Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: **Theory of Structures (2)**
Course Code : **CIV 202**

Academic Year : **2014-2015**
Semester : **Second**
Level : **2nd**
Time : **1½ Hours**
Date : **29 / 3 / 2015**
Examiner: ***Dr. M. Abdel-Kader***

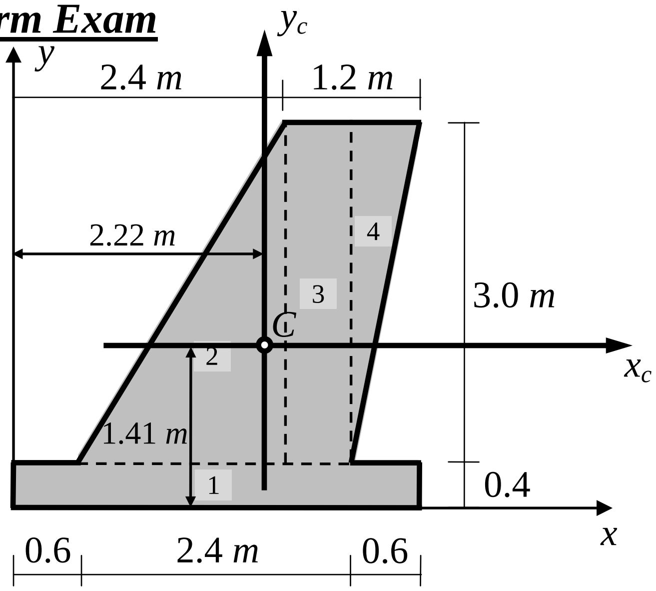
Solution of Mid-Term Exam

Question (1): (12 Marks)

For the shown cross-section, determine the following:

(a) The location of the centroid ($\bar{x}$, $\bar{y}$).

(b) The moments of inertia about the centroidal axes (I_{xc}, I_{yc}).



Solution:

$A = 3.6\times0.4 + 0.5\times3\times1.8 + 3\times0.6 + 0.5\times3\times0.6$

$= \boxed{6.84\ m^2}$

$S_y = \sum A_i x_i = (3.6\times0.4)(1.8) + (0.5\times3\times1.8)(1.8) + (3\times0.6)(2.7) + (0.5\times3\times0.6)(3.2) = \boxed{15.192\ m^3}$

$S_x = \sum A_i y_i = (3.6\times0.4)(0.2) + (0.5\times3\times1.8)(1.4) + (3\times0.6)(1.9) + (0.5\times3\times0.6)(2.4) = \boxed{9.648\ m^3}$

$\bar{x} = \sum A_i x_i / A = 15.192 / 6.84 = \boxed{2.22\ m}$

$\bar{y} = \sum A_i y_i / A = 9.648 / 6.84 = \boxed{1.41\ m}$

$I_{xc} = [3.6\times0.4^3/12 + (1.44)(0.2-1.41)^2] + [1.8\times3^3/36 + (2.7)(1.4-1.41)^2]$
$+ [0.6\times3^3/12 + (1.8)(1.9-1.41)^2] + [0.6\times3^3/36 + (0.9)(2.4-1.41)^2] = \boxed{6.592044\ m^4}$

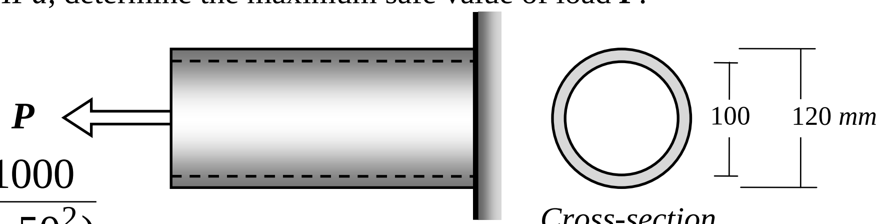
$I_{yc} = [0.4\times3.6^3/12 + (1.44)(1.8-2.22)^2] + [3\times1.8^3/36 + (2.7)(1.8-2.22)^2]$
$+ [3\times0.6^3/12 + (1.8)(2.7-2.22)^2] + [3\times0.6^3/36 + (0.9)(3.2-2.22)^2] = \boxed{4.122576\ m^4}$

Question (2): (8 Marks)

A hollow steel tube with an inside diameter of 100 *mm* and outside diameter of 120 *mm* carries a tensile load ***P*** as shown in the figure.

