UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

EAS 254E/3 – Structural Analysis
[Analisis Struktur]

Duration: 3 hours
[Masa : 3 jam]

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

Instructions: Answer **ALL** questions in Part A and any **ONE** (1) question in Part B. All questions carry the same marks.
*[**Arahan**: Jawab **SEMUA** soalan di Bahagian A dan pilih **SATU** (1) soalan di Bahagian B. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or in English or a combination of both languages.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris ataupun kombinasi kedua-dua bahasa.]

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

Part A – Answer All Questions.
(Bahagian A – Jawab Semua Soalan).

1. [a] Explain briefly with the help of suitable sketches, **TWO (2)** disadvantages of statically indeterminate structures when compared to statically determinate ones.

(4 marks)

*Terangkan secara ringkas **DUA (2)** kekurangan struktur tidak-bolehtentu statik berbanding dengan struktur bolehtentu statik dengan bantuan lakaran yang sesuai.*

[b] Figure 1 shows a frame with pin and roller support at A and C, respectively. The frame is subjected to: uniformly distributed loads of 10kN/m along AB, 5kN/m along BD and 2.5kN/m along the vertical member BC. EI for all members of the frame are the same. Compute the vertical deflection at point D. Use method of virtual work.

In order to reduce the vertical deflection at D, a proposal to increase the EI of portion AB to 1.5EI has been made. Re-compute the vertical deflection at D based on the above proposal and comment on the effectiveness of the proposal.

(16 marks)

Rajah 1 menunjukkan satu kerangka dengan penyokong jenis pin pada A dan jenis rola pada C. Kerangka berkenaan dikenakan : beban teragih seragam 10kN/m di sepanjang AB, 5kN/m di sepanjang BD dan 2.5kN/m di sepanjang anggota pugak BC. EI untuk kesemua anggota kerangka adalah sama. Kirakan anjakan pugak titik D dengan menggunakan kaedah kerja maya.

Untuk tujuan mengurangkan anjakan pugak pada titik D, satu cadangan untuk meningkatkan EI bahagian AB kepada 1.5EI telah dibuat. Kira semula anjakan pugak pada D berdasarkan cadangan tersebut di atas dan seterusnya komen tentang keberkesanan cadangan berkenaan.

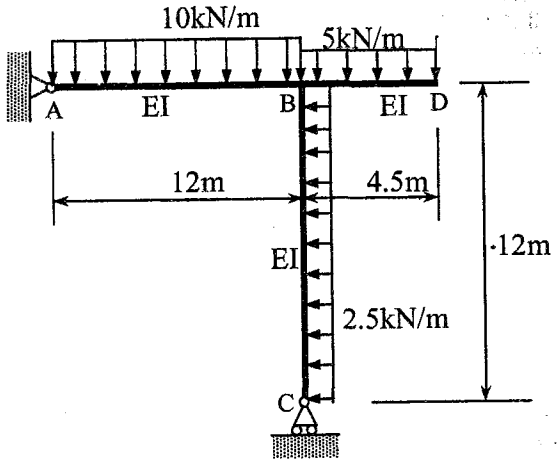


Figure 1

2. [a] Derive the expression for reaction force at A for the propped cantilever beam subjected to a linearly distributed load as shown in Figure 2. Use method of least work.

(6 marks)

Terbitkan persamaan untuk daya tindakbalas pada A untuk rasuk julur tertopang yang dikenakan satu beban teragih secara lelurus seperti yang ditunjukkan dalam Rajah 2. Gunakan kaedah kerja terkurang.

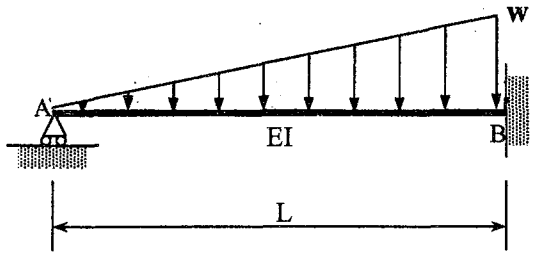


Figure 2

2. [b] Figure 3 shows the construction sequence of a giant triangular pin-jointed truss. At the final stage III, the truss will be pinned at A and roller supported at B and C. The geometry of the truss will remain the same and a vertical load of P = 50kN will act at joint C during all three stages I, II, III.

