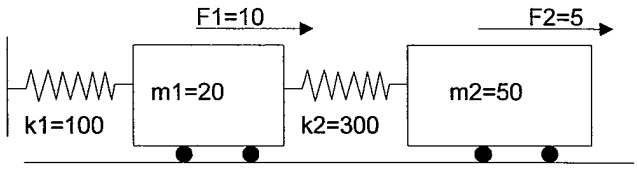


Fig.2b

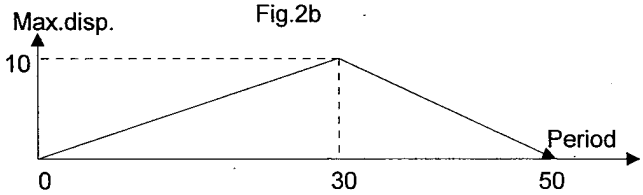


Fig.2c

Fig.2 (Mass unit=T, spring constant unit=kN/m, force unit=kN)

3. 研究探討一列車通過橋樑時的共振問題，首先必須先知道移動中列車的主要頻率。若每節車廂有四個輪軸，移動中的一節車廂可簡化假設成為四個輪軸荷載，並以下列表示：

$$F(t)=P_{wheel}[\delta(t-t_1)+\delta(t-t_2)+\delta(t-t_3)+\delta(t-t_4)]$$

其中 t_i=輪軸荷載通過特定點之時間，下標 i 為輪載荷重編號，P_{wheel} 為輪軸荷載。若有無限節車廂，則此函數之週期為 L/V，其中 V=列車速度，L=列車長度。請問此列車輪軸荷載除 L/V 週期外，還有那些重要之週期。提示：使用傅利葉指數級數展開 F(t)。並請說明何種狀況，車通過橋樑時會共振。25%

Note: $\delta(t)=0$ for $t\neq 0$, $\delta(t)=\infty$ for t=0.

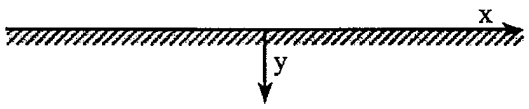
Theory of Elasticity

(Closed Book, 60% to Pass)

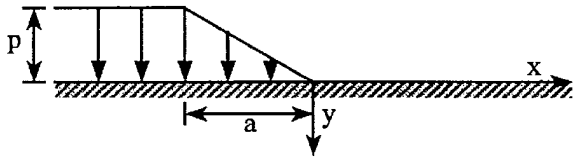
1. (a) Investigate what problem is solved by the following stress function

$$\phi = \frac{p}{2\pi a}\left[\left(\frac{1}{3}x^3 + xy^2\right)\tan^{-1}\left(\frac{y}{x}\right) + \frac{1}{3}y^3\ln(x^2+y^2) - \frac{1}{3}x^2y\right]$$

applied to a semi-infinite plate shown below. (25%)

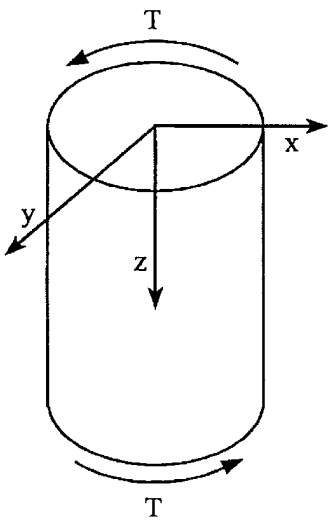


(b) Using superposition and the results of (a), determine the stress function for the case shown below. (5%)



2. A shaft of elliptic cross section is twist by a torsion T. Let the boundary of the cross section be given by the equation

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$



Assume that the displacements corresponding to rotation of cross sections are

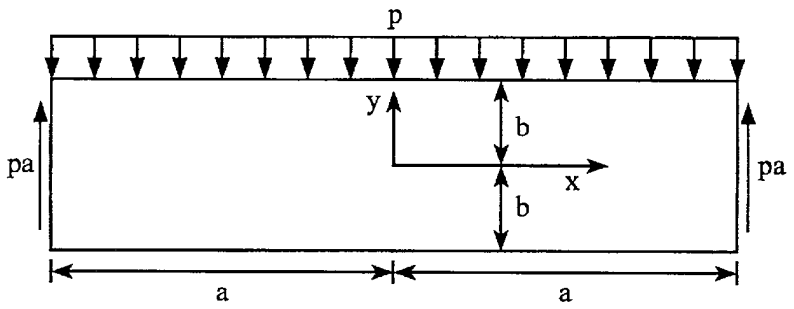
$$u = -\theta zy, \qquad v = -\theta zx$$

where θ is the angle of twist. The warping of cross section is defined by a function $\psi(x,y)$ as

