



First Semester Examination
2019/2020 Academic Session

December 2019 / January 2020

**EAS253 – Teori Struktur
(Theory of Structures)**

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of **TWELVE (12)** pages of printed material including appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini].*

Instructions: This paper contains **SEVEN (7)** questions. **PART A IS COMPULSORY** and answer **TWO (2)** questions in **PART B**.

[Arahan: Kertas ini mengandungi **TUJUH (7)** soalan. **BAHAGIAN A WAJIB DIJAWAB** dan jawab **DUA (2)** soalan di **BAHAGIAN B**.]

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

PART A: Answer **ALL** questions.

BAHAGIAN A: Jawab **SEMUA** soalan.

- (1). (a). Show that the degree of statical indeterminacy of the frame shown in **Figure 1** is 4.

*Tunjukkan bahawa darjah ketidakbolehtentuan statik untuk kerangka dalam **Rajah 1** adalah 4.*

[2 marks/markah]

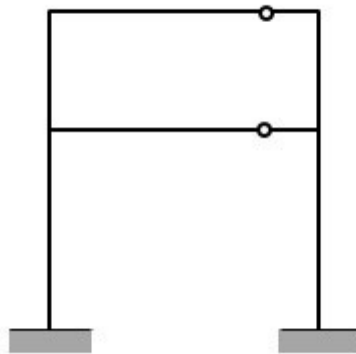


Figure 1/Rajah 1

- (b). **Figure 2** shows a continuous beam with pinned support at A, roller supports at B, D and hinge joint at C. The beam is loaded with a uniformly distributed load 15 kN/m and 25 kN/m along spans AB and BD, respectively; and a concentrated load 5 kN at E. Draw the shear force and bending moment diagrams for the beam. Sketch also the qualitative deflected shape.

***Rajah 2** menunjukkan satu rasuk selangar dengan penyokong pin di A, penyokong rola di B, D dan sambungan engsel di C. Rasuk berkenaan membawa beban teragih seragam 15 kN/m dan 25 kN/m masing-masing di sepanjang rentang AB dan BD; dan satu beban tertumpu 5 kN di E. Lukiskan gambarajah daya ricih dan momen lentur untuk rasuk berkenaan. Lakarkan juga bentuk terpesong kualitatif.*

[18 marks/markah]

...3/-

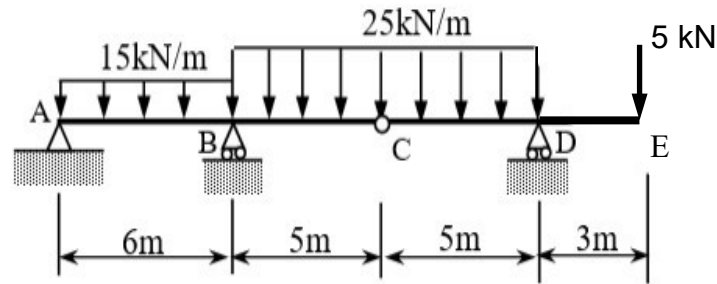


Figure 2/Rajah 2

- (2). (a). The conjugate-beam method is based on the analogy between the relationship among load, shear force and bending moment and the relationships among M/EI , slope and deflection. Explain how to adopt this analogy to construct a conjugate beam.

Kaedah rasuk konjugat adalah berasaskan analogi antara hubungan beban, daya ricih dan momen lentur dengan hubungan M/EI , kecerunan dan pesongan. Jelaskan bagaimana menggunakan analogi ini untuk membina satu rasuk konjugat.

[6 marks/markah]

- (b). A beam as shown in **Figure 3** is subjected to a uniformly distributed load of 5 kN/m on span BC and a concentrated moment of 30 kNm at point A. Point C is the internal hinge. Use $E = 200$ GPa and $I = 250(10^6)$ mm⁴, calculate the slope and deflection at point C of the beam. Use either moment-area method or conjugate-beam method.

