UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2006/2007

April 2007

EAS 452/3 – REKABENTUK KONKRIT PRA-TEGASAN

Masa : 3 jam

Please check that this examination paper consists of NINE pages of printed material including appendices before you begin the examination.
[Sila pastikan kertas peperiksaan ini mengandungi SEMBILAN muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]

Instructions: Answer **FIVE** (5) questions only. All questions carry the same marks.
*[**Arahan**: Jawab **LIMA** (5) soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question in English except one question should be answered in Bahasa Malaysia.
[Anda dibenarkan menjawab soalan dalam Bahasa Inggeris kecuali satu soalan mestilah dijawab dalam Bahasa Malaysia.]

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. [a] Terangkan dengan ringkas hubungan antara pengecutan dan rayapan konkrit dalam anggota prategasan yang menyebabkan pemendekan dawai-dawai yang ditegangkan serta pengurangan tegasan keluli tegangan-tinggi dan akhirnya mengakibatkan kehilangan tegasan.

(8 markah)

Briefly explain the relationship between shrinkage and creep of concrete in prestressed member which results in a shortening of tensioned wires and reducing the stress in high-tensile steel and hence contributes to the loss of stress.

[b] Sebuah rasuk konkrit prategasan yang mempunyai lebar 200 mm dan kedalaman 300 mm dikenakan daya prategasan dengan dawai (luasnya = 320 mm^2) yang terletak pada kesipian malar 50 mm dan dikenakan tegasan awal 1000 N/mm^2. Panjang rentang rasuk ialah 12 m. Kirakan peratus kehilangan tegasan dawai jika;

(i) rasuk adalah prategangan
(ii) rasuk adalah pascategangan

Gunakan data di bawah dalam pengiraan:

Es	= 210 kN/mm^2
Ec	= 35 kN/mm^2
Santaian dalam tegasan keluli	= 5% daripada tegasan awal
Pengecutan konkrit	= 300 x 10^{-6} (prategangan)
	= 200 x 10^{-6} (pascategangan)
Pekali rayapan	= 1.6
Kegelinciran pada tambatan	= 1 mm
Pekali geseran untuk kesan gelombang	= 0.0015 per m.

(12 markah)

A prestressed concrete beam, 200 mm wide and 300 mm deep, is prestressed with wires (area = 320 mm^2) located at a constant eccentricity of 50 mm and subjected to an initial stress of 1000 N/mm^2. The span of the beam is 12 m. Calculate the percentages loss of stress in wire if;

(i) the beam is pretensioned
(ii) the beam is posttensioned

Use the following data in the calculation:

Es	= *210 kN/mm^2*
Ec	= *35 kN/mm^2*
Relaxation of steel stress	= *5 % of the initial stress*
Shrinkage of concrete	= *300 x 10^{-6} (pretensioning)*
	= *200 x 10^{-6} (posttensioning)*
Creep coefficient	= *1.6 m*
Slip at anchorage	= *1 mm*
Frictional coefficient for wave effect	= *0.0015 per m.*

2. Rasuk prategasan seperti di Rajah 1 ditegangkan dengan daya tendon 1400kN. Anggap ketumpatan konkrit yang digunakan adalah 24kN/m^3.

A prestressed beam as shown in Figure 1 is stressed with a tendon force of 1400kN. Assume the density of concrete is 24kN/m^3.

(i) Kira kesipian maksimum (e) jika tegasan tegangan tidak dibenarkan semasa pindahan. Anggap keratan kritikal berlaku pada bahagian tengah rentang tersebut dan tiada kehilangan prategasan semasa pindahan selepas ditujah.

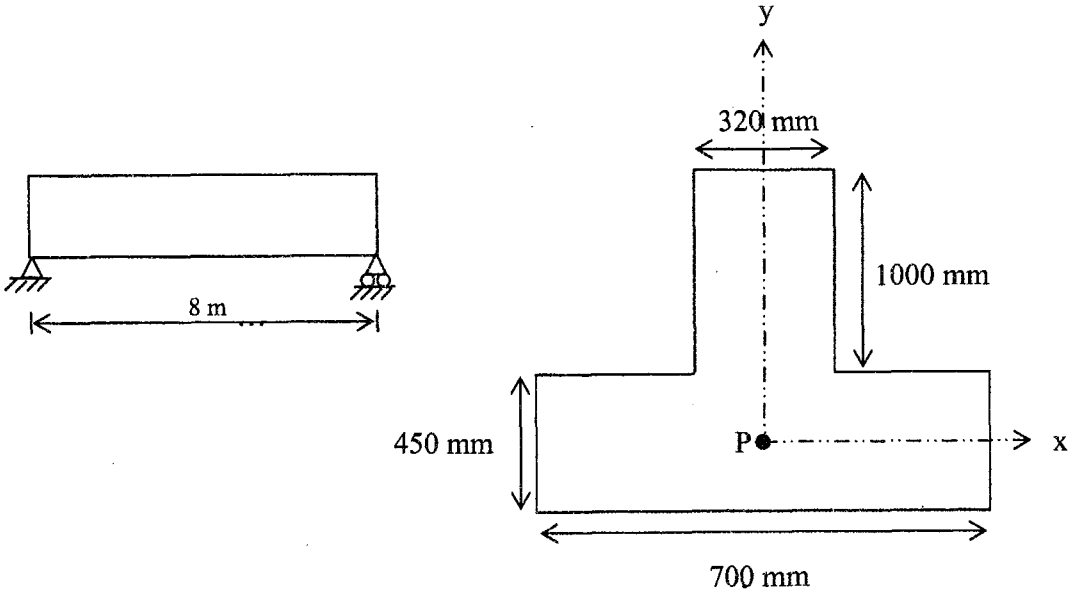
(10 markah)

