# 八十九學年度第二學期博士學位候選人資格考試時間表

| 時　間 | 考　試　科　目 | 考試地點 |
|---|---|---|
| 8:30<br>｜<br>10:10 | √▲ 有限元素法　(CLOSE BOOK)<br>√▲ 岩石力學　(CLOSE BOOK)<br>√▲ 鋪面工程　(OPEN BOOK)<br>√▲ 鋼結構學　(OPEN BOOK) | 大會議室 |
| 10:20<br>｜<br>12:00 | √▲ 結構動力學　(OPEN BOOK)<br>√▲ 基礎工程　(CLOSE BOOK)<br>√▲ 工程地質　(CLOSE BOOK)<br>√▲ 混凝土構件行為學　(OPEN BOOK) | 大會議室 |
| 14:30<br>｜<br>16:10 | √▲ 土壤力學　(CLOSE BOOK) | 4506教室 |

- 考試日期：90年3月30日（星期五）
- 地　　點：土木系大會議室、4506教室
- 考試時請攜帶學生證。

89(F)

Qualified Examination Spring 2001

# Finite Element Method

(Close Book, 100 Minutes, 60% to Pass)

1. Consider a three-dimensional solid body composed of linearly elastic isotropic homogeneous material with Young's modulus E and Poisson's ratio ν. The body is subjected to body forces $\{F\}$, surface tractions $\{\Phi\}$, initial stresses $\{\sigma_0\}$ and initial strains $\{\varepsilon_0\}$. Use the following notations

   $\{F\} = \{F_x, F_y, F_z\}^T$, the body forces.
   $\{\Phi\} = \{\Phi_x, \Phi_y, \Phi_z\}^T$, the surface tractions.
   $\{u\} = \{u,v,w\}^T$, the displacements.
   $\{\sigma\} = \{\sigma_x, \sigma_y, \sigma_z, \tau_{xy}, \tau_{yz}, \tau_{zx}\}^T$, the stresses.
   $\{\sigma_0\} = \{\sigma_{xo}, \sigma_{yo}, \sigma_{zo}, \tau_{xyo}, \tau_{yzo}, \tau_{zxo}\}^T$, the initial stresses.
   $\{\varepsilon\} = \{\varepsilon_x, \varepsilon_y, \varepsilon_z, \gamma_{xy}, \gamma_{yz}, \gamma_{zx}\}^T$, the strains.
   $\{\varepsilon_0\} = \{\varepsilon_{xo}, \varepsilon_{yo}, \varepsilon_{zo}, \gamma_{xyo}, \gamma_{yzo}, \gamma_{zxo}\}^T$, the initial strains.
   [E] = the material property matrix, in which $\{\sigma\} = [E]\{\varepsilon\}$
   V = volume of the body
   S = surface area of the body.

   (a) Derive the expression for the total potential energy Π of the body in a matrix form. (5%)

   (b) Assume the body to be modeled by N elements. Let $\{d\}_i$, $V_i$, and $S_i$ be the nodal degrees of freedoms, the volume and the surface area of the i-th elements. Use the relations $\{u\} = [N]\{d\}_i$, $\{\varepsilon\} = [B]\{d\}_i$ to develop the expression for the total potential energy Π of the entire N elements. (5%)

   (c) If the total potential energy of the body can be written in the following form:

$$\Pi = \frac{1}{2}\{D\}^T[K]\{D\} - \{D\}^T\{R\} \qquad (1)$$

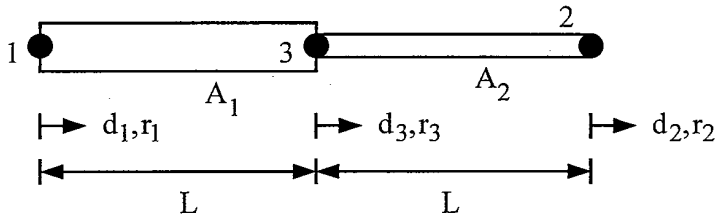
   where {D}, {R} and [K] are the nodal degrees of freedoms, the load vector, the structural stiffness of the entire body. Based on the entire N elements, what are the expressions for {R} and [K]? (5%)