*Satu rasuk seperti yang ditunjukkan dalam **Rajah 3** dikenakan beban teragih seragam 5 kN/m sepanjang rentang BC dan momen tertumpu 30 kNm di titik A. Titik C ialah engsel dalaman. Guna $E = 200$ GPa dan $I = 250(10^6)$ mm⁴, kirakan kecerunan dan pesongan di titik C. Guna kaedah momen-luas atau kaedah rasuk konjugat.*

[14 marks/markah]

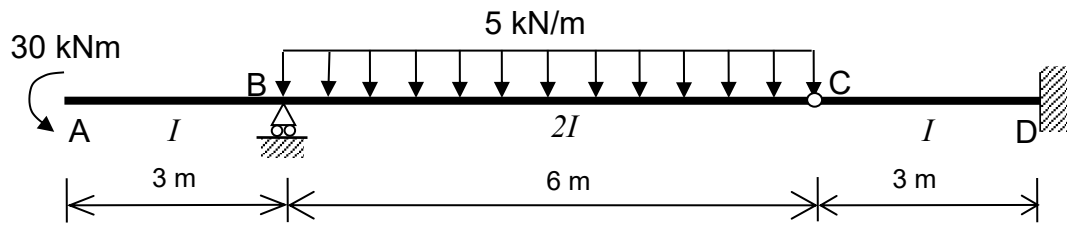


Figure 3/Rajah 3

- (3). (a). **Figure 4** shows a plane truss. Check for the statical determinacy of the trusses. Support C is pinned and support A is roller. All member connections are pinned. Find the reactions at both supports and identify zero force members if any. Determine the forces in members DF, DB and AB by using section method and members CE, CB and EB by using joint method. Classify whether they are in tension or compression.

Rajah 4 menunjukkan satu kekuda satah. Semak kebolehtentuan statik kekuda berkenaan. Penyokong C adalah pin dan penyokong A adalah rola. Semua sambungan anggota adalah pin. Kira nilai daya tindakbalas di kedua-dua penyokong dan kenalpasti anggota kekuda yang mungkin mempunyai daya sifar, sekiranya ada. Kira daya dalam anggota DF, DB and AB menggunakan kaedah keratan dan anggota CE, CB dan EB menggunakan kaedah sambungan. Nyatakan sama ada anggota tersebut mengalami daya mampatan atau tegangan.

[16 marks/markah]

- (b). If the length of all the members in the truss shown in **Figure 4** are double as shown in **Figure 5**, what will be the forces in members CE, CB and EB?

Sekiranya panjang semua anggota kekuda dalam **Rajah 4** diubahsuai menjadi dua kali ganda seperti dalam **Rajah 5**, apakah nilai daya dalam anggota CE, CB dan EB?

[4 marks/markah]

