CIV102F Assignment # 3 – September 27-29, 2022

Due October 4-6, (before assigned tutorial time), 2022

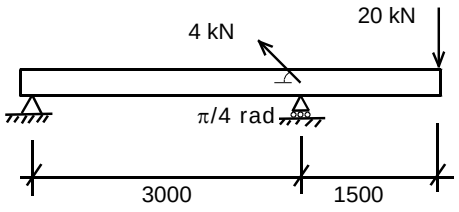
General Instructions

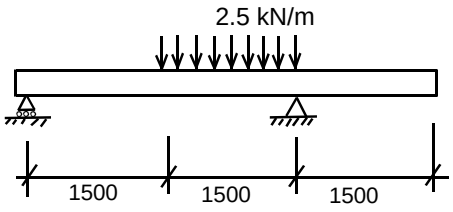
- There are five questions on this assignment. All questions must be attempted; however, only one question will be graded.
- Submissions which are incomplete and do not contain a serious attempt to solve each question will receive a grade of 0.
- Intermediate steps must be provided to explain how you arrived at your final answer. Receiving full marks requires both the correct process and answer.
- All final answers must be reported using slide-rule precision (ie, four significant figures if the first digit is a "1", three otherwise), and engineering notation for very large or very small quantities.
- Submissions must be prepared neatly and be formatted using the requirements discussed in the course syllabus. Marks will be deducted for poor presentation of work.

Assignment-Specific Instructions

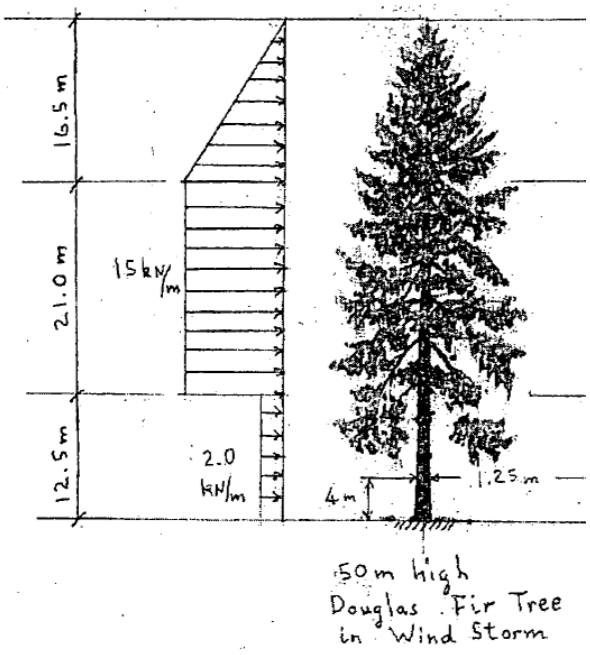
- For each question, free body diagrams must be drawn to explain how you obtained the corresponding equations of equilibrium.

1. Calculate the support reactions for the following beams (All dimensions are in mm):



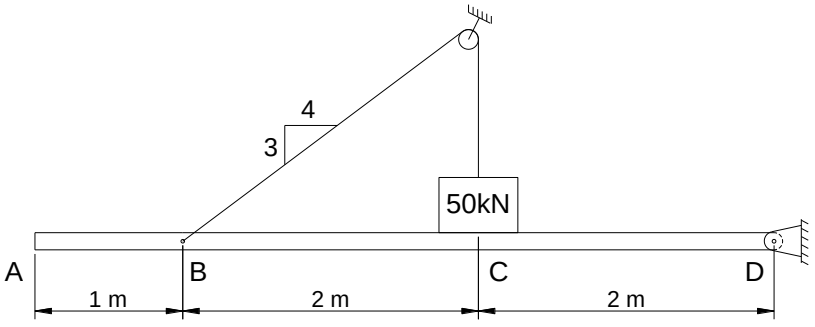


2. During an extreme wind storm a 50 m high Douglas Fir tree is subjected to a horizontal wind pressure of about 1.5 kN/m^2 on the frontal area of the tree. The resulting horizontal loads which must be resisted by the trunk of the tree and carried to the ground can be approximated as shown in the diagram below. Calculate the reaction forces which must be resisted at the base of the tree. The tree acts as a vertical "cantilever" which is attached to the ground by a "fixed end" which can resist horizontal, vertical and rotational displacements.

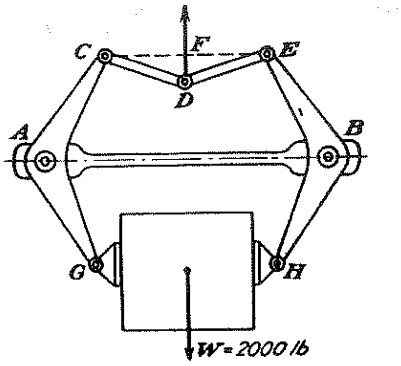


3. In the structure shown below, a cable is attached to the 50 kN weight and to the beam A-D at point B. If the horizontal uniform beam weighs 8 kN/m, determine the following:

a) The horizontal and vertical component of the force that the pin at D exerts on the beam A-D.
b) The force in the cable.
c) The normal force exerted by the beam A-D on the 50-kN weight at point C.