   (d) From Equation (1), use the principal of stationary potential energy to derive the finite element expression for the body. (5%)

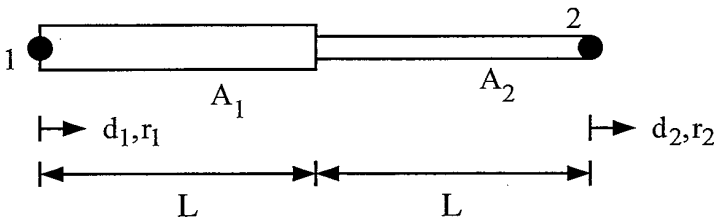
2. (a) What is the parasitic shear? Use the eight-node isoparametric plane element to illustrate the way to avoid it. (7%)

   (b) What is the zero-energy mode (hourglass mode)? Draw a possible zero-energy mode for an eight-node plane element with reduced integration. (8%)

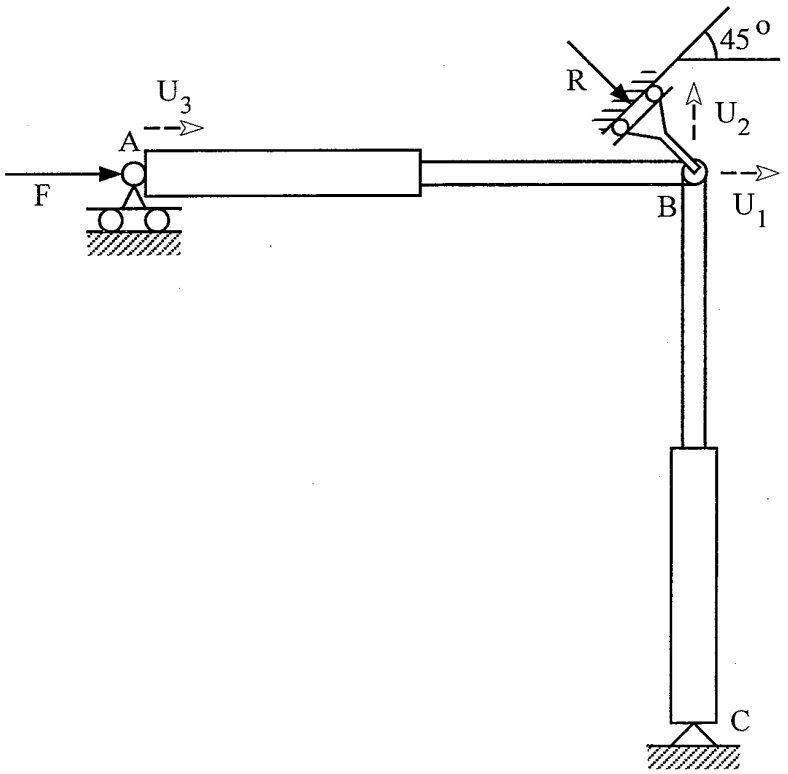
3. (a) Assume L = 10 in, E = 10 ksi, $A_1 = 3$ in$^2$, $A_2 = 2$ in$^2$. Let $d_1$, $d_2$, $d_3$ and $r_1$, $r_2$, $r_3$ be the axial displacements and equivalent axial loads at nodes 1, 2, 3 respectively. Construct the stiffness matrix $[k]_{3\times3}$ for the assembly shown below. (Hint: $k_{11} = 3000$ lb/in) (10%)




(b) Assume $r_3 = 0$. Obtain the substructure stiffness $[k']_{2\times2}$ for a single assembly shown below by condensing out the middle displacement $d_3$ in (a). (Hint: $k'_{11} = 1200$ lb/in) (5%)

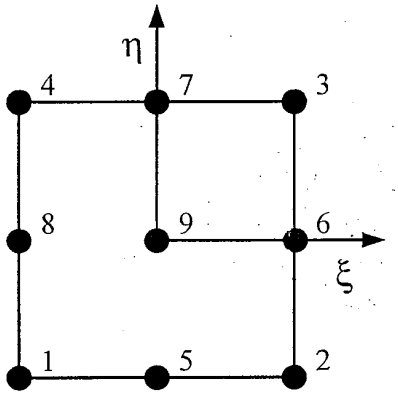



(c) Use the substructure stiffness in (b) to form the global stiffness matrix $[K]_{3\times3}$ for the structure ABC shown below. Members AB and BC have the same dimensions and material property as those in (b). Please note that there is a skew roller support at node B. (10%)

