UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2009/2010 Academic Session

April/May 2010

EAS 453/2 – Pre-Stressed Concrete Design

[*Rekabentuk Konkrit Pra-Tegasan*]

Duration : 2 hours
[*Masa : 2 jam*]

Please check that this examination paper consists of **THIRTEEN (13)** pages of printed material including appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **TIGA BELAS (13)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions. All questions carry the same marks. Please attach Appendix A together with answer sheet.

[***Arahan** : Kertas ini mengandungi **LIMA (5)** soalan. Jawab **EMPAT (4)** soalan. Semua soalan membawa jumlah markah yang sama. Sila kepilkan Lampiran A bersama kertas jawapan.*

You may answer the question either in Bahasa Malaysia or English.
[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris*].

All questions **MUST BE** answered on a new page.
[*Semua soalan **MESTILAH** dijawab pada muka surat baru*].

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) Determining the minimum sectional properties is among the earliest step in designing a pre-stress member. Briefly discuss the importance by referring to any of the basic equations.

[5 marks]

(b) A Class 1 grouted post-tensioned beam with rectangular cross section 400 mm x 1200 mm consist of 3300 mm^2 standard strands located 280 mm below the neutral axis. The characteristic strength of the strand is 1700 N/mm^2 and stressed up to 1200 N/mm^2. The concrete grade is C50 with modulus of elasticity taken as 33 kN/mm^2. If the total pre-stress loss is 20%, calculate the ultimate moment of resistance of the beam section. Take $\varepsilon_{cu} = 0.0035$. The tendon stress-strain curve is shown in Appendix A.

[20 marks]

2. A simply supported Class 1 post-tensioned 'I' beam is subjected to a service load and its own selfweight. The total pre-stress loss is taken as 20 % and transfer of pre-stress force is done after 7 days of concrete casting. Determine the pre-stressing force, ***P*** and eccentricity, ***e*** at critical section subject to the following data :-

i.	*fcu* (28 days)	= 50 N/mm^2
ii.	$1/A$	= 2.04 x 10^{-6} mm^{-2}
iii.	$1/Z_t$ $=1/Z_b$	= 8.33 x 10^{-9} mm^{-3}
iv.	$M_{min}/Z_t = M_{min}/Z_b$	= 3.136 N/mm^2
v.	$M_{max}/Z_t = M_{max}/Z_b$	= 9.0 N/mm^2
vi.	Limit of eccentricity	= 600 mm

[25 marks]

3. (a) Briefly discuss the effects of shear in pre-stressed beams?

[5 marks]

(b) For a pre-stressed beam, the maximum shear force is 697.5kN and the bending moment is 3520kNm.

i. Check whether the section is cracked or uncracked.

ii. Design the required shear reinforcement

The characteristics of the section are

Width (b)	= 650 mm
overall depth (h)	= 1500mm
effective depth (d)	= 1310mm
Area of pre-stressing tendon (A_{ps})	= 4650mm^2
f_{pu}	=1770 N/mm^2
f_{pe}	=0.6f_{pu}
f_{cu}	=50 N/mm^2
f_{yv}	=250 N/mm^2
e_s	=560 N/mm^2
β	=3°at section considered
φ_{duct}	=127mm^2

[20 marks]

4. (a) Discuss the **TWO (2)** problems associated with end-block design.

[5 marks]

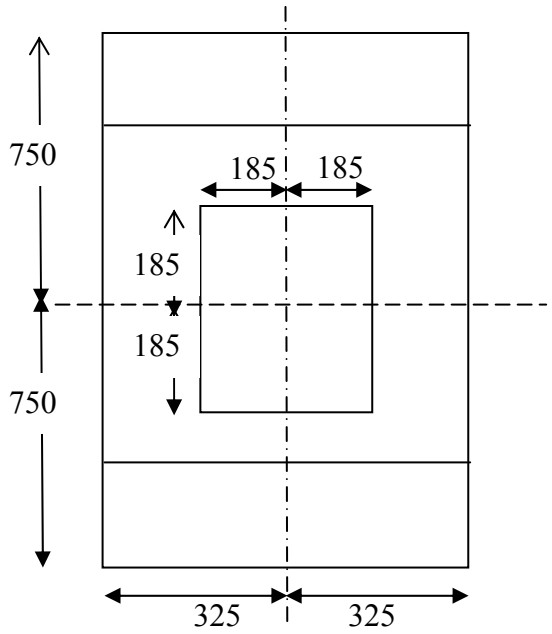
(b) Using the end block of a post tensioned concrete member, discuss the stress distribution for a single anchor plate and a double anchor plate.

