

Qualifying Examination (Finite Element Method)

- (1) Develop the quadratic shape functions  $N_i(\xi)$ ,  $i = 1, 2, 3$  by considering a three noded standard element with nodes at  $\xi = -1$ ,  $\xi = 0$ ,  $\xi = +1$ , assuming a trial solution

$$u = \alpha_0 + \alpha_1\xi + \alpha_2\xi^2. (25\%)$$

- (2) Solve

$$\frac{d^2u}{dx^2} = 2 \quad 1 < x < 3$$

(25%)

$$u(1) = 1, \quad u'(3) = 6$$

by using two linear elements of equal length.

- (3) Explain the meaning of the following terms (30%)
- (a) convergence criterion= completeness + compatibility
  - (b) patch test
  - © isoparametric element
- (4) Consider the four-node bilinear element. Prove that the one-point Gauss quadrature formula in two dimensions is sufficient to exactly integrate the area

$$\int_D e \, dA \quad (20\%)$$

## 結構動力

1. 說明歷時分析(Time history analysis)及反應譜(Response-spectrum analysis)，並比較此兩方法。(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 0.05, 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%)

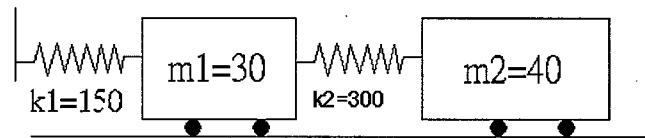


Fig.2a

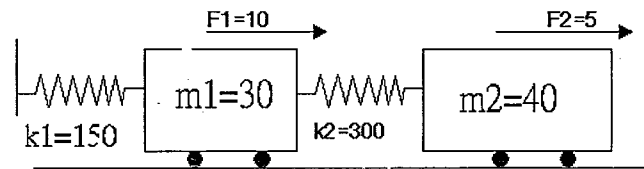


Fig.2b

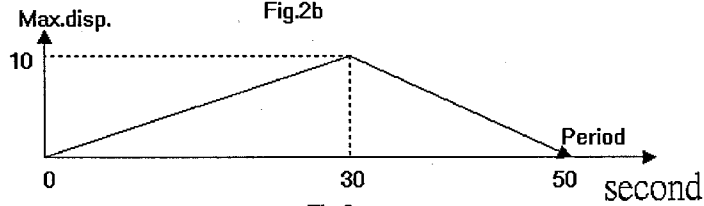


Fig.2c

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

3. Fourier transfer(傅利葉轉換)常被應用在處理結構動力的問題中，請解釋並說明下列名稱:(1) Fourier transfer, (2) Fast Fourier transfer, (3) Fourier series, and (3) Fourier integral. (25%)

題 1 及 3 為申論題，沒有標準答案，請盡力回答。



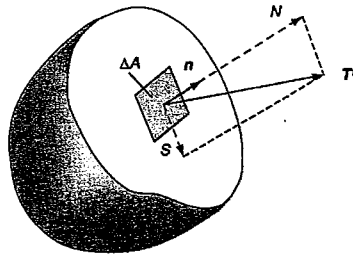
國立成功大學土木工程學系九十五學年度第二學期  
結構工程組博士學位候選人資格考試試題

考試科目：彈性力學  
考試時間：2007年03月30日  
作答時間：100分鐘  
及格標準：60分

1. (15%) Show that the shear stress  $S$  acting on a plane defined by the unit normal  $\mathbf{n}$  in the figure can be written as

$$S = \left[ n_1^2 n_2^2 (\sigma_1 - \sigma_2)^2 + n_2^2 n_3^2 (\sigma_2 - \sigma_3)^2 + n_3^2 n_1^2 (\sigma_3 - \sigma_1)^2 \right],$$

where  $n_1, n_2, n_3$  and  $\sigma_1, \sigma_2, \sigma_3$  denote the principal axes and principal stresses, respectively.