Calculate the maximum eccentricity (e) if no tensile stress is allowed in concrete at transfer. Assume that the critical section occurs at mid-span of the beam and no loss of prestress at transfer after jacking.

(ii) Jika rasuk tersebut dikenakan beban hidup 20 kN/m dan kehilangan prategasan semasa pindahan adalah 20%, kira tegasan pada serat teratas dan serat terbawah di bawah beban khidmat.

(10 markah)

If the beam is subjected to live load of 20 kN/m and the losses of prestress at transfer is 20%, calculate the stress at extreme top and bottom fibers under service load.



Rajah 1

3. [a] Terangkan secara ringkas perbezaaan antara kaedah **Pascategangan** dan **Prategangan** untuk konkrit prategasan.

(4 markah)

Briefly explain the difference between Post-tensioning and Pre-tensioning methods of prestressed concrete.

[b] Apakah perbezaan antara **Konkrit Prategasan Kelas 1** dan **Konkrit Prategasan Kelas 3** dari segi kelebaran rekahan?

(2 markah)

What is the difference between prestressed concrete Class 1 and prestressed concrete Class 3 in term of crack width?

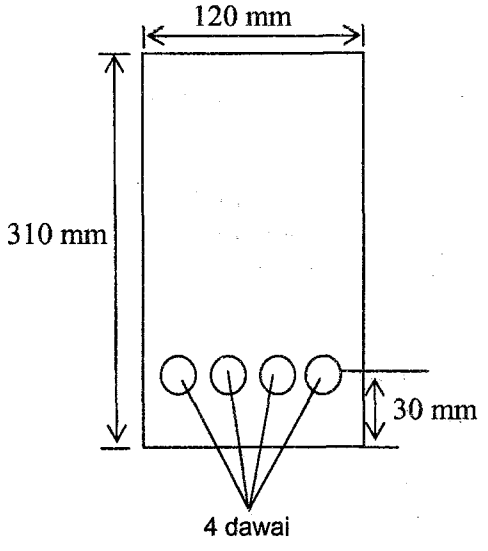
3. [c] Keratan seperti di Rajah 2 ditegangkan oleh 4 bilangan dawai (Rujuk Rajah 2). Setiap dawai mempunyai garis pusat 7 mm. Kekuatan ciri dawai, fpu adalah 1570 N/mm^2. Dawai tersebut pada mulanya ditegangkan sehingga 1100 N/mm^2 dan kehilangan dalam prategasan adalah 30%. Menggunakan **Strain Compatibility method,** tentukan;

(i) Nilai sebenar terikan atas (ε_1) dan terikan bawah (ε_2)
(ii) Terikan disebabkan prategasan (ε_{pe})
(iii) Terikan disebabkan pemendekan elastik (ε_{ce})
(iv) Keterikan disebabkan oleh kedalaman blok tegasan setara (ε_{ct}). Anggap kedalaman blok tegasan setara adalah 125mm
(v) Jumlah terikan dalam tendon keluli pada keadaan had (ε_{pu})
(vi) Rintangan momen muktamad keratan tersebut. Anggap kedalaman blok tegasan setara adalah 125mm

Data asas untuk rekabentuk adalah seperti berikut:

(E_c = 28 kN/mm^2, E_s = 205 kN/mm2, f_{cu} = 40 N/mm^2)

(14 markah)



Rajah 2

3. [c] *The section in Figure 2 is to be stressed by 4 number of wires (Refer to Figure 2), each wire has a diameter of 7 mm. The wires have a characteristic strength, fpu = 1570 N/mm^2. The wires were initially stressed to 1100 N/mm^2 and the losses in prestress is assumed to be 30%. Using* ***Strain Compatibility method,*** *determine;*