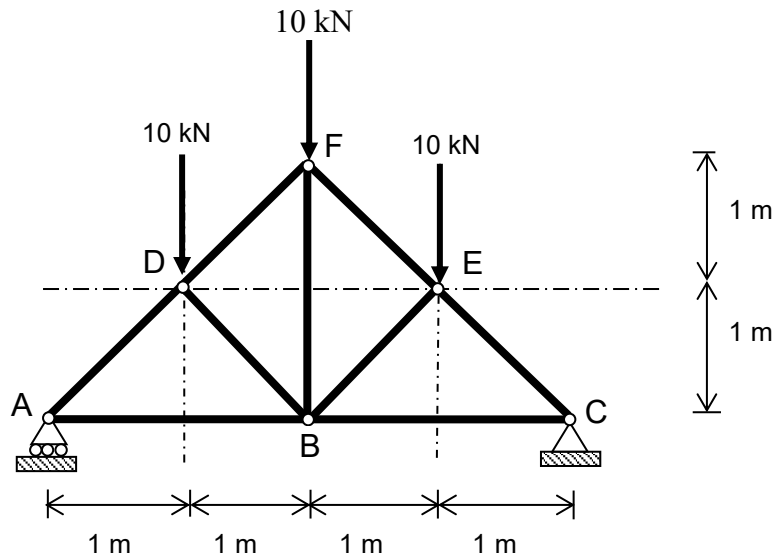


Figure 4/Rajah 4

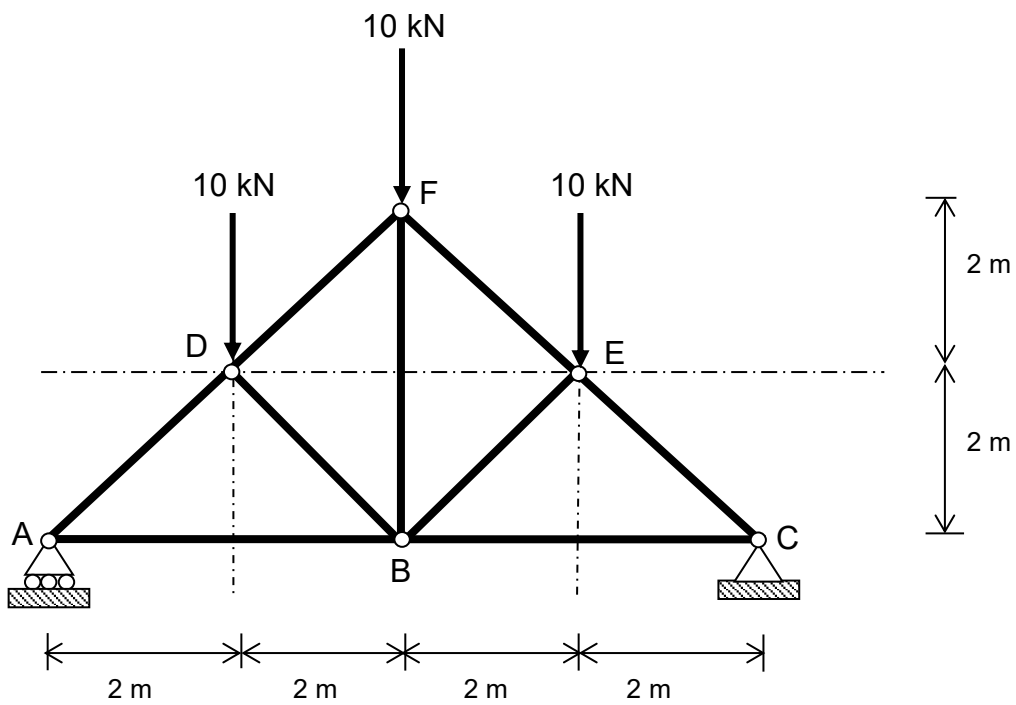


Figure 5/Rajah 5

PART B: Answer **TWO (2)** questions.

BAHAGIAN B: Jawab **DUA (2)** soalan.

- (4). The cable system shown in **Figure 6** carries a uniformly distributed load of 8 kN/m between the supports and two point loads of 40 kN at 10 m away from both supports A and B, respectively. The horizontal distance between supports is 50 m and the vertical distance between the lowest point and the left hand support is 3 m. The right hand support is 6 m higher than the left support. Determine:

*Satu sistem kabel seperti yang ditunjukkan dalam **Rajah 6**, menanggung beban teragih seragam sebanyak 8 kN/m di sepanjang rentang antara kedua-dua penyokong dan dua beban tumpu 40 kN yang berjarak 10 m dari kedua-dua penyokong A dan B, masing-masing. Jarak ufuk antara penyokong ialah 50 m dan jarak menegak dari titik terendah dan penyokong di sebelah kiri ialah 3 m. Penyokong di sebelah kanan berada 6 m lebih tinggi daripada penyokong kiri. Tentukan:*

- (a). the lowest point of the cable (x).
kedudukan titik terendah kabel (x).
- (b). the maximum and minimum tension in cable between A and B (T_{\max} and T_{\min}).
nilai tegangan maksimum dan minimum kabel antara penyokong A dan B (T_{\max} dan T_{\min}).
- (c). the tension in anchor cables (T_A' and T_B').
tegangan kabel sauh (T_A' dan T_B').

- (d). vertical and horizontal reactions at supports (R_{VA} , R_{HA} and R_{VB} , R_{HB}).

tindakbalas menegak dan mengufuk di penyokong (R_{VA} , R_{HA} dan R_{VB} , R_{HB}).

- (e). minimum size of the cable, if the allowable stress is 15500 kN/m^2 .

saiz minimum kabel yang diperlukan sekiranya tegasan kabel dibenarkan ialah 15500 kN/m^2 .

