**ENGN 2217 – Mechanical Systems and Design**

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**CLAB 1 Handout – Design of a crane frame**

Q1. What is the highest value of “maximum combined stress” in your loaded structure?​

1.4838\*10^8 Pa

Q2. Why are the values of combined stress and bending stress very close? ​

There is very little direct stress (29830 Pa Max) and so the combined stress is mostly just the bending stress.

Q3. Compare the maximum stress result from the simulation with the failure stress for steel. What is the factor of safety for this structure?​

Yield stress = 250\*10^6 = 2.5\*10^8, Max combined stress = 1.48\*10^8

2.5\*10^8/1.48\*10^8= 1.69

Q4.  What could you change in the design to increase the factor of safety?​

Decrease max combined stress by increasing the size of the beams.

Q5: which member cross-section option would make your structure the strongest with respect to the loads considered in this tutorial? ​

Most of the force encountered is bending stress and so doubling total depth would increase the distance decreasing the bending stress, double flange thickness would also decrease the bending stress.

Q6: which would make it the most expensive? (steel cost is a function of weight)

Double width would make it the most expensive as it has the most surface area.

Q7. What is the value of load multiplier you have computed in your simulation?​

15.138

Q8. In terms of safety, how does the load multiplier compare with the safety margin you calculated earlier on? What type of failure will this structure exhibit most likely?​

The load multiplier is an order of magnitude greater than 1 and so is much safter than the safety margin.

Q9. What design changes could the structure undergo so that its cost may be reduced, without compromising safety?​

Some of the members are closer to their failure points than others, increase the size/change the dimensions to reduce the stress on the members that are close to their failure points while decrease the size/change the dimensions of members that are far away from their failure points.

Diagram

Description automatically generated

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ​ | unit​ | I beam tested this tutorial​ | Rotated section (H beam)​ | Double Width​ | Double flange thickness​ | Double total depth​ | Double web thickness​ |
| Total depth (W1) ​ | mm​ | 170 | 170 | 170 | 170 | 340 | 170 |
| Width (W2)​ | mm​ | 230 | 230 | 460 | 230 | 230 | 230 |
| Flange thickness (t1)​ | mm​ | 20 | 20 | 20 | 40 | 20 | 20 |
| Web thickness (t2)​ | mm​ | 15 | 15 | 15 | 15 | 15 | 30 |
| Area A​ | mm2​ | 11100 | 11100 | 20600 | 19700 | 13700 | 13100 |
| y (centroid distance)​ | mm​ | 85 | 115 | 85 | 85 | 170 | 85 |
| I (moment of inertia)​ | mm4​ | 54800000 | 40600000 | 108000000 | 81100000 | 270000000 | 57500000 |