九十七學年度第一學期土研所博士班資格考試(97.10.31)
有限元素法

(1) A second-order ordinary differential equation with variable coefficients and its corresponding boundary conditions are given as follows.

GE: $\frac{d}{dx}\left(a(x)\frac{du(x)}{dx}\right)+b(x)=0 \qquad \text{in } 0<x<1$ (1a)

BCs: $u(x=0)=0$

$$a\frac{du}{dx}\bigg|_{x=1}=0; \tag{1b}$$

where $u(x)$ is the unknown function; $a(x)$ and $b(x)$ are given functions.

(a) State a physical problem of which governing equation and possible boundary conditions refer to Eqs. (1a) and (1b). (10%)

(b) Construct the weak forms. (10%)

(c) Let $a(x)=1$ and $b(x)=\sin(\pi x)$, and determine the exact solution of u(x). (10%)

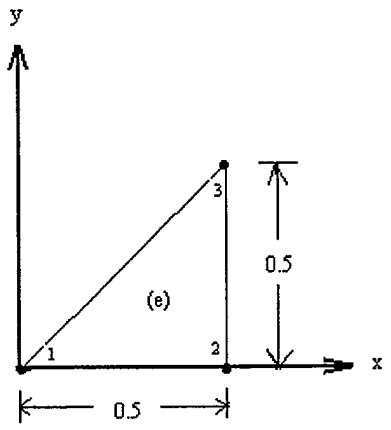
(d) Let $a(x)=1$ and $b(x)=\sin(\pi x)$. Compute the 2-parameter Ritz approximation of Eqs. (1a) and (1b) using algebraic polynomials as the approximate functions. (15%)

(e) Let $a(x)=1$ and $b(x)$=0. Compute the finite element solution using two linear elements with a uniform mesh. (15%)

Hint: A detailed description for the FEM process in problem (1e) is much more important than a lengthy calculation.

(2) If the nodal values of the element shown in Fig. 2 are $u_i=\hat{u}_i$ $(i=1, 2, 3)$, compute u, $\partial u/\partial x$ and $\partial u/\partial y$ at point $(x, y)=(0.375, 0.375)$. (20%)

Hint: The linear interpolation functions $\phi_i^{(e)}(x, y)=\frac{1}{2A_e}\left(\alpha_i^{(e)}+\beta_i^{(e)}x+\gamma_i^{(e)}y\right)$ $(i=1, 2, 3)$ and $\alpha_i^{(e)}=x_j y_k-x_k y_j$, $\beta_i^{(e)}=y_j-y_k$, $\gamma_i=-(x_j-x_k)$, $(i\neq j\neq k$; i, j and k permute in a natural order).



(3) Show that the bilinear interpolation functions for the four-node triangular element in Fig. 3 are of the form (20%)

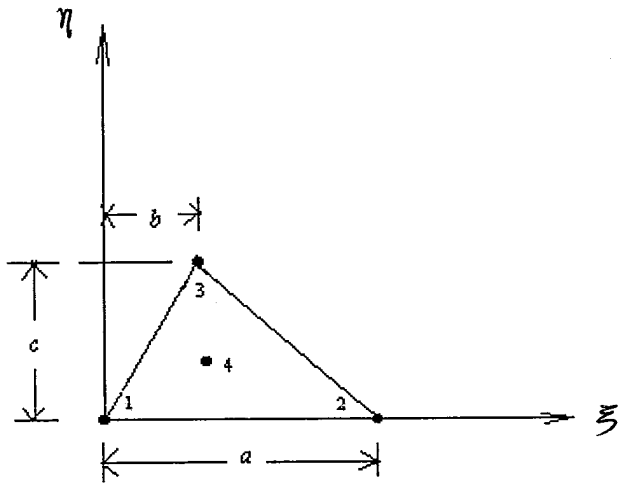
$$\phi_i^{(e)} = A_i + B_i\,\xi + C_i\,\eta + D_i\,\xi\eta \quad (i=1, 2, 3, 4)$$

where $A_1 = 1$, $A_2 = A_3 = A_4 = 0$, $-B_1 = B_2 = 1/a$, $B_3 = B_4 = 0$,

$$C_1 = \frac{6ab - a^2 - 2b^2}{ac(a-2b)}, \quad C_2 = \frac{2b(a+b)}{ac(a-2b)}, \quad C_3 = \frac{a+b}{c(a-2b)}, \quad C_4 = \frac{-9b}{c(a-2b)}$$

$$D_1 = D_2 = D_3 = -\frac{1}{3}D_4 = -\frac{3}{c(a-2b)}.$$

Hint: The coordinate of point 4 is $\left(\frac{a+b}{3}, \frac{c}{3}\right)$.



Structural Dynamics

For the structure shown, assume vertical columns are much lighter in weight than m.