[5 marks]

(c) Design the end block design with the following parameters,

Tendon unit	= 6-31
Duct size, φ	= 127mm
Bearing plate size, c	= 370 mm x 370 mm
Anchorage spacing, x	= 600mm
Closed link width, H	= 560mm
Edge distance, X_R	= 320mm
Maximum section width	= 640mm
P_o	= 5, 714kN

The cross section of the beam is shown below



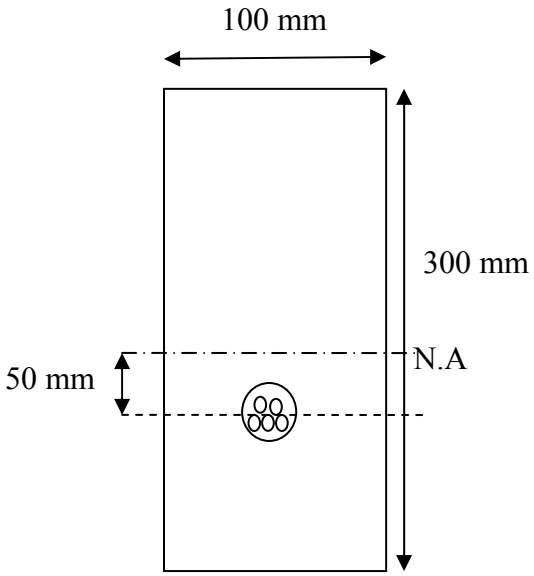
[15 marks]

5. (a) A concrete beam with a cross-section of 100 mm x 300 mm is a post-tensioned with 5 straight wires of 7 mm diameter. The average pre-stressed after short-term losses is 1200 N/mm^2 and the age of loading is given as 28 days. Find out the losses of pre-stressed due to creep. Neglect the weight of the beam in the computation of the stresses. Given:

Modulus of Elasticity of prestressing steel, E_p	=	200 kN/mm^2
Modulus of Elasticity of concrete, E_c	=	35 kN/mm^2
Creep coefficient, θ	=	1.5

[10 marks]

The cross section of the beam is shown below:



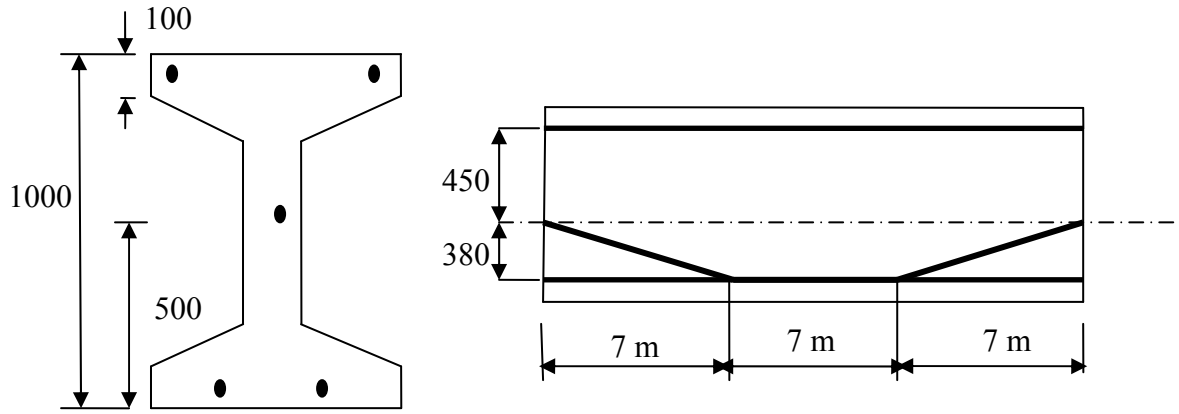
(b) Calculate the short-term deflection at the mid span of the pre-stressed beam due to pre-stressing force, self weight of the beam and the imposed load by neglecting all losses. Given:

Modulus of elasticity of concrete, E_c	=	30 kN/mm^2
Cross sectional area, A	=	4 x 10^5 mm^2
Inertia moment, I	=	6 x 10^{10} mm^4
Total pre-stressed load, P_o	=	3300 kN
Imposed load	=	3 kN/m

Use APPENDIX B as a guideline.

