มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

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| การสอบปลายภาคการศึกษา: ประจำภาคการศึกษาที่ 1 | ปีการศึกษา : 2552 |
| วันที่: 3 ตุลาคม 2552 | เวลา : 09.00-12.00 น. |
| วิชา: 220-502 Advanced Mechanics of Solids | ห้อง : R201 |

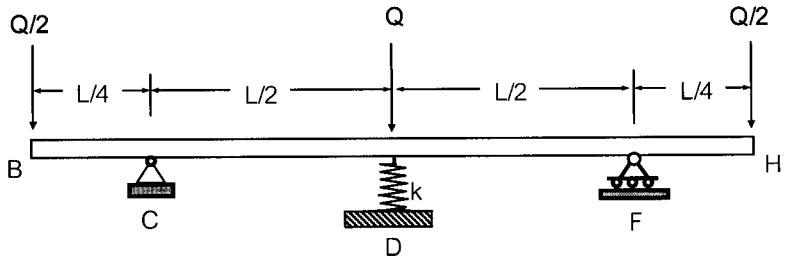
คำอธิบาย

1. ข้อสอบมีจำนวนทั้งหมด 6 ข้อ
2. ให้เลือกทำข้อสอบ 4 ข้อ
3. อนุญาตให้นำเครื่องคิดเลขทุกชนิดเข้าห้องสอบได้ และให้นำตำราเรียน, เอกสารทุกชนิด เข้าห้องสอบได้
4. ไม่ต้องส่งกระดาษทดเลขที่แจกให้คืน

| ข้อ | คะแนนเต็ม | ได้คะแนน |
|---|---|---|
| 1 | 25 | |
| 2 | 25 | |
| 3 | 25 | |
| 4 | 25 | |
| 5 | 25 | |
| 6 | 25 | |
| รวม | | |

ผู้ออกข้อสอบ : บุญ จันทร์ทักษิโณภาส

1. (25 points) A steel I-beam (E = 200000 MPa, depth = 200 mm, $I_x$ = 20.0 x$10^6$ $mm^4$) is subjected to three applied point loads and supported at C, D, F by a pinned support, a spring support and a roller support respectively, as shown below. Determine the displacement of the beam at mid length and the maximum bending stress in the beam, given L = 8000 mm, k = 3.75x$10^5$ N/m, Q = 15000 N.




2. (25 points) A hollow thin-wall steel torsion member (G = 72000 MPa), with cross section shown below in Fig.(a), is subjected to a pure torque T.

(a) If the applied torque T = 12 kN.m, determine the maximum shear stress developed and calculate the unit angle of twist.

(b) Given that the cross section is an open cross section instead of a closed cross section, Fig.(b), determine the permissible value for T if the maximum shear stress must not be greater than 60 MPa. Evaluate also the corresponding unit angle of twist.