2. (15%) A hydrostatic stress field is described by

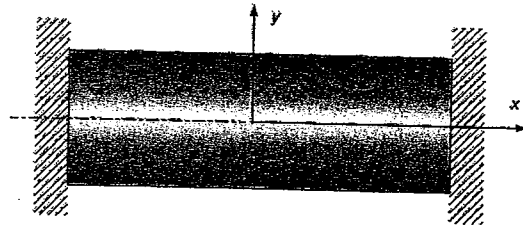
$$\sigma_{ij} = -p\delta_{ij} = \begin{bmatrix} -p & 0 & 0 \\ 0 & -p & 0 \\ 0 & 0 & -p \end{bmatrix},$$

where  $p = \hat{p}(x_1, x_2, x_3)$  and may be called the pressure. Show that the equilibrium equations imply that the pressure must satisfy the relation  $\nabla p = \mathbf{F}$  ( $\mathbf{F}$ : body force per unit volume).

3. (20%) Consider the one-dimensional thermoelastic problem of a uniform bar constrained in the axial direction but allowed to expand freely in the  $y$ - and  $z$ -directions, as shown in the figure. Taking the reference temperature to be zero, show that the only nonvanishing stress and strain components are given by

$$\sigma_x = -E\alpha T, \quad e_y = e_z = \alpha(1+\nu)T,$$

where  $E$  is the Young's modulus,  $\alpha$  the thermal expansion coefficient,  $\nu$  the Poisson's ratio and  $T$  the temperature.

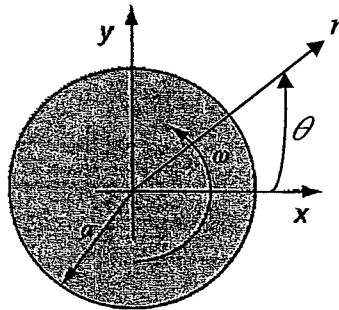


4. (25%) Since the strain energy  $U$  has physical meaning that is independent of the choice of coordinate axes, it must be invariant to all coordinate transformations. Because  $U$  is a quadratic form in the strains, it cannot depend on the third invariant  $III_e$ , and so it must depend only on  $I_e$  and  $II_e$ . Show that

$$U = \left( \frac{1}{2} \lambda + \mu \right) I_e^2 - 2\mu II_e,$$

where  $\lambda$  and  $\mu$  are the Lamé's constant and the shear modulus, respectively.

5. (25%) A thin uniform circular disk is subjected to a constant rotation  $\omega$ , as shown in the figure. The rotational motion generates centrifugal acceleration on each particle of the disk, which becomes the source of external loading for the disk. No other additional external loadings are considered. Find the stress components  $\sigma_r$ ,  $\sigma_\theta$  in the  $r$ - and  $\theta$ -directions, respectively.



(Hint: The particular stress function  $\varphi = \varphi(r)$ , satisfying automatically the equilibrium equations, is given by

$$\sigma_r = \varphi / r, \quad \sigma_\theta = \frac{d\varphi}{dr} + F_r,$$

where  $F_r$  is the generated centrifugal force per unit volume. Use the compatibility condition to determine the governing equation of the stress function.)

**國立成功大學土木工程學系博士班資格考**  
**土壤力學 試題**

1. 解釋下列名詞：(20 分)

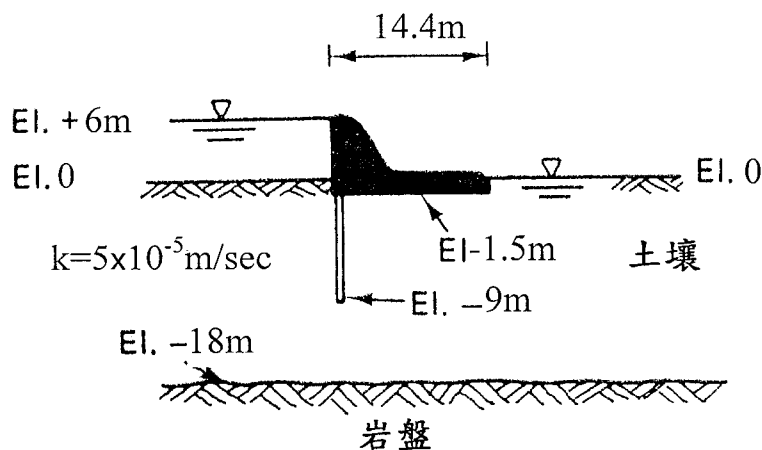
- (1) 受壓水流(Confined flow)
- (2) 壓縮係數  $\alpha_v$  (Coefficient of compressibility)
- (3) 臨界孔隙比(Critical Void Ratio)
- (4) 動力夯實(Dynamic Compaction)