$$w = \theta\psi(x,y)$$

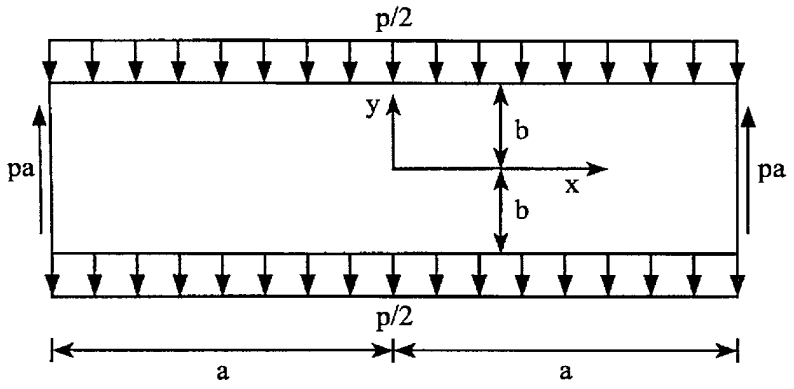
Determine (i) the angle of twist θ, (ii) the warping of cross section w, and (iii) the shear stresses τ_{xz} and τ_{yz}. (25%)

3. A beam is simply supported at $x = \pm a$ and loaded by a uniform pressure p on the top surface $y = b$. Find the stresses $\sigma_x, \sigma_y, \tau_{xy}$ in the beam. (30%)



Hint: The stress function of the beam shown below is

$$\phi = C_1x^4y + C_2x^2y^3 + C_3y^5 + C_4x^2y + C_5y^3 \qquad (C_1, C_2, C_3, C_4, C_5 \text{ are constants})$$



4. For a three dimensional body with body force F_x in x direction. Prove that the following three equations must be satisfied at all points throughout the volume of the body. (15%)

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} + F_x = 0$$

$$\frac{\partial^2 \varepsilon_x}{\partial y^2} + \frac{\partial^2 \varepsilon_y}{\partial x^2} = \frac{\partial^2 \gamma_{xy}}{\partial x \partial y}$$

$$2\frac{\partial^2 \varepsilon_x}{\partial y \partial z} = \frac{\partial}{\partial x}\left[-\frac{\partial \gamma_{yz}}{\partial x} + \frac{\partial \gamma_{xz}}{\partial y} + \frac{\partial \gamma_{xy}}{\partial z} \right]$$

九十四學年度第二學期博士學位候選人資格考試

考試科目: 土壤力學

一. 解釋名詞 (20%)

(1) 簡述美國統一土壤分類法中 OL、Pt、CH 與 GP-GM 所代表的意義? (4%)

(2) 何謂臨界水力梯度? 何謂管湧? (4%)

(3) 簡述 Terzaghi 單向壓密理論的假設? (6%)

(4) 何謂黏土的靈敏度(Sensitivity)? (2%)

(5) 試說明何謂標準貫入試驗 (Standard Penetration Test)? (2%)

(6) 試說明 Casagrande 求取試體取樣點預壓密壓力圖解法。(2%)

二. 某場址內有一飽和黏土層厚 4m，可雙向排水。承受某一載重 1 年後發生 8cm 沉陷量，當時黏土壓密度(Degree of Consolidation) 爲 50%。若相同的黏土層厚度改爲 40m，一樣可以雙向排水，在承受相同載重 1 年與 4 年後，分別會發生多少沉陷量？(20%)

三. 試以總應力狀況之應力路徑(Total Stress Path, TPS)示意圖，說明開挖黏土層時，開挖區底部土體 A 與開挖區側向土體 B(圖 1)之應力變化情況。(20%)

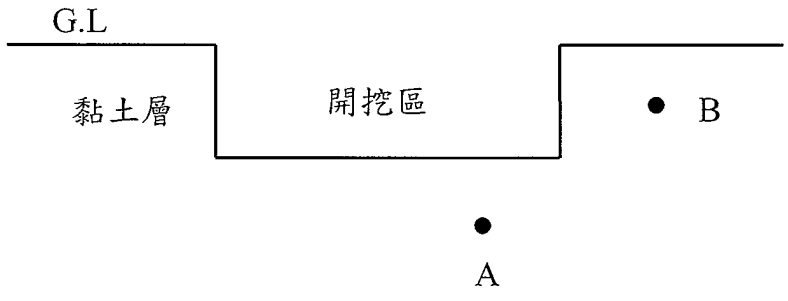


圖 1 黏土層開挖

四. 有一層厚爲 8m 的砂土層，其上、下皆爲不透水層，原地下水位面位於砂土層頂端上方 15m 處，進行抽水試驗後量得流量爲 $0.6m^3/min$，距抽水井分別爲 9m 與 22m 觀測井的水位分別在砂土層頂端上方 10m 與 14m。

(1) 推導透水係數公式，並求出此砂土層的透水係數(m/sec)。(10%)

(2) 推估此砂土層之有效粒徑。(10%)