(i) Compute the change in magnitude of all member forces of the truss in stage III when compared to stage I. EA is constant for all members.

(ii) If EA of member AC is increased by 20%, compute the corresponding change in magnitude of the horizontal reaction force at support C when the truss is at the final stage III compared to stage I.

(14 marks)

Rajah 3 menunjukkan turutan pembinaan satu kekuda segitiga gergasi. Pada peringkat akhir III, kekuda berkenaan akan disokong melalui satu sambungan pin pada A dan sambungan rola pada B dan C. Bentuk kekuda akan kekal sama dan satu beban pugak P = 50kN akan bertindak pada sambungan C semasa ketiga-tiga peringkat I, II, III.

(i) Kirakan perubahan dalam magnitud daya dalam semua anggota kekuda pada peringkat III berbanding dengan peringkat I. EA adalah sama untuk semua anggota.

(ii) Sekiranya EA untuk anggota AC ditambah sebanyak 20%, kirakan perubahan dalam magnitud daya tindakbalas ufuk pada penyokong C untuk kekuda dalam peringkat akhir III berbanding peringkat I .

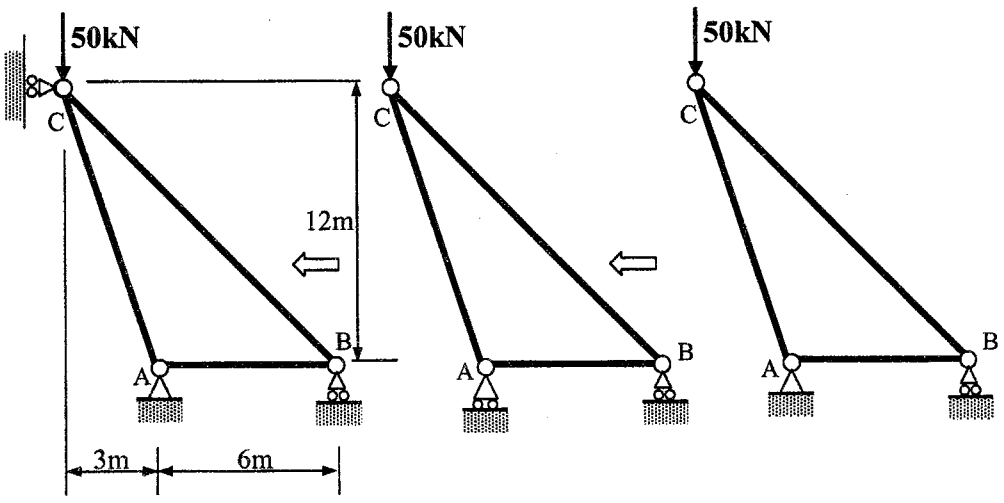


Figure 3

3. Figure 4 shows a beam carrying a uniformly distributed load of 20 kN/m on span AB. Supports A and D are fixed and supports B and C are rollers. The support at C settles vertically by 30 mm. Given the value of E = 200 GPa and value of I = 600 x 10^6 mm^4. Using the Slope Deflection Method, calculate internal moments at the supports of the beam. Subsequently, sketch the deflected shape and bending moment of the frame. Neglect axial deformation. (Fixed end moment formula are given in the APPENDIX)

(20 marks)

Rajah 4 menunjukkan satu rasuk yang membawa beban teragih seragam 20kN/m bertindak di sepanjang rentang AB . Penyokong A dan D adalah jenis tegar dan penyokong B dan C ialah rola. Penyokong C mengalami enapan pugak sebanyak 30mm. Diberi nilai E = 200 GPa dan I = 600 x 10^6 mm^4. Dengan menggunakan Kaedah Cerun Pesongan, kira nilai momen dalaman di setiap penyokong rasuk tersebut. Seterusnya lakarkan bentuk terpesong kerangka tersebut dan rajah momen lentur. Abaikan ubahbentuk paksi. (Formula momen hujung terikat diberi di LAMPIRAN)