1.(25) Determine an approximate expression for the stiffness k and the damping c of the equivalent singer degree of freedom system (SDOF), in terms of l, EI of the columns.

(a) If point A is a hinged connection.

(b) If point A is a clamped connection.

2.(25) In a vibration test, apply a static load p by hydraulic jack to displace the girder m by an amount δ_1, than instantaneous release of p, measure and obtain the max return saying is δ_2, in τ sec, find k, c and equivalent EI of the column from the results in problem 1.

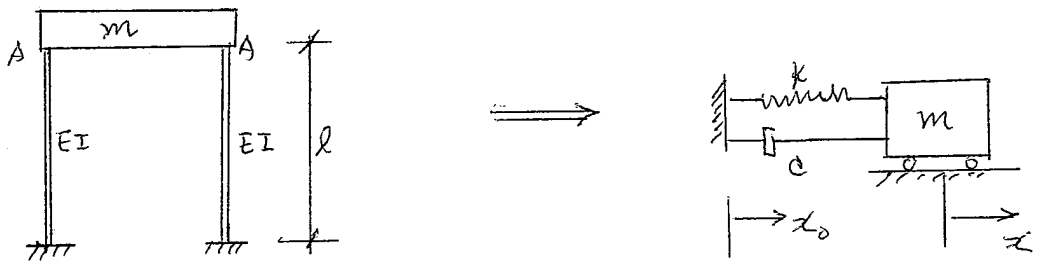
3.(25) Suppose the ground motion $\ddot{x}_0$ is measured as

$$\ddot{x}_0 = A_0 \sin(\pi t/t_1) \qquad \text{for } 0 \leqq t \leqq t_1, \quad (\text{acceleration})$$

$$\ddot{x}_0 = 0 \qquad \text{for } t \geqq t_1.$$

Investigate the dynamic response of the system to $\ddot{x}_0$, for what value of t_1 the structural deformation becomes dangerously large. (Discussion (i) if $\ddot{x}_0$ can be considered short duration. (ii) if $\ddot{x}_0$ cannot be considered short duration).

4.(25) Discussion the method of mode superposition for the analysis of multi degree of freedom system (MDOF).



Qualifying examination, Oct., 2008 (Elasticity)

1. For isotropic materials,
   (a) express Hooke's law for plane stress, giving strains in terms of stresses. (10%)
   (b) express Hooke's law for plane strain, giving strains in terms of stresses. (10%)
   (c) Compare result for plane stress with that for plane strain. (5%)

2. Using only the linearity of the constitutive law, derive the Betti reciprocal theorem,

$$\int_D \sigma_{ij}^{(1)} \varepsilon_{ij}^{(2)} dv = \int_D \sigma_{ij}^{(2)} \varepsilon_{ij}^{(1)} dv$$

   The superscripts represent different states of loading on the same body with the same constraints. (25%)

3. The following state of strain exists at a point in a body

$$[\varepsilon_{ij}] = \begin{bmatrix} 0.01 & -0.02 & 0 \\ -0.02 & 0.03 & -0.01 \\ 0 & -0.01 & 0 \end{bmatrix}$$

   In a direction $\boldsymbol{n} = (0.6,0,0.8)$, what is the normal strain ε_{nn} along the direction $\boldsymbol{n}$? (25%)

4. State the "Principle of virtual Work" and proof it. (25%)

九十七學年度第一學期博士班資格考 (2008.10)

科目：土壤力學

考試時間：100 分

滿分：100 分；及格 60 分

一. 申論題：

1. 試繪出示意圖，並推導流砂(Quick sand)及臨界水力坡降(Critical hydraulic gradient)之形成條件。 (20 分)

2. 試說明 Rankine 及 Coulomb 側向土壓力理論之異同點。 (20 分)

3. 試繪圖說明位於邊坡之剛性基腳承受地震力時之破壞機制 (10 分)，並以公式說明如何估計其極限承載力 (10 分)。

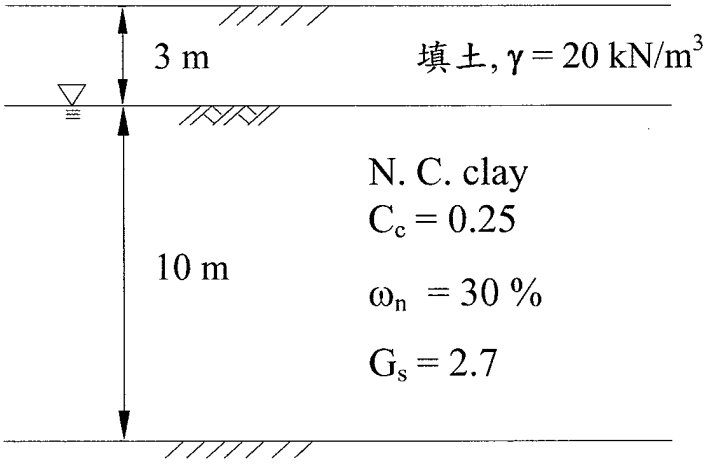
4. 計算題 (20 分) 如圖之正常壓密狀態之飽和粘土層，採用預壓密工法來促進其壓密沈陷，採用之載重材料為 3 m 高之填土，已知填土 12 個月可完成 80%之壓密沈陷量：