五. Boussinesq 導出在半徑爲 R 之圓形均佈荷重 q 作用下，圓心下方深度爲 Z 的點，垂直應力增加量 Δp 的公式如下：

$$\Delta p = q\left\{1-\frac{1}{\left[(R/Z)^2+1\right]^{3/2}}\right\}$$

(1)試繪製 Newmark 影響圖(Influence Chart)，以及說明其原理。(單位長度爲 2cm，影響值爲 0.005) (10%)

(2)有一長爲 6m 寬爲 3m 之矩形基礎，受 $q=500t/m^2$ 的均佈荷重作用，利用(1)所繪製的 Newmark 影響圖，求該矩形基礎長側邊中點 A 點下方 3m 處垂直應力的增加量。(10%)

土木系博士資格考試　岩石力學試題(2006.03)

(1.Close Book　　2.試題與試卷一起交回)

1.何謂 Hydrostatic Compression 及 Deviatoric Compression？給岩石材料分別施加 Hydrostatic Compression 及 Deviatoric Compression 將會產生何種反應？(20%)

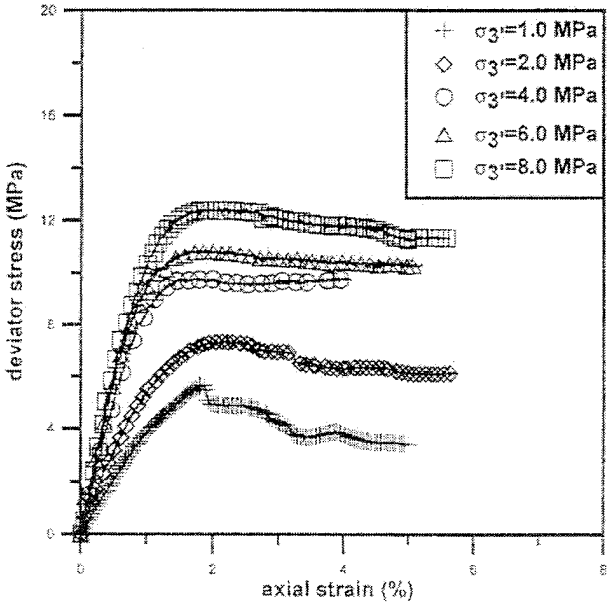
2.變質岩的成因與種類，其在我國的分佈情形如何？(10%)

3.請說明節理的種類與成因？斷層的種類與成因又如何？(15%)

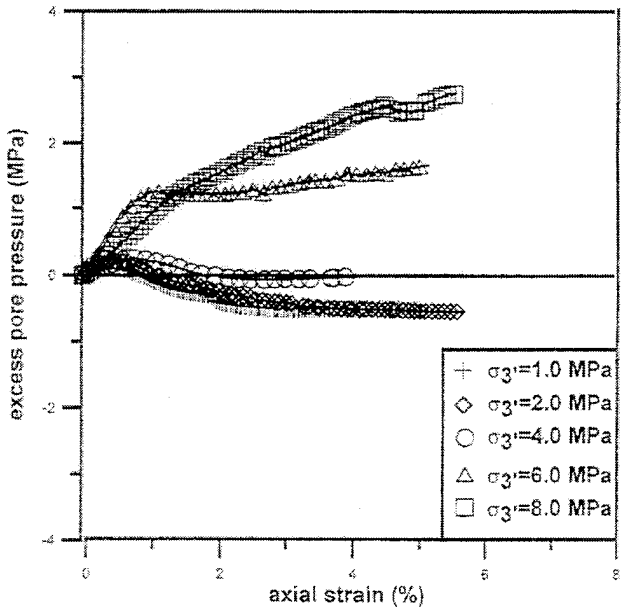
4.如何表現岩石的風化程度？(5%)

5.何謂 Brittle-ductile transition pressure？(5%)

6.自一多孔質砂岩岩塊採 5 個試樣進行三軸壓密不排水試驗，所用圍壓為 σ＝1 Mpa、2 Mpa、4 Mpa、6 Mpa、8 Mpa，得各試體之軸差應力($\sigma_1-\sigma_3$)與軸向應變(ε_a)之關係如圖(a)，孔隙水壓與軸向應變(ε_a)的關係如圖(b)所示，請繪出(i)各試體之尖峰強度(peak strength)之有效應力摩爾圓及此岩石材料的尖峰強度破壞準則。(ii)各試體之殘餘強度(residual strength)之有效應力摩爾圓及此岩石材料之殘餘強度破壞準則。(20%)



圖(a)　應力應變曲線(岩塊 A)



圖(b)　超額孔隙水壓-應變曲線(岩塊 A)

7.有一岩盤其三組節理面 a、b、c 之走向及傾斜如下表所示：(25%)