(a) Determine the normal stress in the tube if the load ***P*** =300 *kN*.

(b) If the allowable stress of steel is 120 *MPa*, determine the maximum safe value of load ***P***.



Cross-section

Solution:

(a) Normal stress, $\sigma = \dfrac{P}{A} = \dfrac{300\times1000}{\pi(60^2-50^2)}$

$= 86.8\ N/mm^2 = \boxed{86.8\ MPa}$

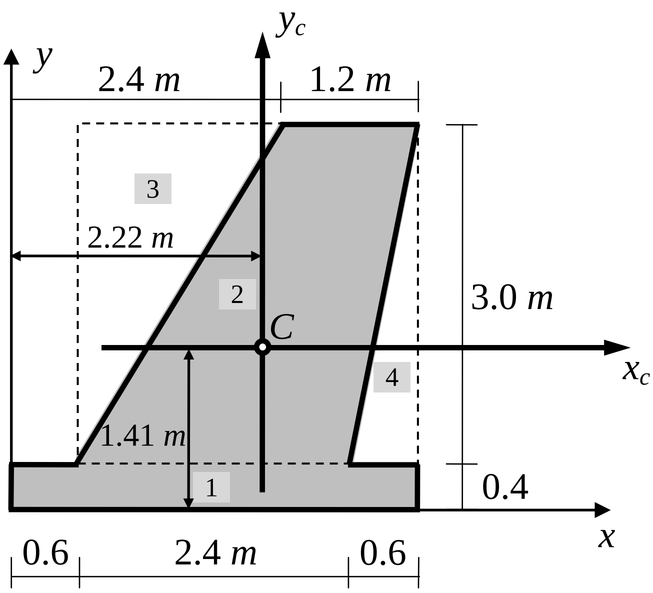
(b) Allowable stress, $\sigma_{all} = \dfrac{P_{max}}{A} \rightarrow 120 = \dfrac{P_{max}}{\pi(60^2-50^2)} \rightarrow P_{max} = 414690\ N = \boxed{414.69\ kN}$

Question (1): (12 Marks)

For the shown cross-section, determine the following:

(a) The location of the centroid ($\bar{x}$, $\bar{y}$).

(b) The moments of inertia about the centroidal axes (I_{xc}, I_{yc}).



Solution:

$A = 3.6\times0.4 + 3\times3 - 0.5\times3\times1.8 - 0.5\times3\times0.6$

$= \boxed{6.84\ m^2}$

$S_y = \sum A_i x_i = (3.6\times0.4)(1.8) + (3\times3)(2.1) - (0.5\times3\times1.8)(1.2) - (0.5\times3\times0.6)(3.4) = \boxed{15.192\ m^3}$

$S_x = \sum A_i y_i = (3.6\times0.4)(0.2) + (3\times3)(1.9) - (0.5\times3\times1.8)(2.4) - (0.5\times3\times0.6)(1.4) = \boxed{9.648\ m^3}$

$\bar{x} = \sum A_i x_i / A = 15.192 / 6.84 = \boxed{2.22\ m}$

$\bar{y} = \sum A_i y_i / A = 9.648 / 6.84 = \boxed{1.41\ m}$

$I_{xc} = [3.6\times0.4^3/12 + (1.44)(0.2-1.41)^2] + [3\times3^3/12 + (9)(1.9-1.41)^2]$

$\quad - [1.8\times3^3/36 + (2.7)(2.4-1.41)^2] - [0.6\times3^3/36 + (0.9)(1.4-1.41)^2] = \boxed{6.592044\ m^4}$

$I_{yc} = [0.4\times3.6^3/12 + (1.44)(1.8-2.22)^2] + [3\times3^3/12 + (9)(2.1-2.22)^2]$

$\quad - [3\times1.8^3/36 + (2.7)(1.2-2.22)^2] - [3\times0.6^3/36 + (0.9)(3.4-2.22)^2] = \boxed{4.122576\ m^4}$

With my best wishes

Dr. M. Abdel-Kader