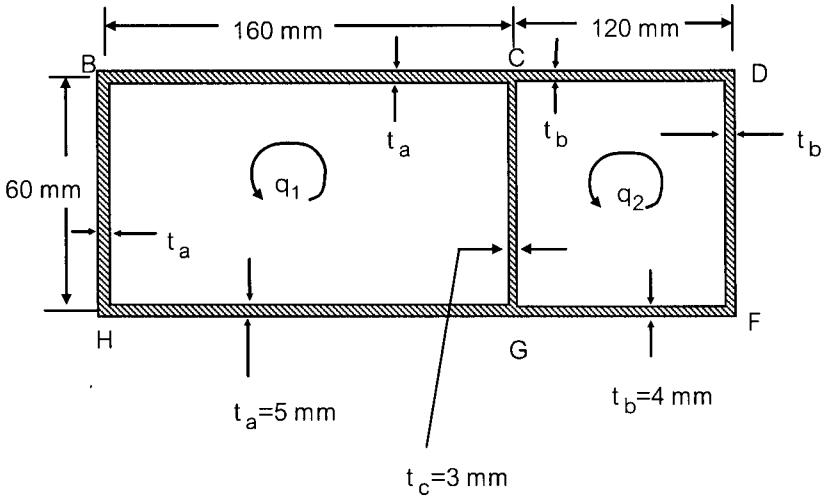



Fig. a

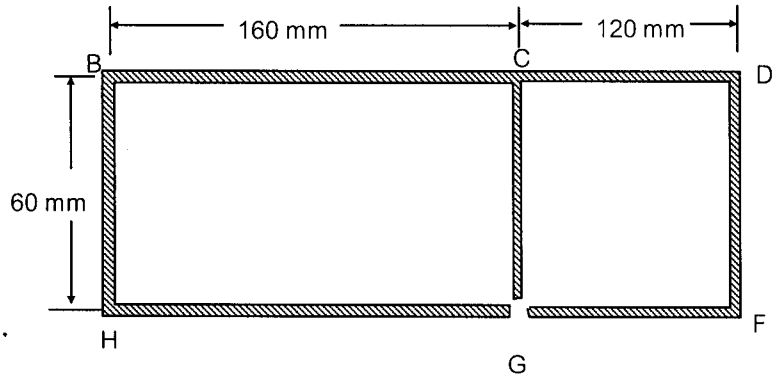



Fig. b

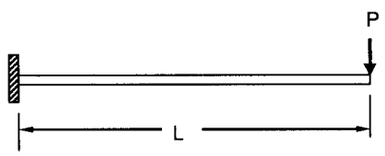
3. (25 points) A steel member (E =200000 MPa) with the cross section shown below is used as a cantilver beam of length L = 2.0 m. The beam is subjected to a point load P = 6.0 kN at the free end passing through the shear centre of the cross-section, and with the direction as shown ($\phi = 60^{\circ}$).

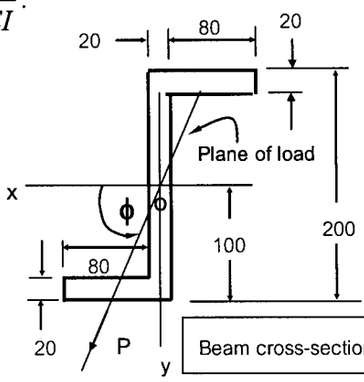
(a) Determine the maximum tensile and compressive stresses in the beam and the deflection at the free end of the beam.

(b) Find a new orientation of the load P such that the beam will have zero horizontal deflection ( ie. zero deflection in the x-direction).

Note : 1. The view shown below is from the free end toward the fixed end of the beam.

2. The deflection at the end of a cantilever beam of length L symmetrically loaded by a point load, Q, at its free end is given by, $\delta = \frac{QL^3}{3EI}$.

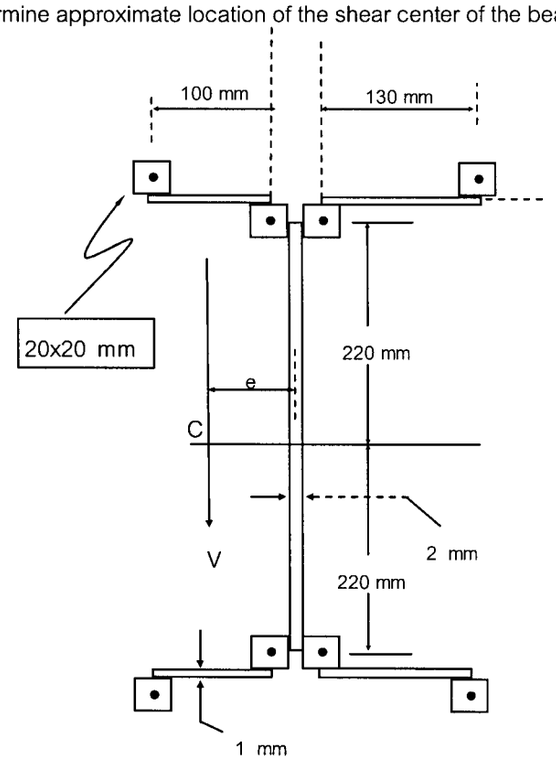


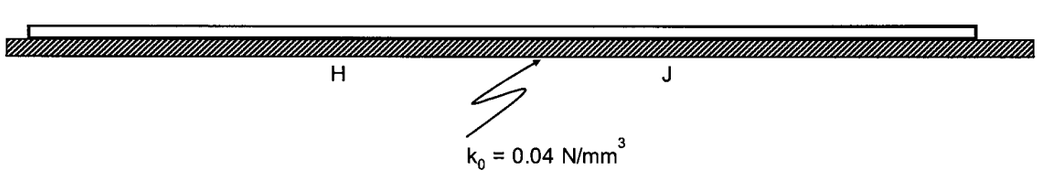




$I_x = 39.36x10^6\ mm^4,$
$I_y = 9.84x10^6\ mm^4,$
$I_{xy} = 14.40x10^6\ mm^4$

Beam cross-section (dimension in mm)