節　理	a	b	c
走　向	N40E	N160E	N70W
傾　斜	45SE	60NE	30NE

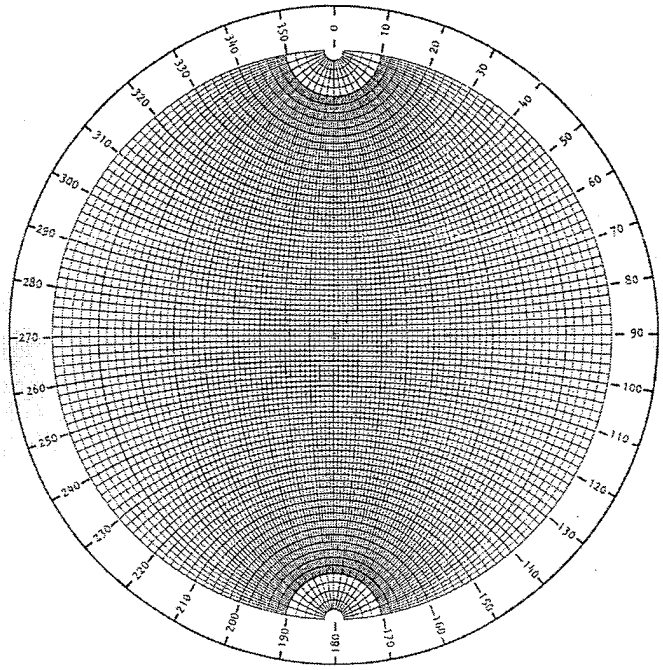
(a) 請用下半球投影法，繪此三組節理面的投影，並繪出其極點。

(b) 請用上半球投影法，繪此三組節理面的投影，並繪出其極點。

(c) a 與 b、b 與 c、c 與 a 之交線與水平面之夾角最小者為何？交線指向東南者為何？

(d) 請用節理 a、c 之極點繪出 a 與 c 之交線，並求其趨向及傾沒角。

(e) 若各節理面的摩擦角為 45°，請問 a 與 b、b 與 c、c 與 a 所構成的楔型岩塊何者會下滑？



九十四年度第二學期博士候選人資格考工程地質試題

一・翻譯及解釋下列名詞: (30%)

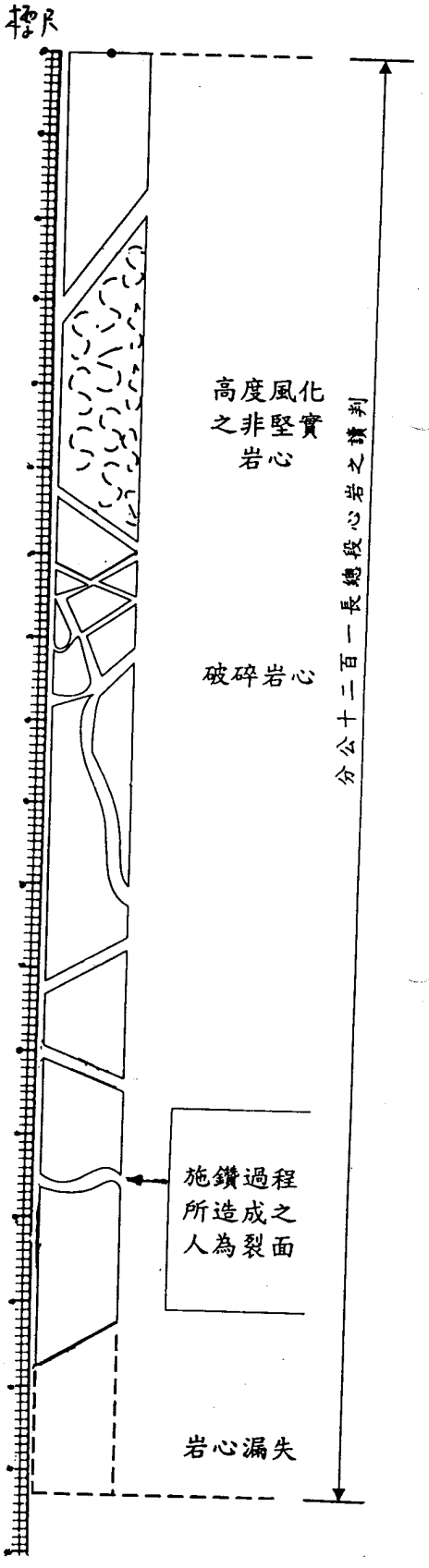
(1) plate tectonics
(2) overturned fold
(3) joint
(4) RMR method
(5) foliation
(6) Bowen's reaction series

二・何謂斷層？斷層有那幾種類型及其各別形成之原因為何？在野外如何鑑別斷層？(20%)

三・何謂剪力帶(shear zone)？試述剪力帶內含有那些弱面？ (20%)