[20 marks/markah]

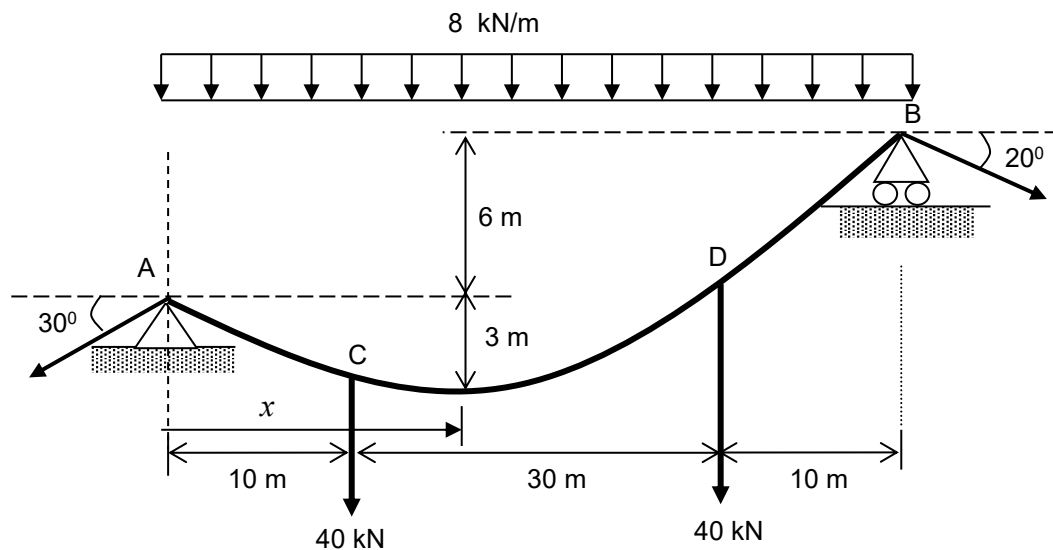


Figure 6/Rajah 6

- (5.) Unsymmetrical three pinned arch shown in **Figure 7** is in the form of

$$y = \frac{4hx(L-x)}{L^2}, \text{ where } L= 40 \text{ m and } h = 8 \text{ m. Support A is } 2.88 \text{ m lower than}$$

support E. It is designed to carry a uniformly distributed load of 8 kN/m on span ABCDE and a point load of 10 kN at D. A horizontal point load of 20 kN is applied at point B. Joints A, C and E are hinges.

...8/-

Gerbang tiga engsel tidak simetri dalam **Rajah 7** dibentuk dari persamaan $y = \frac{4hx(L-x)}{L^2}$, iaitu $L = 40$ m dan $h = 8$ m. Penyokong A berada 2.88 m ke bawah daripada penyokong E. Ia direkabentuk untuk membawa beban teragih seragam sebanyak 8 kN/m di sepanjang rentang ABCDE dan satu beban tumpu di titik D. Beban mengufuk sebanyak 20 kN dikenakan di titik B. Sambungan A, C dan E adalah engsel.

Determine:

Tentukan:

- (a). support reactions at A and E.
daya tindakbalas di penyokong A dan E.
- (b). bending moment at B and D.
momen lentur di titik B dan D.
- (c). shear force, Q and thrust, N at point B and D (with loading).
daya ricih, Q dan daya paksi N di titik B dan D (dengan beban kenaan)
- (d). Sketch the bending moment diagram of the arch.
lakarkan gambarajah momen lentur untuk gerbang tersebut.

[20 marks/markah]