[15 marks]

The cross section of the beam is shown below:



1. (a) *Penentuan ciri-ciri keratan minimum merupakan antara langkah awal merekabentuk anggota pra-tegasan. Bincangkan dengan ringkas kepentingannya dengan merujuk kepada salah satu daripada persamaan asas.*

[5 *markah*]

(b) *Satu rasuk pasca-tegasan Kelas 1 dengan keratan rentas 400 mm x 1200 mm mempunyai 3300 mm^2 lembar piawai yang berada 280 mm di bawah paksi neutral. Kekuatan ciri lembar adalah 1700 N/mm^2 dan dikenakan tegasan sehingga 1200 N/mm^2. Konkrit bergred C50 digunakan dengan modulus keanjalan 33 kN/mm^2. Jika jumlah kehilangan pra-tegasan adalah 20%, kira momen rintangan muktamad keratan rasuk tersebut. Ambil ε_{cu} = 0.0035. Geraf lengkok tegasan-terikan lembar adalah seperti di Lampiran A.*

[*20 markah*]

2. *Satu rasuk pasca-tegasan 'I' tersangga mudah Kelas 1 menanggung beban khidmat dan beban swa-berat. Jumlah keseluruhan kehilangan pra-tegasan adalah 20% dan perpindahan daya para-tegasan dilakukan selepas 7 hari konkrit dituang. Tentukan daya pra-tegasan,* ***P*** *dan kesipian,* ***e*** *pada keratan genting dengan mengambil kira data berikut :-*

i.	*fcu* (28 hari)	= 50 N/mm^2
ii.	$1/A$	= 2.04 x 10^{-6} mm^{-2}
iii.	$1/Z_t$ $=1/Z_b$	= 8.33 x 10^{-9} mm^{-3}
iv.	M_{min}/Z_t $= M_{min}/Z_b$	= 3.136 N/mm^2
v.	M_{max}/Z_t $= M_{max}/Z_b$	= 9.0 N/mm^2
vi.	Had kesipian	= 600 mm

[*25 markah*]

3. (a) *Bincangankan dengan ringkas kesan ricih dalam rasuk pra-tegasan?*

[5 *markah*]

(d) *Untuk sebuah rasuk pra-tegasan, daya ricih maksima adalah 697.5kN dan momen lentur ialah 3520kNm,*

i. *Semak samada keratan tersebut retak atau tidak.*

ii. *Rekabentuk tetulang ricih yang diperlukan*

Ciri-ciri kertan tersebut adalah

Lebar (b)	*= 650 mm*
Kedalaman keseluruhan (h)	*= 1500mm*
Kedalaman efektif (d)	*= 1310mm*
Luas kawasan tendon pra tegasan(A_{ps})	*= 4650mm^2*
f_{pu}	*=1770 N/mm^2*
f_{pe}	*=0.6f_{pu}*
f_{cu}	*=50 N/mm^2*
f_{yv}	*=250 N/mm^2*
e_s	*=560 N/mm^2*
β	*=3° di keratan tersebut*
φ_{duct}	*=127mm^2*

[20 *markah*]

4. (a) *Bincang* ***DUA (2)*** *masalah yang berkaitan dengan rekabentuk blok hujung.*

[5 *markah*]