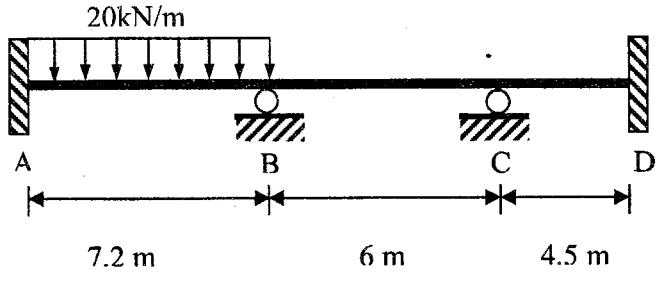


Figure 4

4. Figure 5 shows a frame carrying a uniformly distributed load of 45 kN/m on span BC and a horizontal load of 60 kN at joint B. Support A is fixed and supports E and D are pinned. Assuming that EI is constant, determine the internal moments at the joints of the frame by using the Moment Distribution Method. Subsequently, sketch the deflected shape and bending moment of the frame. (Fixed end moment formula are given in the APPENDIX).

(20 marks)

Rajah 5 menunjukkan satu kerangka yang membawa beban teragih seragam sebanyak 45 kN/m direntang BC dan beban tumpu mengufuk 60 kN di sambungan B. Penyokong A adalah tegar dan penyokong D dan E adalah pin. Anggap nilai EI adalah malar. Kira nilai momen dalaman di setiap sambungan kerangka tersebut menggunakan Kaedah Agihan Momen. Seterusnya lakarkan bentuk pesongan kerangka tersebut dan rajah momen lentur. (Formula momen hujung terikat diberi di LAMPIRAN).

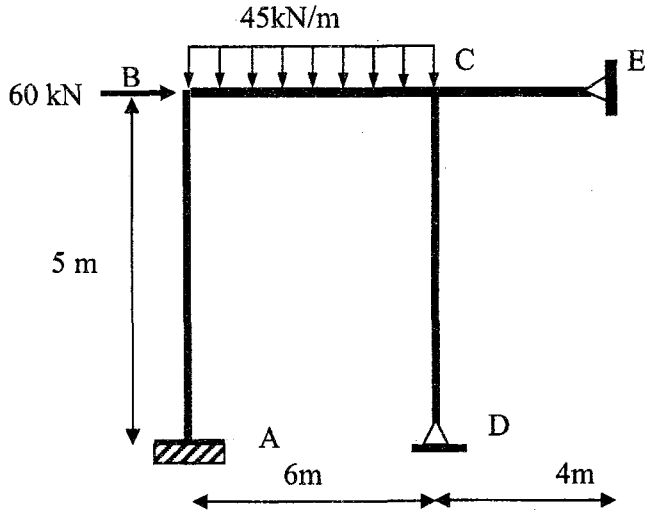


Figure 5

Part B – Answer Any One Question.
(Bahagian B – Jawab Satu Soalan Sahaja.)

5. [a] Determine the vertical deflection of joint C for the truss shown in Figure 6. A = 1100mm^2 and E = 200GPa for all members. Use Castigliano's Second Theorem.

(10 marks)

Tentukan anjakan pugak sambungan C untuk kekuda yang ditunjukkan dalam Rajah 6. A = 1100mm^2 dan E = 200Gpa untuk kesemua anggota. Gunakan Teorem Castigliano Kedua.

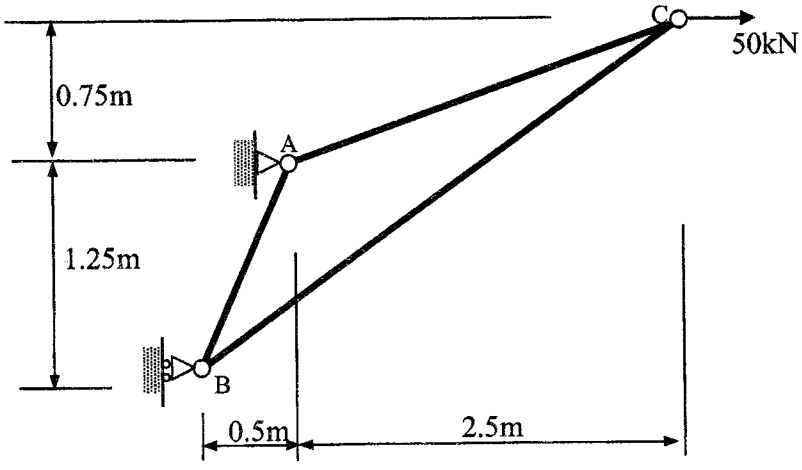


Figure 6

5. [b] For the stepped cantilever beam shown in Figure 7, determine the rotation at point B. Given E = 200GPa and I = 300 x 10^6 mm^4. Use Castigliano's Second Theorem.