(i) Actual value of upper (ε_1) and lower yield strain (ε_2)
(ii) Strain due to prestress (ε_{pe})
(iii) Strain due to elastic shortening (ε_{ce})
(iv) Strain due to the depth of equivalent stress block (ε_{ct}). Assume the depth of equivalent stress block as 125mm
(v) The total strain in steel tendon at ultimate condition (ε_{pu})
(vi) Ultimate moment of resistance of the section. Assume the depth of equivalent stress block as 125mm

The basic design data are as follows:

(Ec = 28 kN/mm^2, Es = 205 kN/mm^2, fcu = 40 N/mm^2)

4. [a] Nyatakan **TIGA (3)** jenis retakan ricih. Lakarkan semua bentuk retakan tersebut.

(5 markah)

State ***THREE (3)*** *types of shear crack. Sketch all the crack patterns.*

[b] Rekabentuk dan perincikan tetulang ricih rasuk pra-tegasan segiempat tepat dengan berpandukan data-data yang diberi. Anggap tegasan berkesan dalam tendon sebagai 60% daripada kekuatan ciri tendon.

Daya ricih keratan, V_L	= 450 kN
Momen pada keratan, M	= 750 kN
Lebar rasuk, *b*	= 300 mm
Kedalaman rasuk, *h*	= 1200 mm
Kedalaman berkesan rasuk, *d*	= 1100 m
Luas keratan rentas tendon, A_{ps}	= 1803 mm^2
Garispusat sesalur	= 100 mm
Luas tetulang pada zon tegangan, A_s	= 1200 mm^2
Kekuatan ciri tendon, f_{pu}	= 1750 N/mm^2
Kesipian susuk tendon dari paksi sentroid,e_s	= 350 mm
Sudut kecondongan tendon, β	= 4^0
Kekuatan ciri konkrit, f_{cu}	= 50 N/mm^2
Kekuatan ciri tetulang ricih, f_{yv}	= 250 N/mm^2
Kekuatan ciri tetulang zon tegangan,f_y	= 460 N/mm^2
M_o	= 0.8 f_{pt} I/y
I	= b d^3 / 12

(15 markah)

4. [b] *Design and provide the shear reinforcement detailing of a rectangular pre-stressed beam by referring to the given data. Assume the effective stress in the tendon as 60 % of the characteristic strength of the tendon.*

Shear force at section, V_L	*= 450 kN*
Moment at section, M	*= 750 kN*
Beam width, b	*= 300 mm*
Beam depth, h	*= 1200 mm*
Beam effective depth, d	*= 1100 m*
Tendon cross sectional area, A_{ps}	*= 1803 mm^2*
Duct diameter	*= 100 mm*
Area of reinforcement in tension zone, A_s	*= 1200 mm^2*
Characteristic strength of tendon, f_{pu}	*= 1750 N/mm^2*
Tendon eccentricity from centroidal axis,e_s	*= 350 mm*
Angle of tendon inclination, β	*= 4^0*
Characteristic strength of concrete, f_{cu}	*= 50 N/mm^2*
Characteristic strength of shear reinforcement, f_{yv}	*= 250 N/mm^2*
Characteristic strength of reinforcement in tension zone, f_y	*= 460 N/mm^2*
M_o	*= 0.8 f_{pt} I/y*
I	*= b d^3 / 12*

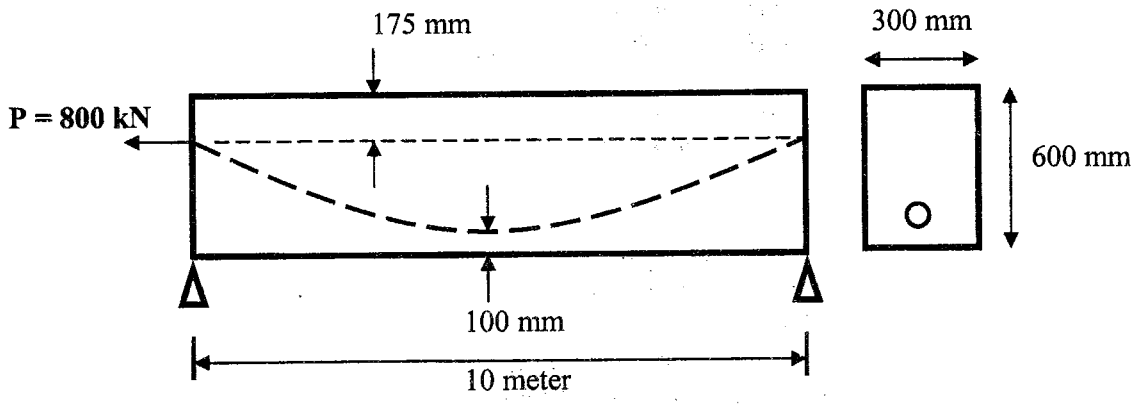
5. [a] Tentukan pesongan bersih untuk rasuk prategasan segiempat tepat yang disebabkan oleh berat diri dan daya tujahan. Gunakan data-data yang diberikan. (Rujuk Rajah 3 dan Lampiran A).