2. 現地夯實成效一般以相對夯實度(Relative Compaction Degree)為檢驗基準，試回答下列問題：(15 分)

- (1) 相對夯實度之定義為何？
- (2) 試以簡圖表示，利用夯實曲線訂出為達到規定相對夯實度之含水量範圍
- (3) 列舉詳述三種求取現地密度之方法

3. 有一不透水壩體，在上游端設有版樁截水設施，如附圖所示

- (1) 試繪其流線網圖並計算其滲流量 (15 分)
- (2) 試求體底面之上舉力與抵抗倒之安全係數 (10 分)
- (3) 最大之水力坡降為何？並研判是否會發生土壤被沖出之情形？  
(10 分)



4. 有一不擾動粘土樣之壓密試驗結果如列表所示：

壓密應力 ( $kN/m^2$ )	0	50	100	200	400	800	0
試體厚度(mm)	25.0	24.6	24.4	24.2	23.9	23.7	24.2

其中試體初始厚度為 25 mm，各階段加載壓密後 24 小時，試體厚度如上表所示。當完成解壓後 24 小時之試體厚度為 24.2mm，此時取土樣作試驗，得知其含水量為 23.1%，而其比重為 2.68。試回答下列各問題：

(1) 計算壓密試驗前土樣之初始孔隙比 (10 分)

(2) 試計算該土樣在壓密壓力介於  $50\sim 100kN/m^2$  之壓縮指數

$C_c$ (Compression index)、壓縮係數  $a_v$  (Coefficient of compressibility) 與體積壓縮指數  $m_v$  (Coefficient of volume change) (20 分)

# 九十五學年度第二期博士學位候選人資格考試

考試科目：工程地質

一. 解釋名詞 (23%)

(1) 何謂震央、震源? (6%)

(2) 何謂岩盤透水 Lugeon 試驗?(3%)

(3) 何謂原生弱面(3%)，次生弱面 (3%)? 分別舉出二例子 (8%)

二. 莫氏硬度表之十種標準礦物為何? (20%)

三. 試述何謂標準貫入試驗(Standard penetration test)，如何求得 N 值 (8%)

四. 試述 RMR 岩體分類法(20%)

五. 請將下列不連續面的方位以 dip direction/dip 的方式表示 (9%)

(1) N35°E, 30°SE

(2) N35°E, 30°NW

(3) S35°E, 30°NW

六. 繪圖並說明圓弧破壞、平面破壞、楔形破壞、傾倒破壞之相對應的岩石邊坡坡面與不連續面的分布情況 (20%)

# 九十五學年度第二期博士學位候選人資格考試

考試科目：基礎工程

一. 解釋名詞 (18%)

- (1) 何謂基樁負摩擦? (4%)
- (2) 何謂點承樁、摩擦樁、夯實樁?(6%)
- (3) 何謂深開挖所引起之隆起(4%)、管湧(4%)?

二. Terzaghi 的基礎承載力理論基本假設為何? (24%)

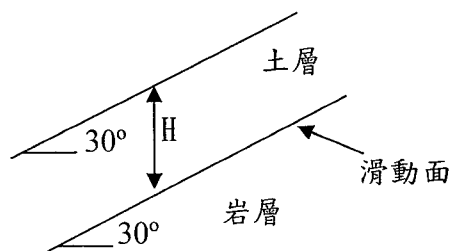
三. (1)簡述基樁之載重試驗 (5%)

- (2)基樁設置完成後是否宜進行載重試驗?黏土與砂土層中是否有不同的考慮?(10%)

四. 試述庫倫土壓力與蘭金土壓力在觀念上有何異同(12%)

五. 假設在台南市五期重劃區或安南區近海濱回填地上興建一大樓，此地地下水位甚高，當進行基礎設計時，請列出四項該場址日後可能發生的問題。(20%)

六. 如下圖一無限邊坡，土層單位重  $18\text{kN/m}^3$ ，滑動面剪力參數  $C=5\text{kN/m}^2$ 、 $\phi=20^\circ$ ，當安全係數=1 情況下，土層最大厚度  $H$ ?(11%)





## 道路工程

(Ph.D. Qualify Exam.)