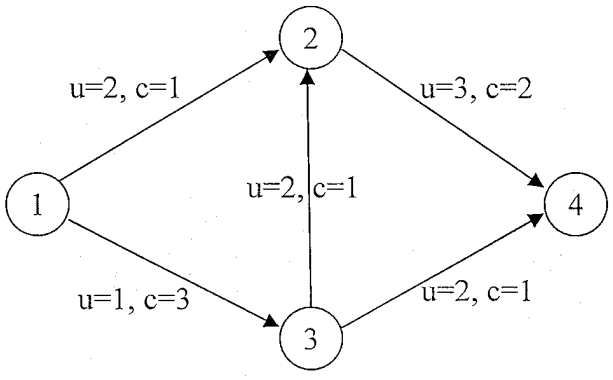
四・何謂原生弱面？何謂次生弱面？簡述岩石弱面對岩石力學性質之影響為何？ (15%)

五・何謂 RQD？試計算右圖之 RQD 及其品質指標？ (15%)



第 1 題：20 分

考慮下圖所示之網路。各節線之容量與成本標示於節線上，其中 u 為容量，c 為成本。令 $x(i,j)$為節線(i,j)之流量。假設此網路中之流量為：$x(1,3) = x(3,2) = x(2,4) = 1$，其餘節線流量均為 0。試繪圖說明對應此網路及流量的 residual network，並說明此 residual network 中各節線的成本。



第 2 題：20 分

考慮一個網路，對每一節點 i 定義一個實數π^i。令 $c(i,j)$為節線(i,j)之成本。為所有節線(i,j)定義 $c^\pi(i,j) = c(i,j) - \pi^i + \pi^j$。令 $P(m,n)$為以 $c(i,j)$為節線成本時由節點 m 至節點 n 之最短路徑。則以 $c^\pi(i,j)$為各節線成本時，$P(m,n)$亦為由節點 m 至節點 n 之最短路徑。試證明之。

第 3 題：20 分

考慮一個網路，其中部份節線成本為負值，但是沒有負值成本的迴圈。試建議一個方法以修改所有節線的成本，使得(1)所有節線之長度均為非負，而且(2)網路中任二節點間之最短路徑均不因此修改而有所變動。說明你的方法為何正確。

提示：(1)第 2 題告訴你什麼？(2)若 $d(i)$為節點 i 的最短路徑長度，則 $d(i)$有何性質？

第 **4** 題：**40** 分，每小題 **10** 分

Successive shortest path algorithm (SSP)為求解網路最小成本流動問題(minimum cost flow problem)的常用方法之一。其基本步驟為在每回合的演算中選擇一個尚有流量的供給節點 i 以及尚有流量需求的需求節點 j。在 residual network 中求解由 i 至 j 的最短路徑，並將流量自 i 送至 j。所送之流量為 i 之供給量、j 之需求量、路徑容量三者之最小者。如此反覆求解直至所有需求與供給均滿足為止。

試回答以下小題。

(a) 即使網路所有節線成本均為非負，以 SSP 求解最小成本流動問題時，在第 2 回合開始 residual network 就可能會出現負值長度的節線。試說明其理由。

(b) 在 SSP 中每回合求解最短路徑應以使用何種演算法為宜？說明理由。

(c) 試設計一個方法，在 SSP 每回合求解最短路徑之前先將 residual network 的所有節線成本轉換為非負。

(d) 你在上一小題中所建議的方法對整體求解效率是否有幫助，原因何在？

國立成功大學土木工程系博士班九十四學年度第二學期資格考試

軌道工程試題

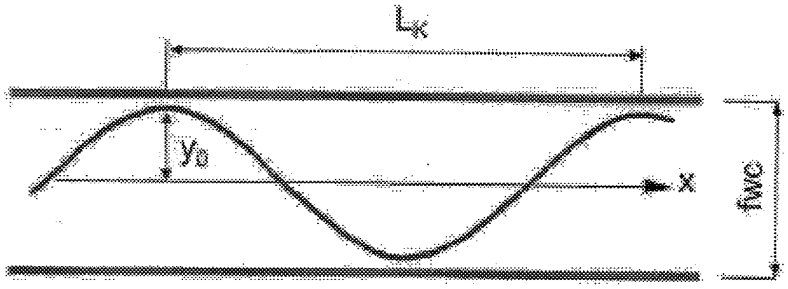
1. 近來台鐵事故頻傳，包括花蓮維修絕緣接頭五名工人遭自強號撞擊殉職，及南迴線魚尾鈑與扣件遭卸除而造成列車出軌。請從英文名稱、功能、設計重點等角度，說明這幾個軌道重要零組件。 (20%)

   甲、絕緣接頭

   乙、魚尾鈑

   丙、鋼軌扣件

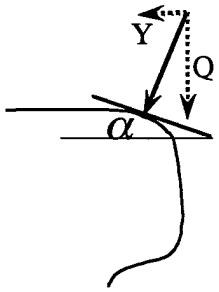
2. 請以右圖解釋軌道車輛 hunting stability 的現象。 (20%)



fwc = flangeway clearance

3. 若台鐵在軌道檢測結果中發現有波長約 20 公尺的不平整，請您評估與解釋可能造成噪音的影響、軌道的損壞、或是乘客不舒適？ (10%)
   又這樣的不平整可能成因爲何？如何消除？(10%)

4. 請推導 Nadal's limit 表示式。(20 %)



$$\frac{Y}{Q}=\frac{tan\alpha-\mu}{1+\mu\cdot tan\alpha}$$

其中 α：接觸角　μ：輪與軌間之摩擦係數

5. 請參考下列內容，說明影響軌道挫屈強度的因素。 (20 %)

4. FACTORS CONTRIBUTING TO TRACK BUCKLING STRENGTH

Apart from the longitudinal resistance and NRT, as already described, buckling strength is affected by many other parameters.