Daya tujahan, *P*	= 800 kN
Modulus Keanjalan Young, *Ec*	= 28 x 10^3 N/mm^2
Ketumpatan konkrit	= 24 kN/m^3

(10 markah)

Calculate the net deflection of a rectangular prestressed beam due to selfweight and jacking force. Use the data given. (Refer to Figure 3 and Appendix A).

Jacking Force, P	*= 800 kN*
Young Modulus of Elasticity, Ec	*= 28 x 10^3 N/mm^2*
Concrete Density	*= 24 kN/m^3*

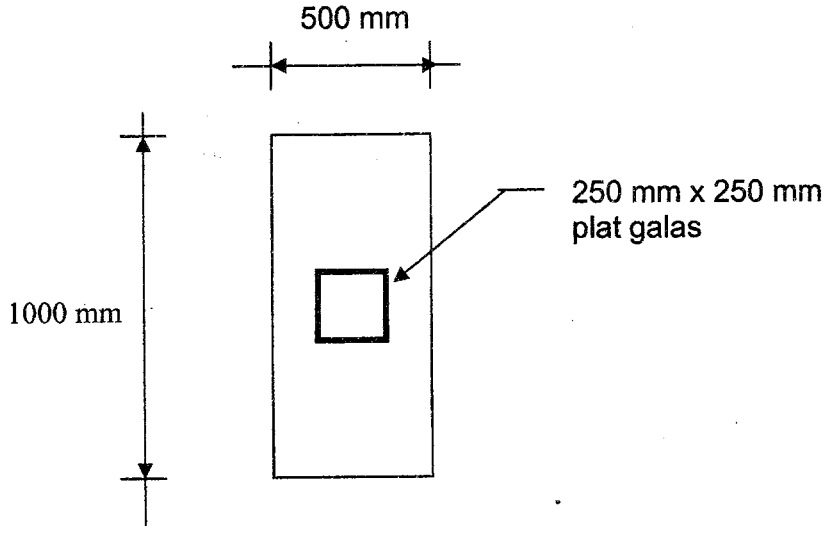


Rajah 3 : Susuk Tendon dan Keratan Rasuk Prategasan

5. [b] Satu rasuk prategasan segiempat tepat mempunyai tendon tunggal ditambat pada **sentroid** blok hujung. Rekabentuk dan lakarkan perincian tetulang blok hujung. Daya prategasan efektif, P_e adalah 2200 kN. (Rujuk Rajah 4).

(10 markah)

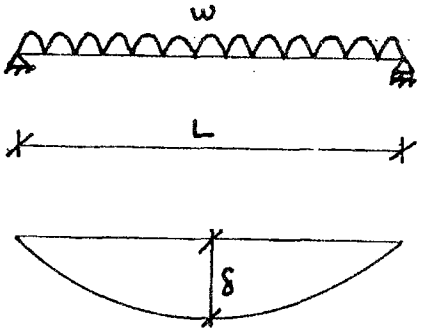
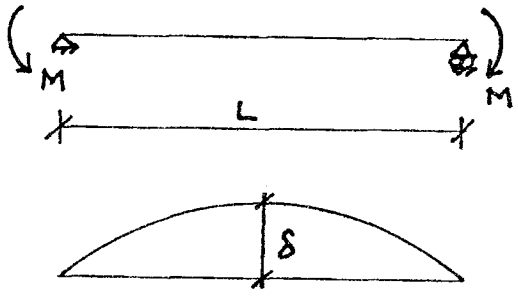
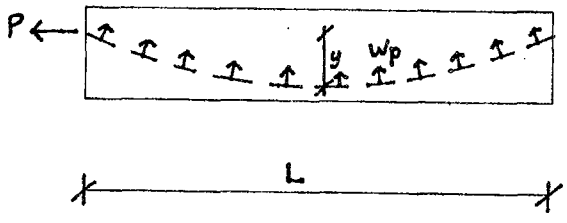
A rectangular prestressed beam with a single tendon is anchored at the centroid of the end block. Design and provide the reinforcement detailing for the end block. Effective prestressing force, P_e is 2200 kN. (Refer to Figure 4).



Rajah 4 : Pandangan Hadapan Blok Hujung

LAMPIRAN A

PERSAMAAN PIAWAI

KES BEBAN	δ
	$\frac{5\ wL^4}{384\ EI}$
	$\frac{ML}{8\ EI}$
	**Wp** $\frac{8\ P\ y}{L^2}$

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