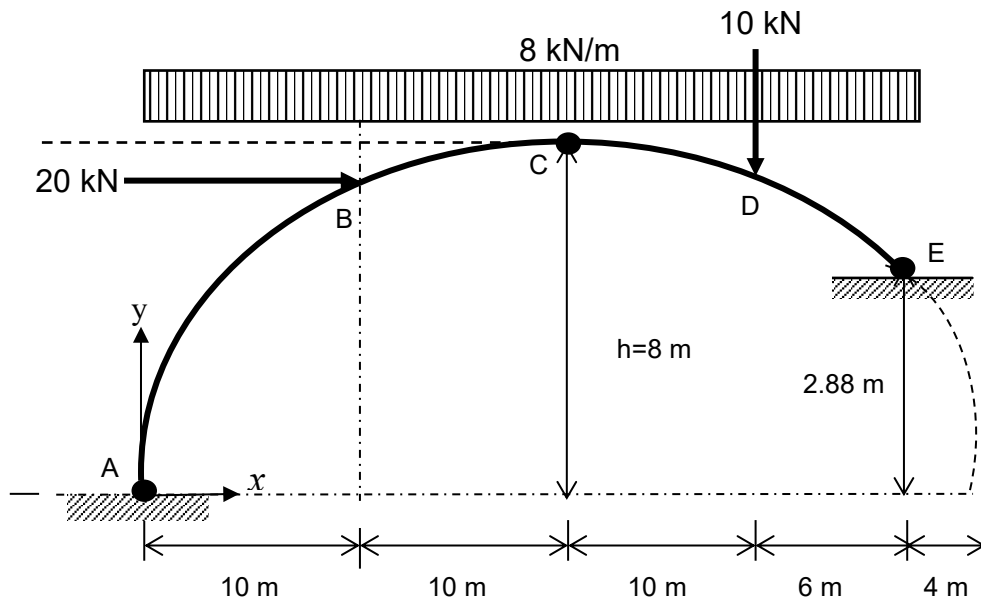


Figure7/Rajah 7

- (6). **Figure 8** shows a frame with pinned and roller supports at A and C, respectively. It is loaded by a horizontal uniformly distributed load 15 kN/m along vertical member AB and a vertical uniformly distributed load 17.5 kN/m along inclined members BC.

Rajah 8 menunjukkan satu kerangka dengan penyokong pin pada A dan penyokong rola pada C. Kerangka berkaitan dibebankan dengan beban teragih seragam ufuk 15 kN/m di sepanjang anggota pugak AB dan beban teragih seragam pugak 17.5 kN/m di sepanjang anggota condong BC.

- (a). Show that the frame is statically determinate.

Tunjukkan bahawa kerangka berkenaan adalah boleh tentu statik.

[2 marks/markah]

...10/-

- (b). Draw the axial force, shear force and bending moment diagrams for the frame. Sketch also the qualitative deflected shape.

Lukiskan gambarajah daya paksi, daya ricih dan momen lentur untuk kerangka berkenaan. Lakarkan juga bentuk terpesong kualitatif.

[18 marks/markah]

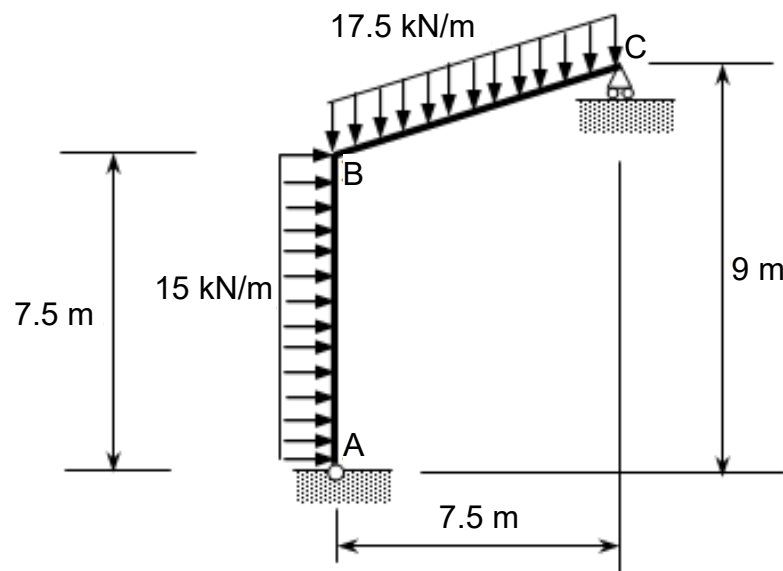


Figure 8/Rajah 8

- (7). (a). **Figure 9** shows a bridge frame which is constructed to allow vehicle to travel on it. Draw the influence lines for

Rajah 9 menunjukkan satu kerangka jambatan yang dibina untuk kenderaan melaluinya. Lukis garis imbas untuk

- (i). the reactions at supports A and E,
tindakbalas di penyokong A dan E,
- (ii). the shear force before and after support C, and
daya ricih sebelum dan selepas penyokong C, dan

...11/-

- (iii) the bending moment at point D.
momen lentur di titik D.

[10 marks/markah]

- (b). Determine the maximum values of the shear force at point C and bending moment at point D due to a truck travels on it.

Tentukan nilai maksimum untuk daya ricih di penyokong C dan momen lentur di titik D disebabkan sebuah lori yang bergerak di atas.