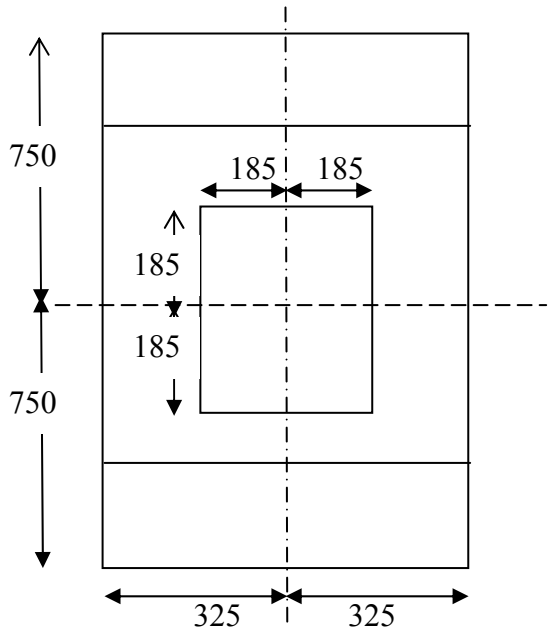
(b) *Dengan menggunakan blok hujung anggota pasca-tegangan, bincangkan agihan tegasan untuk sebuah plat tambatan tunggal dan plat tambatan berkembar.*

[5 *markah*]

(c) *Rekabentuk blok hujung dengan parameter-parameter rekabentuk berikut;*

Unit Tendon	*= 6-31*
Saiz saluran, φ	*= 127mm*
Saiz plat galas, c	*= 370 mm x 370 mm*
Jarak ikatan, x	*= 600mm*
Lebar ikatan tertutup, H	*= 560mm*
Jarak hujung, X_R	*= 320mm*
Lebar keratan maksima	*= 640mm*
P_o	*= 5, 714kN*

Keratan rentas rasuk adalah:



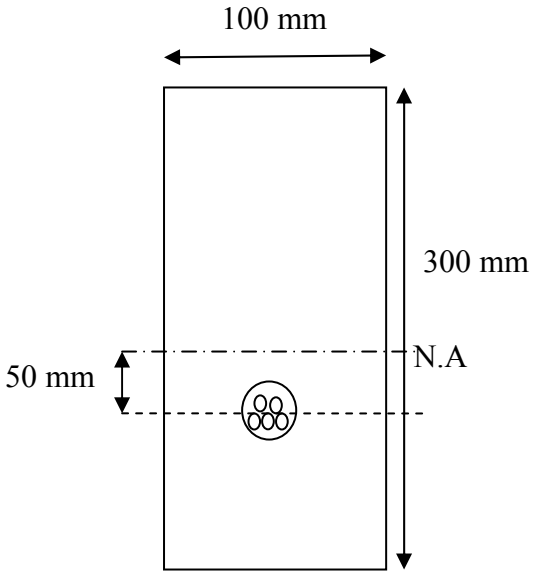
[15 *markah*]

5. (a) *Satu rasuk konkrit pra-tegasan pasca-tegasan dengan keratan rentas 100 mm x 300 mm ditegaskan dengan 5 utas dawai lurus bergaris pusat 7 mm. Purata prategasan selepas kehilangan jangka pendek ialah 1200 N/mm^2 dan tempoh pembebanan ialah 28 hari. Hitungkan kehilangan prategasan disebabkan oleh rayapan. Abaikan berat diri rasuk dalam pengiraan. Diberi:*

Modulus keanjalan besi prategasan, E_s	=	*200 kN/mm^2*
Modulus keanjalan konkrit, E_c	=	*35 kN/mm^2*
Pekali rayap, θ	=	*1.5*

[10 *markah*]

Keratan rentas rasuk adalah seperti yang ditunjukkan dibawah:



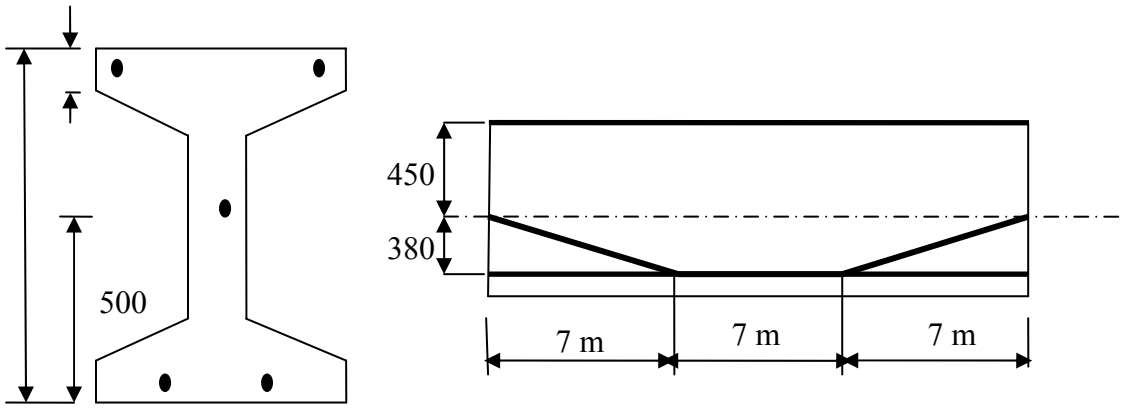
(b) *Hitungkan pesongan jangka pendek di pertengahan rentang rasuk prategasan yang disebabkan oleh daya prategasan, berat diri rasuk dan beban kenaan dengan mengabaikan semua kehilangan. Diberi:*

Modulus keanjalan konrit, E_c	=	*30 kN/mm^2*
Luas keratan rentas, A	=	*4 x 10^3 mm^2*
Momen inersia, I	=	*6 x 10^{10} mm^4*
Jumlah daya prategasan, P_o	=	*3300 kN*
Beban kenaan	=	*3 kN/m*

Gunakan LAMPIRAN B sebagai panduan.

[15 *markah*]

Keratan rentas rasuk adalah sepeti yang ditunjukkan dibawah



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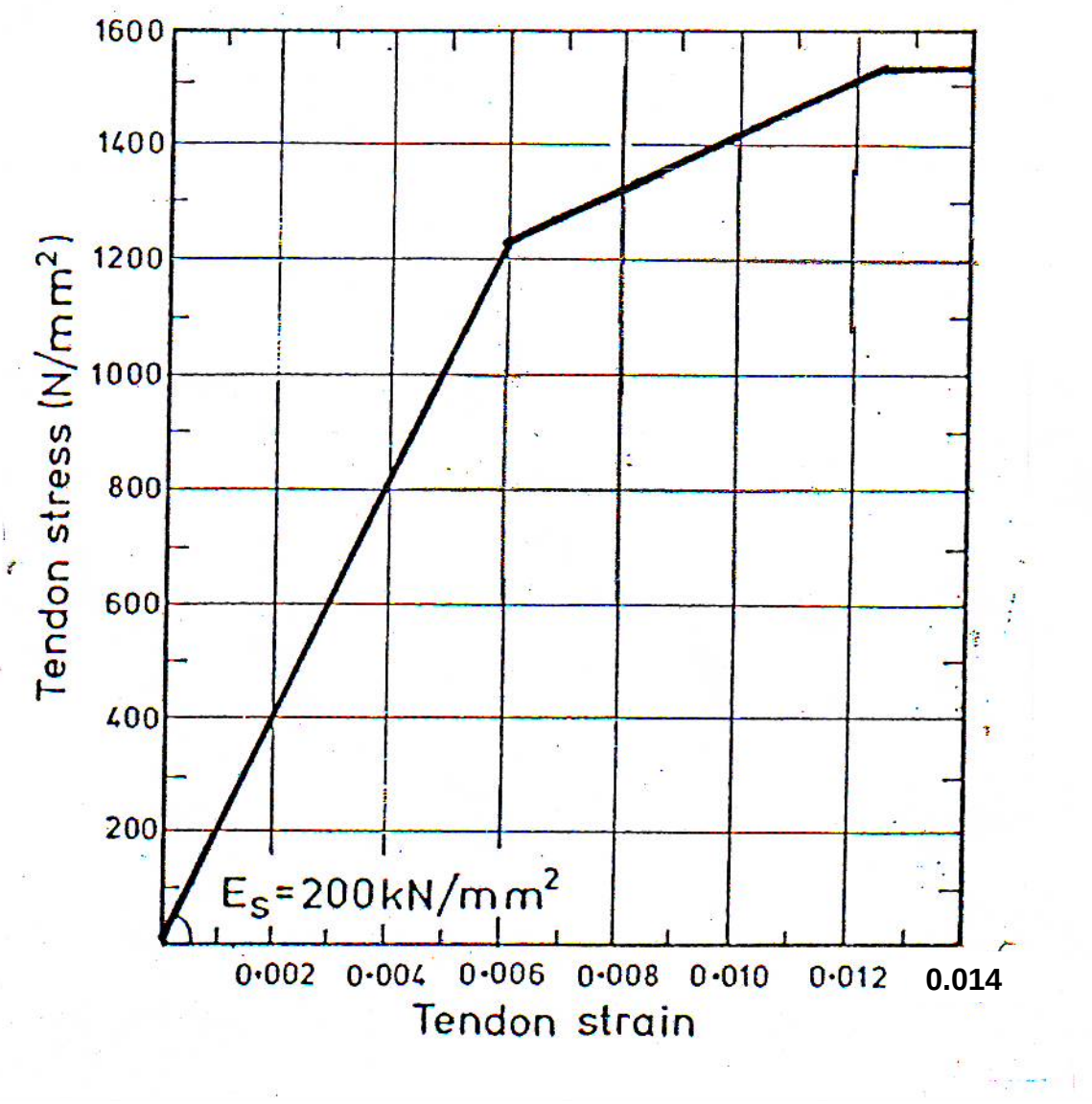
APPENDIX A / *LAMPIRAN A*