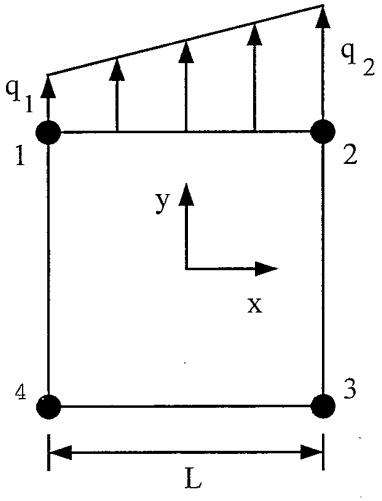



(d) In (c), if the horizontal displacement of node A is $U_3 = 0.1$ in, calculate the displacements $U_1$ and $U_2$ of node B, the magnitude of force F applied at A, and the reaction R at the skew roller support. (10%)

4. What are the shape functions $N_1$, $N_5$, $N_9$ for the nine-node Lagrange element shown below in the natural coordinates $(\xi,\eta)$? Make a sketch for each shape function. (15%)




5. A linearly varying distributed load acts normal to an edge of a four-node plane element. Calculate the consistent (or equivalent) nodal loads at nodes 1 and 2 in y direction. (15%)



# 2001年土木研究所博士資格考試 岩石力学試題 (2001, 3)

一、解釋名詞 (30%)

(1) 走向与傾斜 (Strike and Dip)

(2) 脆延性転換圧力 (Brittle-to-Ductile Transition Pressure)

(3) 崩解耐久性指数 (Slake Durability Index)

(4) 剛性試験机 (Stiff Testing Machine)

(5) RQD (Rock Quality Designation)

二. 請說明 RMR (Rock Mass Rating) 之内容及応用情形。(20%)

三. 請說明如何利用水力破裂法 (Hydraulic Fracturing) 来求得岩盤的現地応力。此法有何限制 (Limitation)? (10%)

四. 請說明如何求得具有節理面的岩石試体之破壞準則。(Failure Criterion) (20%)

五. 有一岩盤具有二組節理面 A. B, 其狀態如下表所示: (20%)

| 節理 | 走向 | 傾斜 |
|---|---|---|
| A | N80°W | 40°SW |
| B | N10°E | 40°NW |

① 請絵出此二組節理的下半球投影, 並絵出極点

② 此二組節理所構成之楔型塊, 若産生滑動, 則其滑動方向為何?

**National Cheng Kung University**

**Department of Civil Engineering**

Pavement Engineering, Qualifying Examination, Spring, 2001

Open books and notes

1. (15%)

An asphalt aggregate mixture contains 34% coarse aggregate and 66% fine aggregate and 6% asphalt by dry weight of aggregate. The specific gravities of materials are as follow: (a) coarse aggregate = 2.62, (b) fine aggregate = 2.71, (c) asphalt = 1.00. The bulk density of the compacted asphalt mixture is 2.30 g/cm$^3$. Please determine

(1) air void content in the compacted asphalt mixture,

(2) voids in mineral aggregate,

(3) percent voids filled with asphalt.

2. (15%)

You obtain the following traffic data on an existing highway. Please use the load equivalence factor (LEF) of a flexible pavement with $P_t = 2.5$ and SN = 4.

(1) You are asked to finish the following table and calculate the equivalent single axle load (ESAL) value.

(2) Based upon the above information, please determine the truck factor.