4. (25 points) A composite thin wall beam has symmetrical cross section as shown below. The cross section consists of 2 mm thick vertical web and 1 mm thick flanges welded to 8 square stringers of 20x20 mm cross section. Determine approximate location of the shear center of the beam.



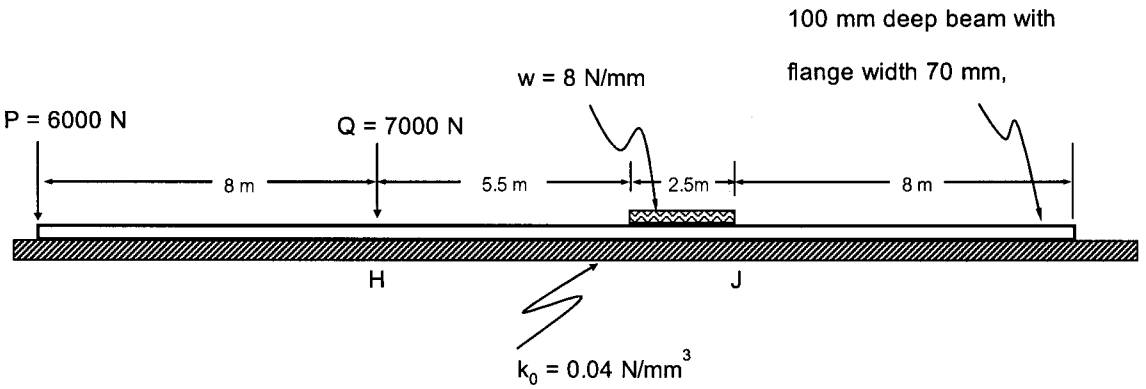

6. (25 points) A closed-end thin wall metal tube has outside diameter 124 mm and inside diameter 116 mm (ie. mean diameter of 120 mm and wall thickness of 4 mm). It is subjected to an internal pressure q = 4 MPa, a bending moment $M_x$ =1.20 kN.m, and an axial external applied load P, as shown below. The material has the following properties. $Y = 320\ MPa,\ E = 200000\ MPa,\ \nu = 0.29$

5. (25 points) A steel I-beam (E = 200000 GPa, depth = 100 mm, flange width b = 70 mm, $I_x = 2.63 \times 10^6\ mm^4$) of 24 m in length, is supported on an elastic foundation for which $k_0 = 0.04\ N/mm^3$. A point load P = 6000 N, and Q =7000 N and a uniformly distributed load of loaded length 2500 mm and intensity w = 8 N/mm is applied to the beam as shown below.

(a) Determine the maximum deflection of the beam.

(b) Determine the maximum bending stress in the beam.

(c ) If the point load Q is a moving load which can traverse the middle third of the beam (ie. can move from H to J), determine the maximum deflection and the maximum bending stress in the beam.




6. (25 points) A closed-end thin wall metal tube has outside diameter 124 mm and inside diameter 116 mm (ie. mean diameter of 120 mm and wall thickness of 4 mm). It is subjected to an internal pressure q = 4 MPa, a bending moment $M_x$ =1.20 kN.m, and an axial external applied load P, as shown below. The material has the following properties, $Y = 320\ MPa,\ E = 200000\ MPa,\ \nu = 0.29$.

(a) Determine the maximum allowable value of the axial load P based on the maximum shear stress criterion of failure, using a safety factor SF = 2.00.

(b) If it is found out later that the tube is occasionally subjected to an additional bending moment $M_y$ = 1.30 kN.m, determine the new value of available safety factor, use the value of external applied load P determined previously in (a).