(10 marks)

Untuk rasuk julur dengan dua keratan berbeza seperti yang ditunjukkan dalam Rajah 7, tentukan putaran pada titik B. Diberi: E = 200GPa dan I=300 x 10^6 mm^4. Gunakan Teorem Castigliano Kedua.

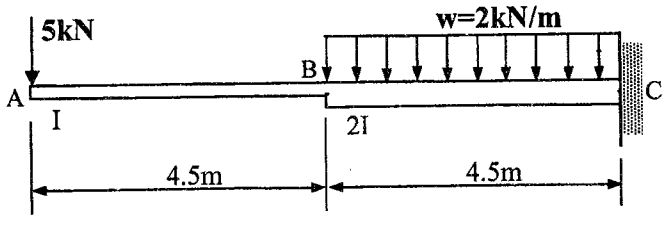


Figure 7

6. [a] Show that the plastic section modulus about x-x for the section shown in Figure 8(a) is given by $Zp = 5tD^2$. Ignore the higher order of t.

(5 marks)

Tunjukkan bahawa modulus keratan plastik di paksi x-x untuk keratan rentas dalam Rajah 8(a) bersamaan dengan $Zp = 5tD^2$. *Abaikan kuasa tertinggi untuk t.*

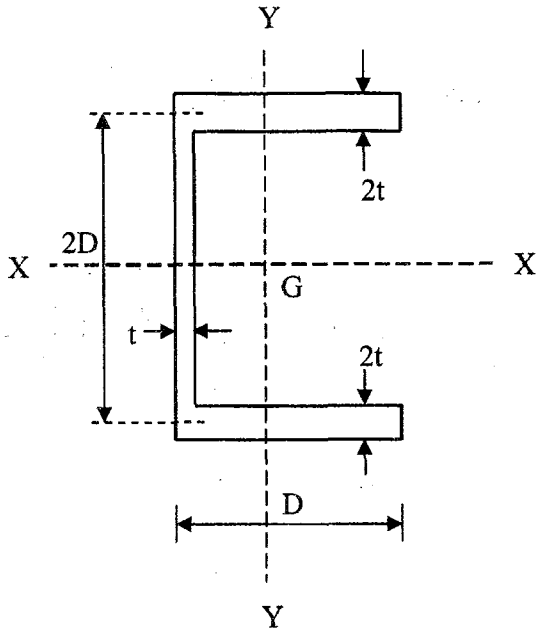


Figure 8(a)

6. [b] A beam spanning 4 m as shown in Figure 8(b) is fixed at both ends. If the uniformly distributed load applied on span AB is 20 kN/m, the load factor, $\lambda_p = 1.7$ and $\sigma y = 250$ N/mm^2 :

i. Determine the value of the bending moment at which the beam will fail in bending.

ii. If the beam section is as shown in Figure 8(a), determine a suitable size for the section.

(5 marks)

Rasuk dalam Rajah 8(b) adalah tegar di kedua hujung dan mempunyai rentang 4m. Sekiranya beban teragih seragam sebanyak 20kN/m dikenakan ke atas rentang AB, faktor beban, $\lambda_p = 1.7$ *dan nilai tegasan* $\sigma y = 250$ N/mm^2*:*

i. Kira nilai momen lentur yang boleh menyebabkan rasuk gagal dalam lenturan.

ii. Sekiranya keratan rentas rasuk adalah seperti yang ditunjukkan dalam Rajah 8(a), tentukan saiz keratan yang sesuai.

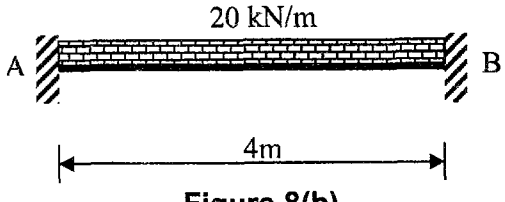


Figure 8(b)

6. [c] Figure 8(c) shows a continuous beam carrying a point load of 36 kN at a distance 6m from support A and uniformly distributed load of 12kN/m on span CD. Find the value of collapse moment, Mp if the load factor , λ_p = 1.7.