(3) Using the above truck factor, you have to determine the ESAL value for a new highway. You have the following information: two-way daily traffic $ADT_0$ = 20,000 for the first year, average initial truck factor = 1.5, 12% truck, 2% annual growth for truck factor, 3% annual growth factor for truck volume, 80% directional distribution, 50% lane distribution, and a 20-year design period.

| Axle Type | Truck Number | Weight, kips | Axle Number | LEF | ESAL |
|---|---|---|---|---|---|
| Single | | 6 | 2000 | | |
| Single | | 12 | 1500 | | |
| Single | | 22 | 1200 | | |
| Single | | 26 | 1500 | | |
| Tandem | | 34 | 1200 | | |
| Tandem | | 38 | 2500 | | |
| Tandem | | 42 | 1500 | | |
| Tandem | | 44 | 1200 | | |
| Total | 10,000 | | | | |

3. (35%)

A flexible pavement for an urban highway is designed to carry 2 million ESALs. Related information presented as follows:

- Elastic modulus of asphalt concrete at 20°C (68°F) = 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 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?

4. (35%)

A joint plain concrete pavement (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:

- 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?

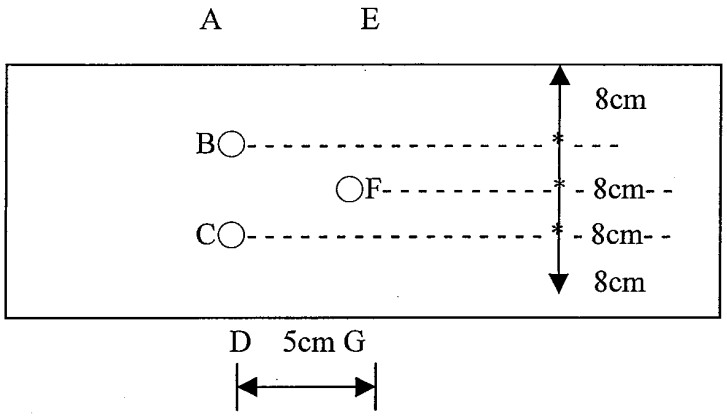
(3) How much thicker would the pavement have to be to handle the same number of ESALs, i.e., 6 million.

(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學系

博士資格考鋼結構學試題〈可看書〉

1. 鈑厚 13mm，採用 $F_y = 2.4^{T}/_{cm^2}$，$F_u = 4^{T}/_{cm^2}$ 之鋼材和19$\phi$ 之螺栓，試決定下圖所示續接鈑之淨斷面積和容許拉力。〈20%〉