1. Briefly describe the SHRP and the LTPP.
2. Briefly describe the Superpave mix design procedures.
3. Briefly describe the historical developments of pavement design. (Flexible pavement and Rigid pavement)
4. Is there a premium composite pavement? Describe the major features of the pavement design section.
5. What is the purpose of the road test? Describe the AASHO road test also.
6. What are the serviceability/performance concepts?
7. Briefly describe the concept of pavement management.

軌道工程試題

1. 請“詳細”說明下圖的意義。(20%)

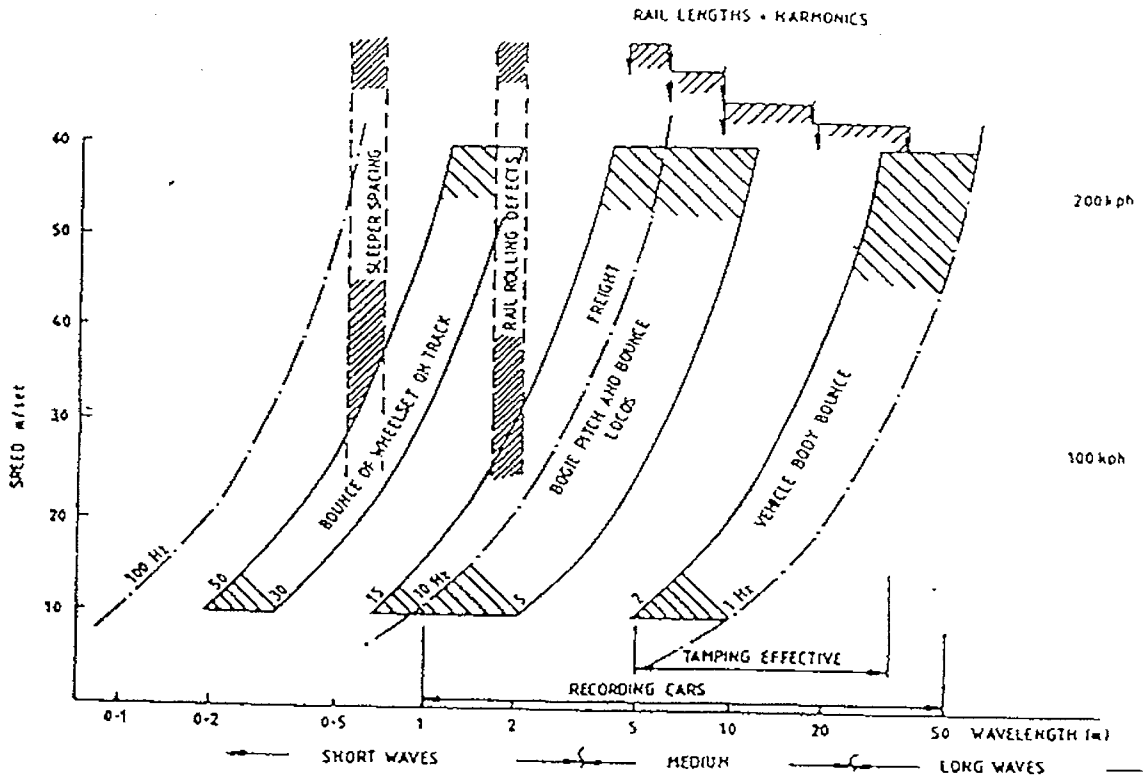
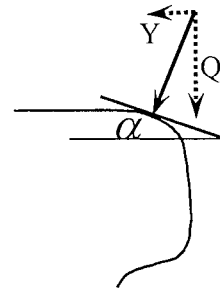


Fig 5 Natural Frequencies of Vehicle and Track

2. 若要降低軌道發出的噪音(通常約為 60Hz 以上), 請提出軌道結構可以採取的措施, 並從結構動力學角度說明原理。(20%)
3. 請推導 Nadal's limit 表示式。(20%)

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

其中  $\alpha$ : 接觸角  $\mu$ : 輪與軌間之摩擦係數



4. 請推導單一輪軸蛇行動(hunting)的軌跡方程式。並說明蛇行動波長與臨界速度間之關係。(20%)
5. 下圖是軌道車輪通過一處銲接瑕疵點所發生的力。請詳細說明這個受力圖形中兩個波峰顯示的意義!(20%)

$\frac{\Delta Q}{Q}$  = Dynamic amplification