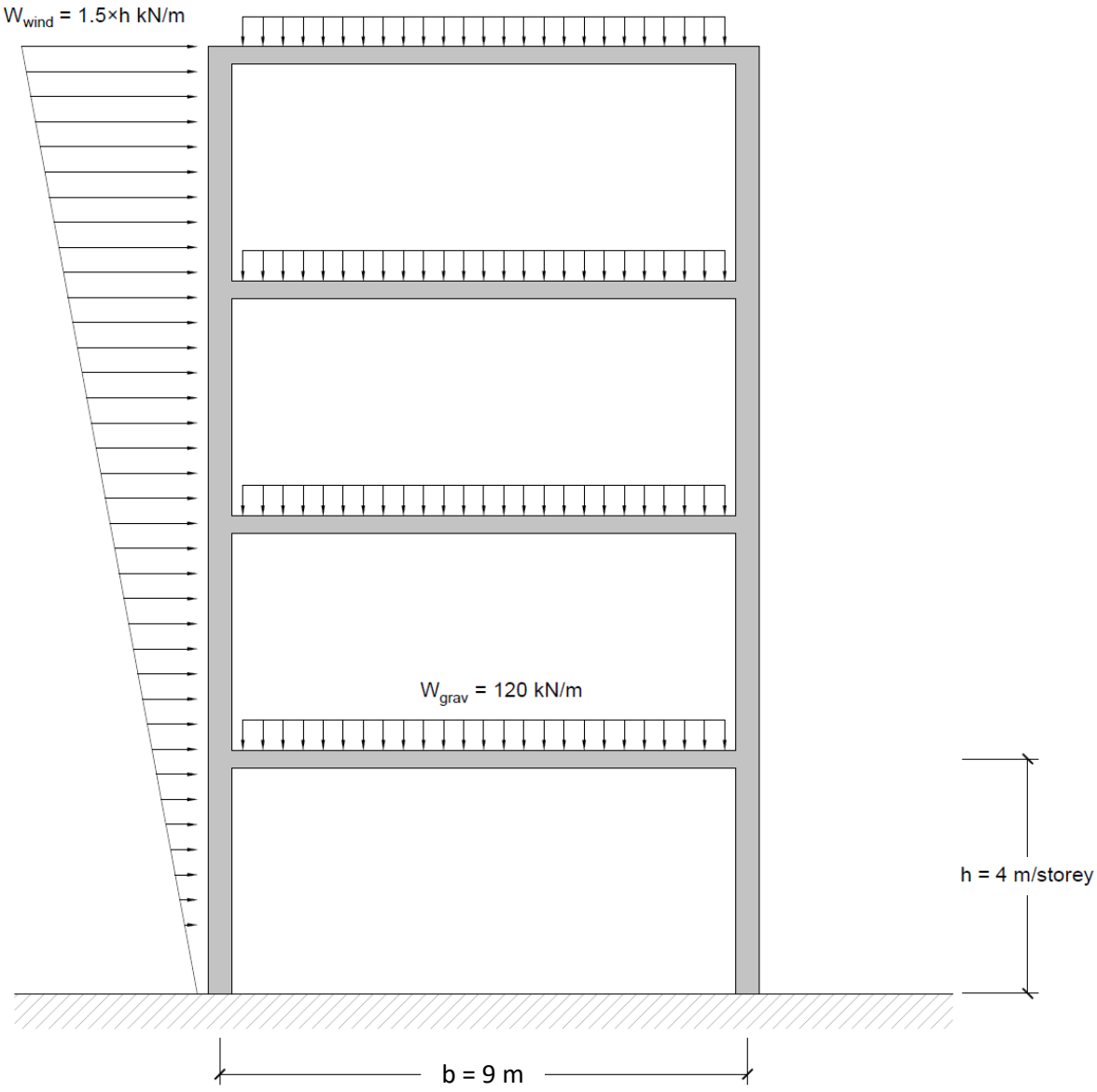
4. The lifting tong shown is suspended from a chain attached at D. The pivot blocks G and H grip the load W, supporting it by means of friction. The bell cranks CAG and EBH pivot about the pins A and B on the crossbar. Assuming no friction in the pivots and neglecting the weight of the mechanism, find the force in the crossbar AB and the gripping force on the load. The bell cranks are symmetrical about their centers; the lines CG and EH are vertical, and the dimensions are CG=40 in, CD=DE=18 in, DF=3 in.



5. Consider the building structure shown on the next page. The gravity loads, due to the weight of the building occupants and the self-weight of the structure, act uniformly on each floor with a value of 120 kN/m of force. High winds also cause large lateral forces to be applied to the side of the structure – these forces are typically larger near the top of buildings and smaller near the ground level. The force distribution along the height of the building can be assumed to have a triangular pattern. The maximum load density at the top of buildings is known to be larger with taller buildings and can be assumed to equal 1.5×h kN/m, where h is the total height of the structure.

For this question, prepare a plot which includes the two relationships described in parts (a) and (b). When performing your analysis, assume that the left side of the building is supported by a roller, and the right side by a pin.

a) Considering the gravity load only, plot how the maximum vertical reaction force supplied by the pin increases as the building height varies from 0 to 75 storeys (0 m tall to 300 m) tall. Plot this trend using at least 5 points.
b) Considering the wind load only, plot how the magnitude of the vertical reaction force supplied by the pin increases as the building height varies from 0 to 75 storeys tall. Plot this trend using at least 5 points.
c) If both the gravity and lateral loads are present, calculate the maximum number of stories the building can be before it starts to tip over if it wasn't anchored to the ground (the left side of the building will begin to lift off the ground).
d) *"Doubling the height probably only doubles the cost of the building"* – do you think this statement is true? Explain using your results from a) and b).


W_{wind} = 1.5×h kN/m
W_{grav} = 120 kN/m
h = 4 m/storey
b = 9 m