2. 利用 AISC 公式，求下圖之容許軸重。

參考資料：〈20%〉

單一槽鋼斷面：

$A = 42.28cm^2$

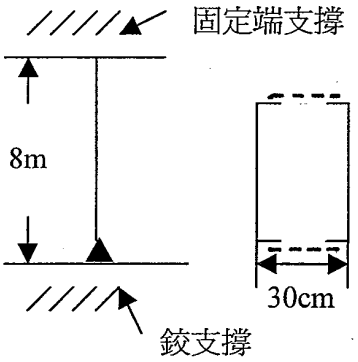
$I_y = 193cm^4$

$r_x = 6.82cm$

$\bar{x} = 2.19cm$

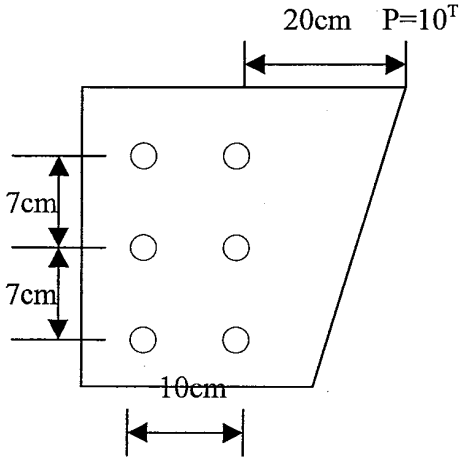
$F_y = 2.4^{T}/_{cm^2}$

$E = 2.04\times10^3\ ^{T}/_{cm^2}$

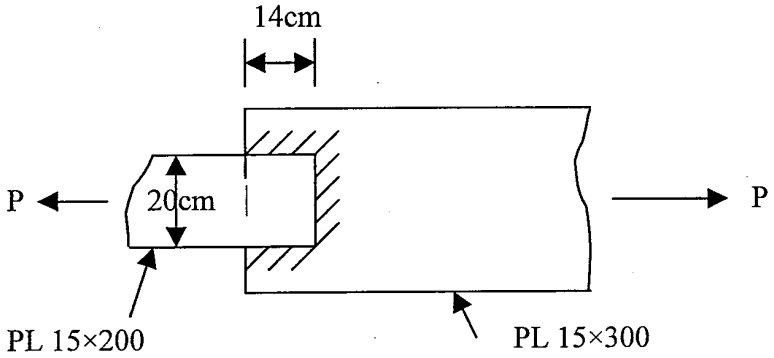



3. $C_c = \sqrt{2\pi^2 E/F_y}$ 是何意義？試導出之。〈20%〉

4. 求下圖所示鉚釘之最大剪力。〈20%〉



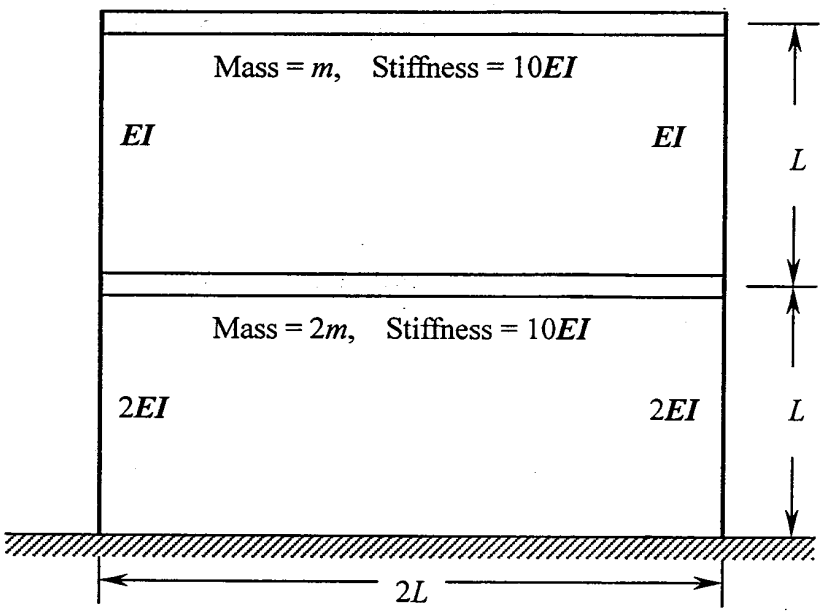
5.如圖之接頭，如採用 E70 之焊條，焊接尺寸 9mm 和 A36 鋼板，試決定容許拉伸荷重。〈20%〉



