Instructions:

* Replace the highlighted areas in yellow above with your own name, section and group numbers and correct dates,
* Watch lab demo video and review related materials in lecture notes, lab manual and other related documents,
* Provide your best answers to the following questions. Add pages as needed,
* Convert this Word worksheet sheet into pdf format and submit to Canvas.

1. Review Week 7 lecture and corresponding reference book materials (Peery is available online from ISU library).
2. (15 points) For the end condition of one free and one fixed (lecture note page 12), why is the effective length twice as long as the actual length? Could you come up with a simple explanation? Hint: think of “mirror” …
3. (25 pts) Derive the formulas for critical load P and slenderness ratio L/ of a circular rod and a rectangular bar subjected to axial loading, in terms of , length L, modulus of elasticity E and specimen radius R (for circular rod) or cross-sectional dimensions B and/or H (for rectangular bar).
4. (30 pts) Use the formulas from 3. to calculate the Ps and Ls for metal specimens made of stainless 304 annealed cold finish steel (elastic modulus E = 29000 ksi and yield strength = 35ksi) and 6061-T6 aluminum (E=10000 ksi and yield strength = 40 ksi) with the sizes and end conditions given in Table 1. What equivalent lengths you will use for the pivot-pivot and pivot-fixed end conditions? For the ¼” x 1” aluminum specimen, which dimension you choose to calculate the slenderness ratio? Hint: see the workout example on pages 14-15 in lecture notes. You may want to write yourself a little computer program for these calculations. Tabulate your calculations on the Ps and Ls. Also list the effective lengths you used.

Table 1. Five column buckling test sets

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Specimen ID | Material | Cross section dimension (inch) | Length (inch) | End condition |
| I | aluminum | 3/8 dia. | 30 | both pivot (round) |
| II | aluminum | 1/4 x 1 | 30 | both pivot (round) |
| III | steel | 1/4 dia. | 30 | both pivot (round) |
| IV | steel | 1/4 dia. | 24 | both pivot (round) |
| V | steel | 1/4 dia. | 27.5 (30 original) | one pivot, one fixed |

Total 70 points

Answers:

2. The effective length replaces the actual length to account with the variation of the critical load due to different end conditions. For the end condition of one free and one fixed, we double the length so we can consider the entire buckle. We can observe from the image that this case the buckling looks like only half of a curvature, so we need to consider the other half for calculations.

3.

A white paper with math equations

Description automatically generated

4. For pivot-pivot end condition, the effective length = nominal length. For pivot-fixed end condition, the effective length = 0.7 \* nominal length. For specimen 2, base will be the longest side. So B = 1 in and H = ¼ in (so we minimize σcr.

|  |  |  |  |
| --- | --- | --- | --- |
| Specimen ID | Effective Length (inches) | P (kips) | L/ρ |
| I | 30 | 0.1065 | 320 |
| II | 30 | 0.1428 | 415.692 |
| III | 30 | 0.0610 | 480 |
| IV | 24 | 0.0953 | 384 |
| V | 19.25 | 0.1481 | 308 |

Code for specimen 2 (rectangular bar):

E = 10000; %ksi

effectiveLenght = 30; %in

base = 1; %in

height = 1/4; %in

P = (pi^2)\*E\*base\*(height^3)/(12\*(effectiveLenght^2)) %kip

LoverRo = 2\*sqrt(3)\*effectiveLenght/height

Code for specimen 1 (example of circular rod):

E = 10000; %ksi

effectiveLenght = 30; %in

diameter = 3/8; %in

radius = diameter/2; %in

P = (pi^3)\*E\*(radius^4)/(4\*(effectiveLenght^2)) %kip

LoverRo = 2\*effectiveLenght/radius