(10 marks)

Rajah 8(c) menunjukkan rasuk selanjar yang membawa beban tumpu sebanyak 36 kN pada jarak 6m dari penyokong A dan 12 kN/m sepanjang rentang CD. Kira nilai momen runtuh, Mp sekiranya faktor beban, λ_p = 1.7.

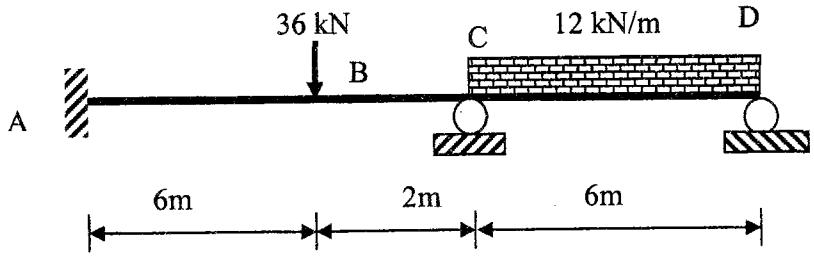
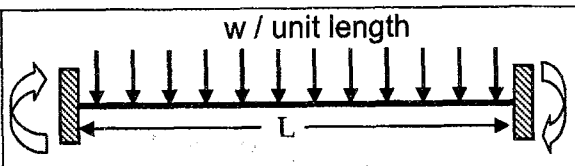
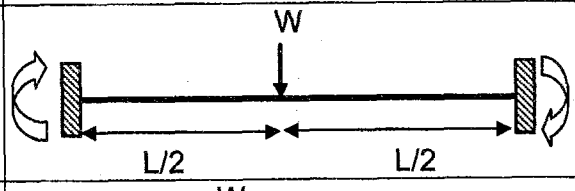
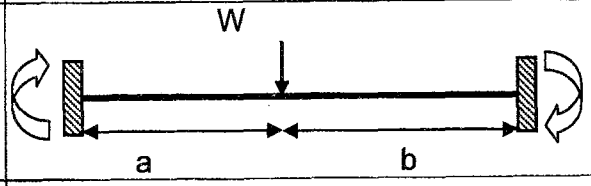
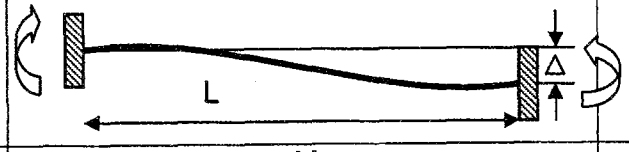
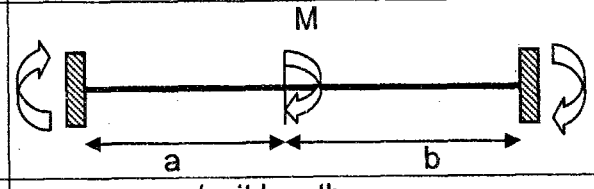
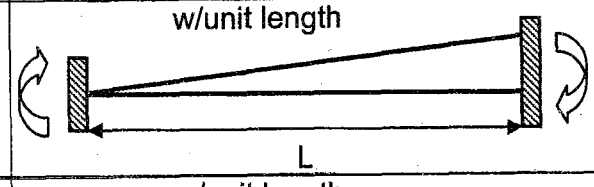
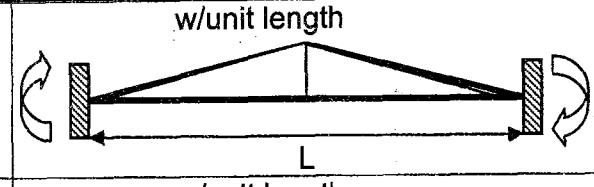
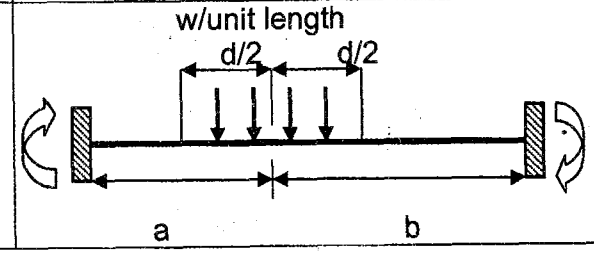