國立成功大學土木工程研究所八十九學年度結構組博士班資格考試

結構動力學試題　　3/30/2001

1. (30%)如下圖結構物，試建立其自由振動之方程式。請說明你建立數學模型所引用之假設條件。




2. (30%)如上題結構，若受一地震作用，試建立其振動方程式。試說明如何分析在隨機外力作用下之結構振動行為。

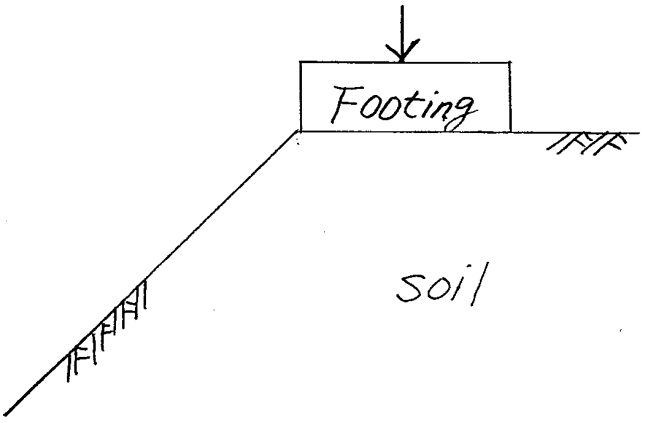
3. (40%)試求出題一結構物之最小自然振動頻率及振態。

博士班資格考試

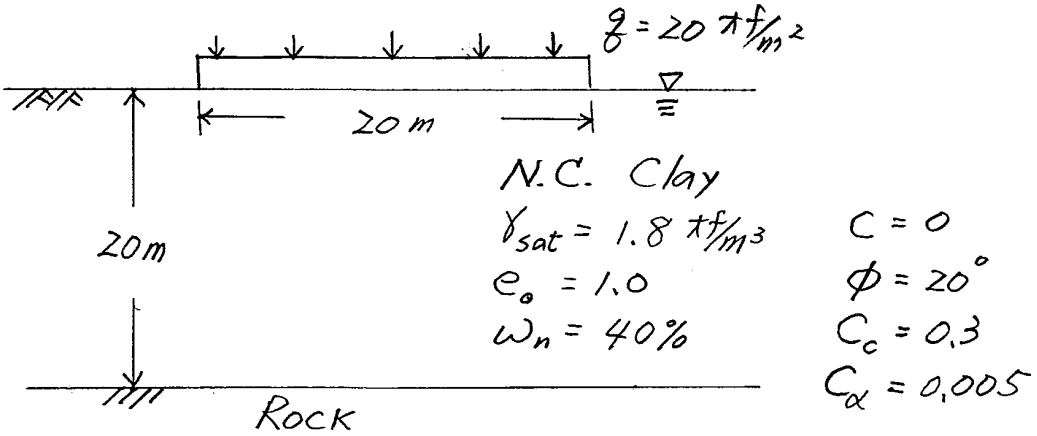
基礎工程，Close-book

※ 注意：條件不足時，自行假設

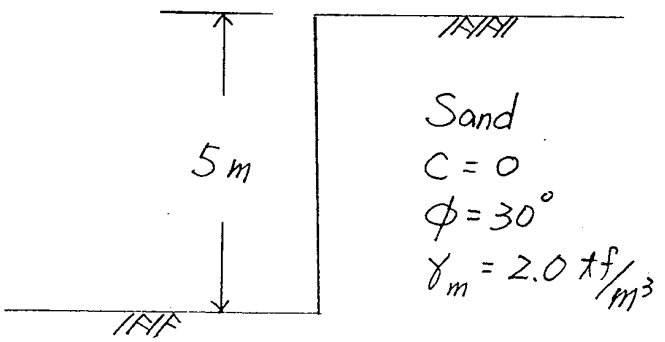
1. 如圖所示，一基腳座落於邊坡上方，承受地震力，請說明其承載力公式，考慮各種必要之修正係數，並敘述其修正的理由。(30 分)




2. 如下圖所示地盤上新建一柔性條形基礎，使用年限預訂爲建造完成後 50 年，試計算可能發生之各種沈陷。(30 分)




3. 如下圖所示之開挖坡面，試建議三種穩定工法，說明其穩定坡面之機制，並對其中一種工法進行穩定分析。(40 分)



# 八十九學年度第二學期博士班資格考試工程地質試題

1.(1)依據 Barton 之建議公式，說明岩石節理面之剪力強度來源。(10%)

(2)如何評估現地岩石節理面之強度？(10%)

2.台灣西部麓山帶平原曾因大地震所引致之主要表面斷層有哪些？主要特徵爲何？(15%)

3.如何從工程地質計量化中之岩體分類法來進行隧道工程的規劃及施作工作？(15%)

4.解釋名詞(15%)

(1)混同層(Melange)

(2)脆展性過度壓力(brittle-to-ductile transition pressure)

(3)岩石變形模數(modulus of deformation)

5.大地應力產生的原因是什麼？目前常用之大地應力量測法有哪些？請詳細說明之。(20%)

6.說明土質隧道與岩質隧道施工時會發生湧水之地質條件及對策？(15%)