Instruction : Please attach Appendix A together with answer sheet

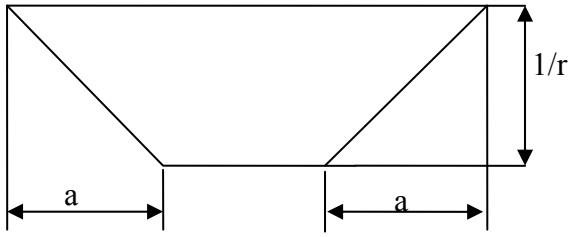
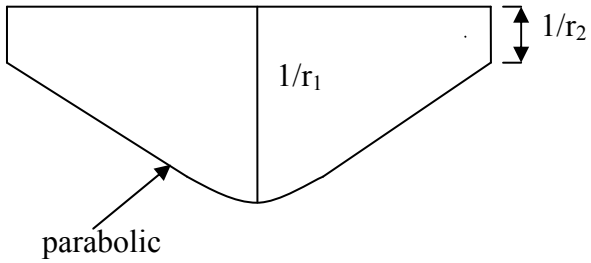
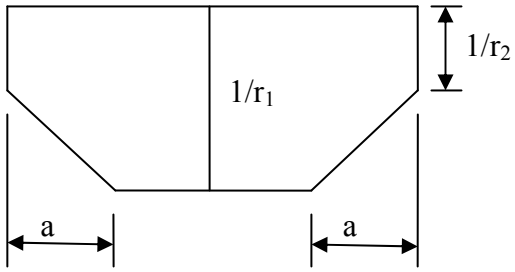
Sila kepilkan Lampiran A bersama kertas jawapan.



Strand stress-strain curve /*Lengkok tegasan-terikan lembar*

APPENDIX B/*LAMPIRAN B*

The relationship between mid span deflection and curvature for simply supported beam.
Hubungan antara pesongan dan kelengkungan untuk rasuk terletak mudah.

Curvature Diagram ***Gambar Rajah Kelengkungan***	**Mid span deflection** ***Pesongan di pertengahan***
	$\frac{L^2}{8}\left[1 - \frac{4}{3}\left(\frac{a}{L}\right)^2\right]\frac{1}{r}$
	$\frac{L^2}{9.6}\left[\frac{1}{r_1} + \frac{1}{5}\left(\frac{1}{r_2}\right)\right]$
	$\frac{L^2}{8}\left[\left\{1 - \frac{4}{3}\left(\frac{a}{L}\right)^2\right\}\left(\frac{1}{r_1}\right) + \frac{4}{3}\left(\frac{a}{L}\right)^2\left(\frac{1}{r_2}\right)\right]$