Figure 8(c)

APPENDIX

Fixed End Moment

$-\frac{wL^2}{12}$		$\frac{wL^2}{12}$
$-\frac{WL}{8}$		$\frac{WL}{8}$
$-\frac{Wab^2}{L^2}$		$\frac{Wba^2}{L^2}$
$-\frac{6EI\Delta}{L^2}$		$\frac{6EI\Delta}{L^2}$
$-\frac{Mb(2a-b)}{L^2}$		$\frac{Mb(2b-a)}{L^2}$
$-\frac{wL^2}{30}$		$\frac{wL^2}{20}$
$-\frac{5wL^2}{96}$		$\frac{5wL^2}{96}$
$-\frac{wd}{L^2}\left(ab^2+\frac{(a-2b)d^2}{12}\right)$		$\frac{wd}{L^2}\left(a^2b+\frac{(b-2a)d^2}{12}\right)$

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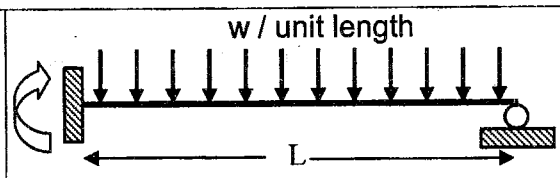
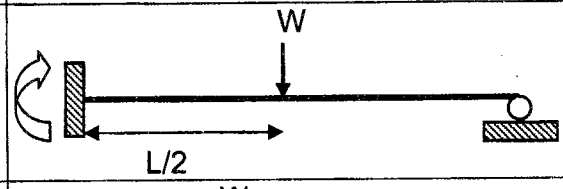
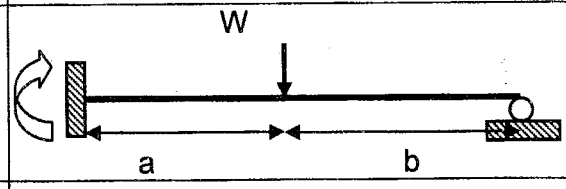
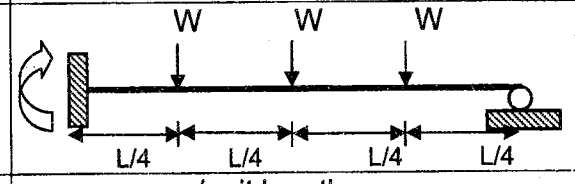
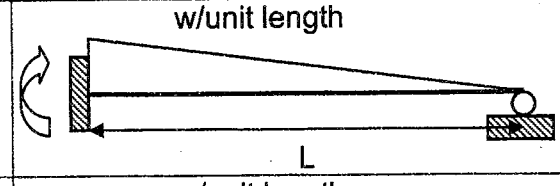
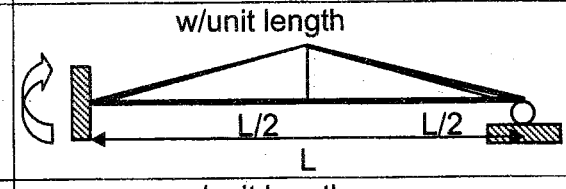
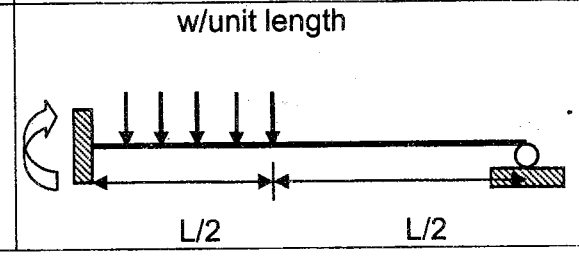
APPENDIX

Fixed End Moment

$-\frac{wL^2}{8}$		
$-\frac{3WL}{16}$		
$-\frac{W}{L^2}\left(b^2a+\frac{a^2b}{12}\right)$		
$-\frac{3EI\Delta}{L^2}$		
$-\frac{45WL}{96}$		
$-\frac{wL^2}{15}$		
$-\frac{5wL^2}{64}$		
$-\frac{9WL}{128}$		

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