4.1 Rail Temperature

This is obviously a primary factor but it can clearly be affected by degree of exposure to the sun, wind cooling etc. The heating effect of the sun can mean that on a calm sunny day the rail temperature is likely to be around 17°C higher than the ambient temperature. Fig 2 shows the relationship between maximum rail temperature and maximum air temperature, which has been derived from experimental data.

4.2 Lateral Resistance

It is possible to consider the resistance of track to lateral movement as being a combination of the ballast resistance and the bending stiffness of the rail. The two effects will be considered separately here.

The resistance to movement of the sleeper in the ballast is itself governed by the sum of several contributory factors, namely:

- Sleeper weight
- Sleeper dimensions and shape
- Sleeper spacing
- Ballast type
- Degree of ballast boxing (between sleepers)
- Dimensions of the ballast shoulder
- Degree of compaction of the ballast

The resistance provided by the sleeper in the ballast can also be considered to come from three sources, i.e. friction on the base of the sleeper and on the sides, and bearing resistance of the shoulder ballast against the sleeper ends. Measurements have shown that the contribution from each of the three sources is approximately equal in the typical case.

4.3 Torsional Resistance

In the case of a localised lateral distortion of the track there is inevitably some rotational movement between the rail and the sleeper. Thus any torsional restraint to this movement is beneficial in resisting buckling. The design of the fastening and the gripping or toe load will obviously influence the characteristics of the behaviour. Once again many measurements have been made of these parameters and the results incorporated into the theoretical modelling of track buckling. In general it can be stated that the modern spring clip types of fastening have negligible torsional resistance when compared to baseplated fastening types.

4.4 Rails

The factors affecting the buckling strength of track are the cross sectional area and the coefficient of thermal expansion (which together govern the temperature/load relationship), and the moment of inertia in lateral bending.

Most variants of standard rails have similar coefficients of thermal expansion including wear resistant and head hardened rails. Manganese steel rails (rolled or cast) do have a dramatically (around 50%) higher coefficient of expansion and therefore should be avoided in any quantity in long welded rail lengths.

In general it is desirable to have a large moment of inertia and a small cross sectional area. In general of course, larger rails have a larger moment of inertia and a larger cross sectional area and thus these effects tend to balance.

4.5 Alignment Quality

The alignment of the track can have a dramatic effect on the buckling temperature of track and this arguably goes some way to explaining why some tracks which are apparently deficient in some of the other areas described above can survive without buckling at high temperatures. It has also been shown that alignment defects can grow in warm weather due to thermal cycling and traffic effects such that they may reach a size which can trigger buckling. Short wavelength kinks can be as important as longer wavelengths also.

A less critical parameter is the vertical alignment, but nevertheless poor track top can cause unloading of sleepers, and voiding under sleepers, if evident, will increase buckling risk.

4.6 Curves

Theoretically and statistically track on curves is more likely to buckle than straight track. This is due to the natural tendency of the curved track to try to move outward when under compressive load. An additional factor has been described above, namely the tendency for the rails to pull inwards, as for the majority of the time the rail is in tension.

It is normal to restrict the use of CWR to curves of radii greater than a certain minimum radius. BR allow CWR on curves down to 600 m radius with track of normal design. Additional sleepers are required on curves of smaller radius to increase the lateral resistance.

4.7 Jointed Track

The expansion gaps in jointed track allow a greater margin against buckling. This is true only when those expansion gaps are maintained. If rail creep occurs for one of the reasons described above, the gaps can close or be reduced and the buckling risk can substantially increase. It is very important with jointed track, therefore, to maintain all joint gaps uniformly to the stipulated values.

4.8 Traffic

Many buckles occur under trains. Passing trains can reduce the margin of safety for three reasons. Firstly the vertical loading of the wheels causes a slight uplift force on sleepers in advance of the wheel, or between the bogies of long wheelbase vehicles. This marginally reduces the lateral resistance. The dynamic vibration of the passing train can also provide an additional component of lateral force. Also on curves, particularly with long trains, the curving friction can raise the rail temperature by a few degrees hence increasing the buckling risk.

Although trains can therefore be the final factor which precipitates the buckle, there still needs to be a potentially unstable situation on the track for it to actually happen.