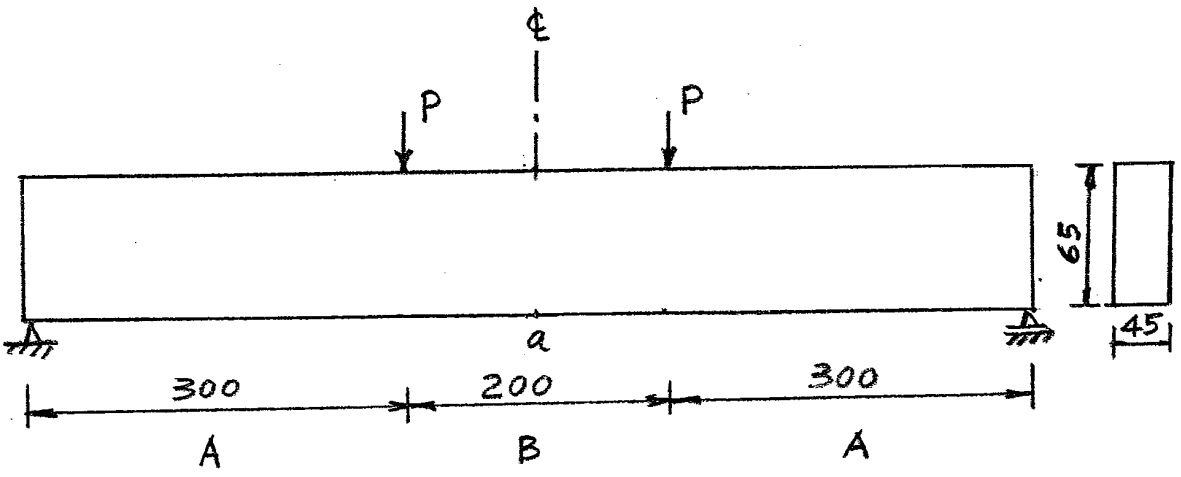
# 鋼筋混凝土構件行爲學 (OPEN BOOK)

1. 試扼要說明圖示鋼筋混凝土梁在產生撓曲及剪力開裂後於 A 區與 B 區之混凝土抗壓應力與抗壓應變關係的同異點。(25%)

2. 試列式說明如何應用 Truss Model 方法進行剪力設計。(25%)

3. 試列式扼要說明如何估算 a 點因靜載重及活載重造成之垂直撓度。(25%)

4. 試列式扼要說明如何評估此梁之撓曲韌性。(25%)




不用進行數字計算　單位: cm

# 國立成功大學 土壤力學博士班(89 下)資格考試題

1. 試寫出 5 點美國 USCS 與 AASHTO 土壤分類系統對土壤分類之相異處。(25%)
2. 如圖所示為在中等緊密之粉土質砂土層開挖狀況，版樁打入土中 6m，水位位於河底上 2.5m 處，開挖底面之水位藉抽水保持與開挖底面齊平，由滲流所產生之流網如圖中所繪，假設此土層之滲透係數 $k=1*10^3$cm/sec，土壤之飽和單位$\gamma_{sat}$為 19KN/m$^3$，試求〈a〉計算每日每單位長流入開挖底面之水量為多少 m$^3$/day〈b〉計算緊鄰版樁水流出口處之水力波降？〈c〉計算位在圖中 A 點之總垂直應力，有效應力及孔隙水壓力？〈d〉版樁外之河水位距河底多高時，開挖底面將發生流砂現象〈quick sand〉？ (28%)
3. 有一正常壓密黏土進行壓密不排水〈CU〉試驗，此土樣首先以圍壓 550kPa 和背水壓力〈back pressure〉240kPa 做同向壓密。壓密完成後，關閉排水閥，將圍壓增至 690 kPa，以檢核試體之飽和度，經檢核，試體完全飽和，此土樣緊接著以圍壓 690 kPa 進行增加軸向壓力直至試體破壞為止。試驗過程發現，土壤在破壞時，主應力差為 186 kPa，總孔隙水壓力為 586 kPa，試求：〈a〉破壞時之最大和最小有效主應力。〈b〉破壞時之有效摩擦角 $\bar{\varphi}$ 〈假設 $\bar{c}=0$〉。〈c〉在土壤受剪前之孔隙水壓力為若干？〈d〉破壞時之孔隙水壓力參數 $\bar{A}_f$=？〈e〉說明〈d〉項計算所得之 $\bar{A}_f$ 是否合理及說明其理由。(25%)
4. 大地工程利用現地取樣進行土壤壓密試驗，先求取土壤之壓密曲線〈即 e~$\bar{\sigma}$ 曲線〉後，並由壓密曲線求取土壤之前期預壓密應力。因此獲取正確之壓密曲線很重要，試繪圖說明在取樣至試驗求取壓密曲線過程中，影響壓密曲線之三個重要因素。(22%)