   (1) 求粘土層之壓密係數,及填土後 8 個月之地表沈陷量 (以 m 表示), (10 分)

   (2) 若需要在 6 個月完成 36cm 之地表沈陷，則填土高度需為多少(以 m 表示), (10 分)

   提示：$T_v = \frac{\pi}{4}\left(\frac{U_{avg}(\%)}{100}\right)^2$, when $U_{avg} < 60$

   $T_v = 1.781 - 0.993 \cdot \log(100 - U_{avg}(\%))$, when $U_{avg} > 60\%$



5. 計算題 (20 分) 對一正常壓密之飽和黏土，進行 $\overline{CU}$ 試驗, $\sigma_3 = \sigma_{3_f} = 200\ kN/m^2$, 破壞時之 $\sigma_{1_f}' = 400\ kN/m^2$。已知該土壤之有效應力摩擦角 $\phi' = 30°$, 凝聚力 $c' = 0$, 求：

   (1) 破壞時之軸差應力 $(\sigma_1 - \sigma_3)_f = ?$ (10 分)。

   (2) 破壞時孔隙水壓係數 A_f (10 分)。

九十七學年度第一學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（12%）

（1）何謂解理、何謂斷口？（4%）

（2）何謂走向、傾角、傾向?(6%)

（3）何謂標準貫入試驗(SPT)?(2%)

二. 試述四項橋樑主要的工程地質課題？（16%）

三. 試述 RMR 岩體分類法與 Q 法(20%)

四. 試述防止邊坡滑動的主要處理原則（12%）

五. 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（16%）

六. 各分別舉出二種體內波與表面波，以及利用繪圖與敘述方式描述各波動傳遞與介質運動關係?(24%)

National Cheng Kung University
Department of Civil Engineering
Pavement Engineering
Qualification Exam for Ph.D. Students
Open Books and Notes (100 minutes)
Fall 2008

1.

You are asked to calculate the equivalent single axle load (ESAL) and the truck factor using the following data:(20 points)

Axle Type	Vehicle Number	Weight, kips	Axle Number
Single		10	1400
Single		18	500
Single		22	300
Single		26	200
Tandem		32	400
Tandem		36	350
Tandem		40	200
Tandem		44	100
Total	1,300		

2.

A flexible pavement for an urban highway is designed to carry 2 million ESALs. Related information is presented as follows: (10 points for each question)

- Elastic modulus of asphalt concrete at 20C (68F) = 3100 MPa (450,000 psi)
- Layer coefficient of base course material = 0.14, and M_r = 214 MPa (31,000 psi)
- layer coefficient of subbase course material = 0.1, and M_r = 93.1 MPa (13,500 psi)
- CBR value of subgrade material = 6, M_r = 62.1 MPa (9,000 psi)
- Reliability level = 99 %
- Overall standard deviation = 0.49
- Initial serviceability = 4.5
- Terminal serviceability = 2.5
- Drainage coefficient for both base and subbase = 0.8

(1) Please design a flexible pavement according to the 1993 AASHTO's procedures.
(2) What would the pavement thicknesses of asphalt concrete be if the modulus of the asphalt concrete surface course used in the calculation is actually 30 percent too high?
(3) What would the structural number be if the original thicknesses from question (1) were used?
(4) With this structural number obtained from (3), what are the estimated 18-kip equivalent single axle load applications (W_{18}) before pavement reaches failure?

3.

A JPCP for a roadway is to be designed to carry 6 million ESALs. The pavement will be a two-lane facility with asphalt concrete shoulders. The joint spacing will be 4.6 m (15 ft) and dowel bars will be used. The estimated time for the water to drain from within the pavement is approximately one week, and the pavement structure will be exposed to moisture levels approaching saturating 30 percent of time. The following values have been determined: (10 points for each question)

- Modulus of rupture of the concrete 4.4 MPa (700 psi)
- Elastic modulus of the concrete = 27.6 GPa (4,000,000 psi)
- Effective modulus of subgrade reaction = 54 kPa/mm (200 pci)
- Initial and terminal serviceability = 4.5 and 2.5
- Reliability level = 85%
- Overall standard deviation = 0.39
- Drainage coefficient = 0.90.