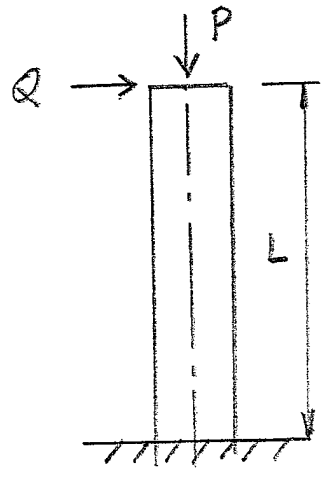
混凝土材料與結構 **Open book test**

1. Please describe the key concepts how to ensure a slender beam behave as flexure-dominated beam. In general, what are the criteria for identifying a beam as shear-dominated beam? (20 %)

2. What is the ACI 318 design concept of reinforced concrete beam-column connection with monolithic construction? (20 %)

3. A ten-story reinforced concrete apartment building designed conforming to the ACI 318 seismic provisions was subject to fire accident at its 2nd and 3rd floor. The fire following the standard E119 fire-temperature curve is assumed lasting for 3 hours. If we can use the existing material properties of concrete and steel under elevated temperature, please describe the procedure how to evaluate the safety of beams and columns at the 3rd floor. (30 %)

4. A reinforced concrete column is subjected to a concentrated load and a horizontal force as shown in the figure. Please describe the procedure how to establish the relationship of curvature ductility and displacement ductility. (30 %)



Date: Mar. 31, 2006

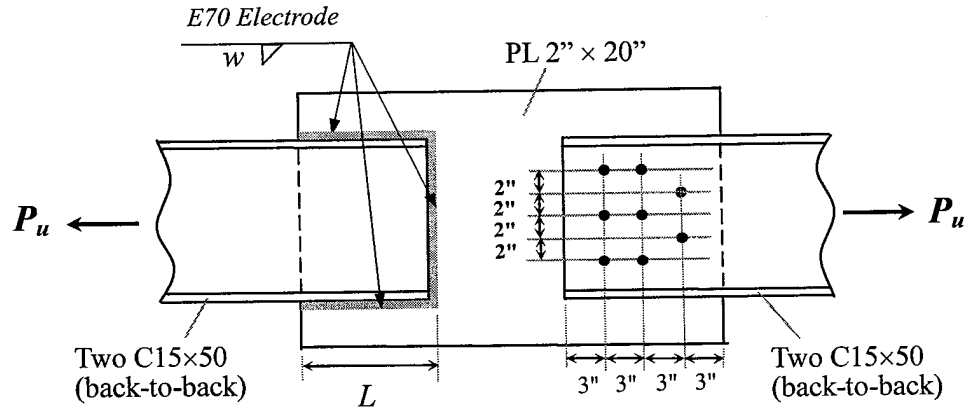
STEEL & STEEL STRUCTURES

(PhD Qualifying Exam)

Note: Please solve the following problems in US units (i.e. inch ("), foot ('), kip, lb, ksi, psi ....)

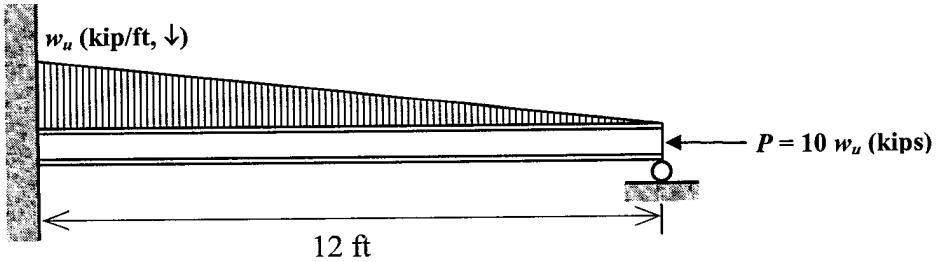
1. (40%) Please give ***detailed*** explanations for the following questions:
   (a) What is "Carbon Equivalent (CE)"? What is its usage in steel design?
   (b) What is "Whitmore Section"? How does it affect steel design?
   (c) What is "Lemellar Tearing"? Please give two examples of this kind of failure in steel structures.
   (d) How do the following chemical components influence the properties of steel?
   Carbon (C), Phosphorous (P), Sulfur (S), Silicon (Si) and Manganese (Mn)

2. (30%) Consider the following tension member with bolted and welded connections:
   (a) Please compute the maximum factored load P_u of the bolted connection by the AISC-LRFD specifications.
   (b) Design the welded connection by the P_u you obtained from (a), i.e. design the weld size w and the weld length L.