[10 marks/markah]

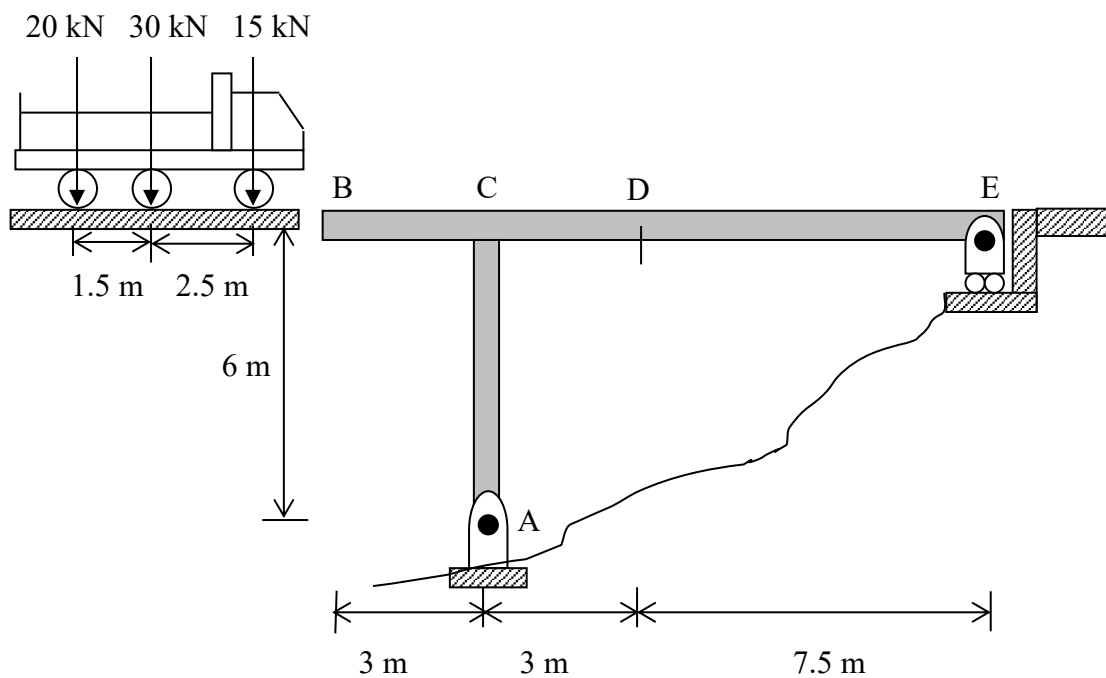
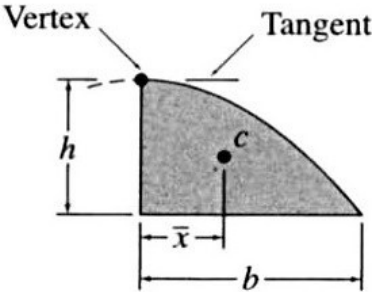
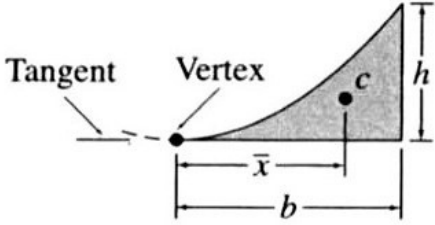
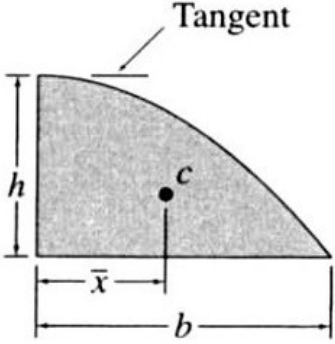
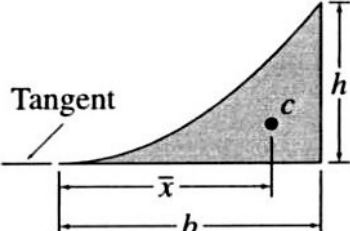


Figure 9/Rajah 9

APPENDIX/LAMPIRAN

Areas and Centroids of Geometric Shapes

| Shape | Area | Centroid |
|--|---------------------|--------------------------|
| <p>Semi-parabola</p>  | $A = \frac{2bh}{3}$ | $\bar{x} = \frac{3b}{8}$ |
| <p>Parabolic spandrel</p>  | $A = \frac{bh}{3}$ | $\bar{x} = \frac{3b}{4}$ |
| <p>Cubic</p>  | $A = \frac{3bh}{4}$ | $\bar{x} = \frac{2b}{5}$ |
| <p>Cubic spandrel</p>  | $A = \frac{bh}{4}$ | $\bar{x} = \frac{4b}{5}$ |