(1) Determine the thickness of the concrete slab needed to carry the estimated traffic by the AASHTO rigid pavement design procedures.
(2) How many ESALs would the pavement be able to handle if dowel bars were not used at transverse joints?
(3) How much thicker would the pavement have to be to handle the same number of ESALs, i.e., 6 million.
(4) In the AASHTO rigid pavement design procedures, JPCP, JRCP, and CRCP can be designed accordingly. Since reinforcement is used in JRCP and CRCP, the thickness needed for traffic loading should be less in JRCP and CRCP than in JPCP. Do you agree on this statement? Please explain your answer.

國立成功大學土木工程系九十七學年度第一學期博士班資格考試

軌道工程試題

1. 請逐句翻譯下列三段內容。(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. 請簡單說明使用 swing-nose crossing 的時機與原因。(10%)

3. 請說明單塊式混凝土軌枕的形狀尺寸設計的三項考量。(10 %)

4. 請根據下列參考公式，估計台灣高鐵與台鐵列車的噪音差異。(10%)
若要以在沿線相當距離限建的方式來降低噪音的危害，請依據軌道工程技術講義的內容，簡略估計噪音較大的路線應該增加多少距離的限建範圍？(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

5. 請說明道碴碎石顆粒的最佳尺寸的考量爲何？(20%)

材料機械性質

博士資格考 Fall 2008

1. The elastic constants of an orthotropic material are:

   E_{11} =1.3GPa, E_{22} =0.9GPa, E_{33} =16.4GPa, G_{32} =910MPa, G_{31} =1180MPa, G_{21}=790MPa, ν_{32}=0.37, ν_{31}=0.43, ν_{21}=0.4, ν_{23}=0.024, ν_{12}=0.63, ν_{13}=0.028

   Calculate (a) the strains and (b) the dilatation, resulting from the following stress state in a block of the material: $\sigma_{11}=\sigma_{22}$ =20MPa and $\sigma_{12}=\sigma_{21}$ =10MPa.

   (25%)

2. (a) Distinguish between diffusional flow and power law creep in terms of phenomenology and the mechanism controlling each type of creep. (b) What is the cause of power law creep **breakdown** ?

   (25%)

3. The tensile strength of a brittle material can be described well by the two-parameter Weibull statistical analysis with $m=6$ and $\sigma_0=20MPa$. Calculate the applied concentrated force P loaded at the center of a simply supported beam with a span $L=10m$ and a rectangular cross-sectional area $10cmx10cm$ when the failure probability of the beam is 0.1.

   (25%)

4. The following data were obtained in a tensile test on a specimen with 100mm gauge length and a cross-sectional area of 100mm^2:

P(KN)	12	25	32	36	40	42	63	80	93	100	101	90
δ (mm)	0.05	0.1	0.15	0.2	0.25	0.3	1.25	2.5	3.75	5.0	6.25	7.5

   (a) When σ_{max} =-σ_{min} =100MPa , determine the number of cycles to failure ?

   (b) When a_0=1cm and σ=100MPa, determine the plastic zone r_y^* (based on the Dugdale plastic strip model) ?

   (c) When a_0=1cm, σ_{max} =100MPa and σ_{min} =0MPa, determine the number of cycles to failure ?

   Note that: $N_f^{1/2}\Delta\varepsilon^{PI}=0.3$, $N_f^{1/10}\Delta\sigma=800$, $da/dN=1x10^{-12}(\Delta\sigma\sqrt{\pi a})^3$ and K_{IC}=40MPa-m$^{1/2}$ for $\Delta\sigma$ in MPa and a in m.

   (25%)

工程時程控制 九十七學年度第一學期博士資格考試試題

姓名：　　學號：　　(Close-book exam)

一、解釋名詞：(每題 6 分)

1. 關係浮時　2. EAC　3. Resource leveling　4. Free float time

二、問答題（每題 12 分）

1. 請繪製時程管理之 5 大過程。你認爲此 5 大過程中那一項最爲困難達成，但對時程管控之影響卻極爲重大（須說明原因）。
2. 試述造成實際進度落後於預定進度之原因。
3. 試述進度成本趨勢分析之目的與常見的方法。

三、計算題：(每題 20 分)

1. 以下爲某新建大樓 10 月份的進度報告資料，請分析進度績效進行進度績效分析（含 SV, SPI, ETC, EAC 計算），計算結果須加以評量績效的好壞。

   Task 10（樓地版） 實際成本： $15,000；Task 20（水電）實際成本：$11,000，BCWP= $22,000; BCWS= $22,400; BAC= $147,500。

2. 請依下表與 PDM 方法計算日程(含 TTF, FF, RF)。請先將下表中所有之 FS 關係均改 SS 關係後計算日程，並比較兩者之差異與說明原因。

Activity	Duration (週)	Following Activity
A	3	B(SS, 2); C(FS, 0)
B	5	D(SS,1); E(FS, 1)
C	4	E(FS, 0)
D	2	F(FS, 0)
E	7	F(FS, 0)
F	**6**	----