All C-Shapes and the plate are A36 Steel
All Bolts are 1" A325 Bolts with Standard Holes

3. (30%) Please determine the maximum factored w_u (kip/ft) that the steel beam (see the figure below) can safely support by the AISC-LRFD specifications. (Neglect beam self-weight)



Beam: W12×96, A992 Steel

Financial &Cost Concepts for Engineering and Construction Qualification

1. Explain the following items (20%)
   1.1. Earning per share
   1.2. Substantial Completion
   1.3. Work in Progress
   1.4. Differences between (contract) line items and (schedule) activity

2. What are the four categories of ratios? How are they used to view a firm's financial position? Do they have any pattern? (20%)

3. A real estate developer is considering building a 25-unit apartment complex in a growing town. Because of the long-term growth potential of the town, it is felt that the company could average 85% of full occupancy for the complex each year. If the items in Table 1 are reasonably accurate estimates, what is the **minimum monthly** rent that should be charged if a 12% per year MARR (Minimum Attractive Rate of Return) is desired? (Assuming that investment in land is recovered at the end of year 20 and that annual upkeep is directly proportional to the occupancy rate,) (20 分)

Hint $F = A\left[\frac{(1+i)^N - 1}{i}\right]$ $P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right]$ $F = P(1+i)^N$

Table 1

Land investment cost	$50,000
Building investment cost	$225,000
Study period, N	20 years
Upkeep expense per unit per month	$35
Property taxes and insurance per year	10% of total initial investment

4. The balance sheet of XYZ construction for July, 1998 and the transactions during 1 Aug. 1999 to 31 Aug. 1999 are shown in Table 2 and Table 3, respectively. Please complete the followings: (40%)
   4.1. Journalize all of the above transactions.
   4.2. Post journal entries to appropriate accounts.
   4.3. Develop income statement for period 1 Jan. 1999 to 31 Dec. 1999

4.4. Develop the balance sheet for XYZ Construction as of 31 Dec. 1999.

Table 2

Assets		**Liabilities**	
Cash	$39,000	Accounts Payable	$78,000
Account Rec.	$75,000	Notes Payable	$20,000
Securities-T-Bills	$35,000	Taxes payable	$25,000
Inventory	$120,000	**Current Liabilities**	$123,000
Current Assets	$269,000	**Term Liabilities**	
Fixed Assets		Mortgage On Bldg.	$340,000
Equipment	$45,000	**Total Term Liabilities**	$340,000
Building	$670,000	**Total Liabilities**	$463,000
Total Fixed Assets	$715,000	**Owners Equity**	
		Common Stock 1,000 shares	$5,000
		Retained earnings	$516,000
Total Assets	$984,000	Total Liabilities and O. E.	$984,000

Table 3

a. Sold on credit, $35,000 in material to South Building.(Note: This is the selling price for the material. The value of the inventory is unknown at this time. At the end of the month, a physical count of the inventory will be made and the CGS entry can be made then).
b. Pay $15,000 on account payable.
c. Advertising in trade journal, paid $3,000.
d. Wages paid, $2,500.
e. Received $22,000 from customer for account receivable
f. Received bill from supplier for repair of equipment, $1,000.
g. Paid sales commission of $1,500.
h. Sold $28,000 of material for each to customer.
i. Billed Simpson Co. $8,000 for installation services.
j. Paid Mortgage Co. $17,000 of which $15,000 was toward principal and $2,000 was interest.
k. Paid part of tax owed, $2,000.
l. Declared and paid dividends of $1,000
m. Depreciation of equipment is $1,000 and the building is $2,000.
n. Physical count of inventory at the end of the month is $80,000. (Beginning inventory-removal during month = ending inventory).

工程時程控制　博士資格考　95 年 3 月 31 日

一、某工作有下列作業與關係，請針對 (1)作業不分裂(split)，(2)作業可分裂，計算各作業最早、最晚時間，劃出網圖，指出要徑。(40 分)

作業	工期	後續作業	關係延時
A	6	B	SS2
		C	SF4,8
B	8	C	FF1
		E	FS2
C	10	D	SS4, FF2
D	12	E	FF7
		H	FS0
E	10	G	SS6, FF5
		H	FS1
		F	SS2, FF2
G	10	H	FF4
H	8		
F	10		

二、請自行舉一案例，模擬時程的規劃與控制。從 WBS 開始分解工作，作出網圖或桿狀圖預定進度表，工作進行中的進度更新，如何評估績效等，說明重點。(40 分)

三、某工程開挖至 94/4/30，其作業資料如下表一，請填入第二表中及表下空格。(20 分)

作業 No.	敘述	開始	完成	原工期	預算
11	開挖 A	4/16	4/22	5	12,500
12	開挖 B	—	—	2	5,000
13	開挖 C	4/30	—	2	5,000
14	開挖 D	4/23	4/29	4	10,000

作業 No.	完成 %	BCWS	BCWP	ACWP	SPI	CPI	好 or 差
11	100	12,500		10,000			
12		0	0	0			
13		5,000		3,000		0.83	
14			10,000	12,000	1.0		

合計 _____ _____ _____ _____ _____ _____ _____

估完工金額 = _____　　算式 =