GLASGOW CALEDONIAN UNIVERSITY

School of Engineering & Built Environment

ENGINEERING DESIGN & ANALYSIS 2 (M2H721926) – Buckling

Tutorial:– Euler Buckling Theory

Where applicable, verify in each case that Euler Theory is satisfied.

1. What is the critical load for an I-section pin-ended strut of length 3.0 m if it has second moments of area of $I_x = 95\times10^6\,mm^4$ and $I_y = 31\times10^6\,mm^4$?. The modulus of elasticity is 200 GN/m^2. **(6.8MN)**

2. What is the critical load for a rectangular section bar 40 mm by 50 mm and length 3.0 m when it is pinned at both ends and subject to axial compressive forces? The modulus of elasticity is 200 GN/m^2. **(59kN)**

3. What is the critical load for a universal section of length 5.0 m when used as a pin-ended strut if the section has second moments of area of $I_x = 299\times10^6\,mm^4$ and $I_y = 98\times10^6\,mm^4$? The modulus of elasticity is 200 GN/m^2. **(7.74MN)**

4. What is the critical load for a strut of length 2.0m and 20mm in diameter when both ends are fixed? The material has a modulus of elasticity of 200 GN/m^2. **(15.5kN)**

5. A steel column is an I-section with a length of 6.0m and second moments of area of $387\times10^6\,mm^4$ and $125\times10^6\,mm^4$. The steel has a modulus of elasticity of 200 GN/m^2. What is the critical load when **(a)** both ends are pinned, **(b)** both ends are fixed, (c) one end is fixed and the other free, **(d)** one end is fixed and the other pinned? **(a: 6.25MN; b: 27.42MN; c: 1.71MN; d: 14.03MN)**

6. A steel compression structural member of length 6 m has the fabricated cross-section as shown in Figure Q6. Given that one end of the member is pinned and the other is fixed, and that the elastic modulus for the structural member material is 203 GN/m^2, calculate the load factor for the column if the maximum working load is 300 kN.

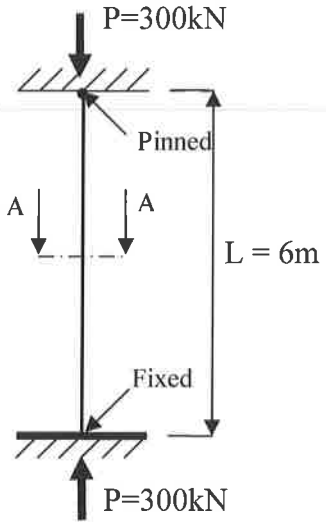
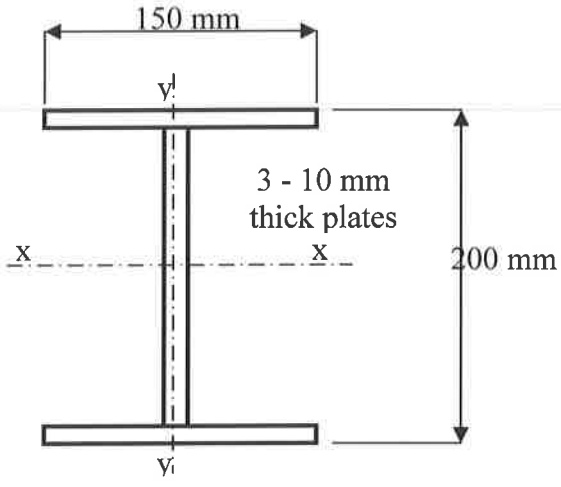


Figure Q6



Section A-A – Fabricated I-Section

7. A steel hollow structural member of length 4.75 m has a hollow round cross-section of 100 mm outside diameter and 10 mm wall thickness. During service, the member is pinned at both ends and is subjected to pure axial compressive loading. The maximum axial compressive loading that the member could be subjected to is 150 kN.

i) Show that Euler theory can be used in the design of the member.
ii) Calculate the load factor based on Euler theory.

8. An 8 m long column is constructed from two 400 mm x 250 mm I-section joists as shown in Figure Q8 below. One end of the column is arranged to be fixed and the other end free. Determine the critical Euler buckling load and the buckling stress.
(1.79MN)

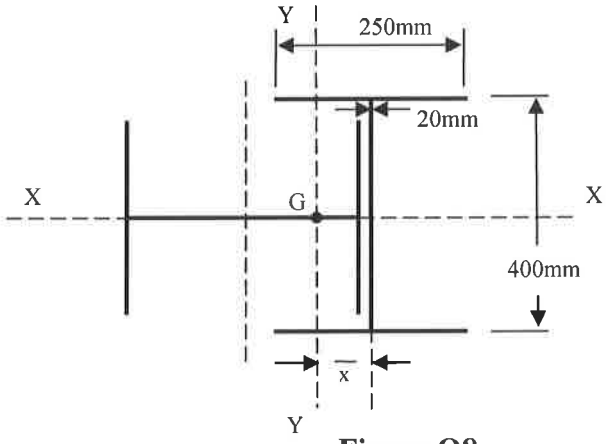


Figure Q8

For each joist:
$I_{max} = 213\times10^{-6}\,m^4$, $I_{min} = 9.6\times10^{-6}\,m^4$, $A = 8.4\times10^{-3}\,m^2$, with web and flange thicknesses of 20mm. For the material of the joist, E = 208GN/m^2.