CVG 2141 – CIVIL ENGINEERING MATERIALS

Mid-term exam (Open book) Time: **80 minutes**

NAME: _____STUDENT N° _____ DATE_____

Total: 25 points

You work for an engineering consulting company. You will participate in the construction of two structures: a) a truss (Figure 1) and, b) reinforced concrete members from a residential building (i.e., columns and slabs – Figure 2a and b, respectively). The two structures will be located in Montreal and will be subjected to freeze-thaw cycles and de-icing salts. As the chief engineer of the project, your goal is to ensure the short and long-term performance of the two structures along with sustainability aspects. In this context, please, answer the following questions:

Note 1: there are multiple possible answers to the questions below. **All answers must be justified!**

Note 2: Replace the **X in the Figures below by your last student number** to figure the dimensions of the members.

Hibbeler, 2011: Mechanics of Materials

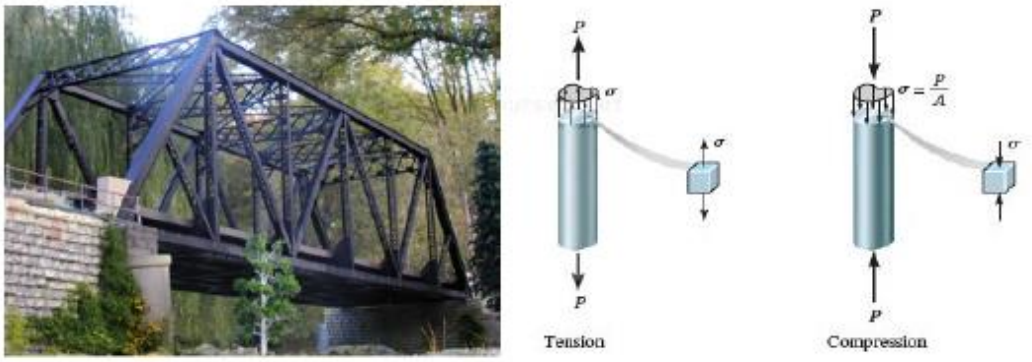

Figure 1. Truss.

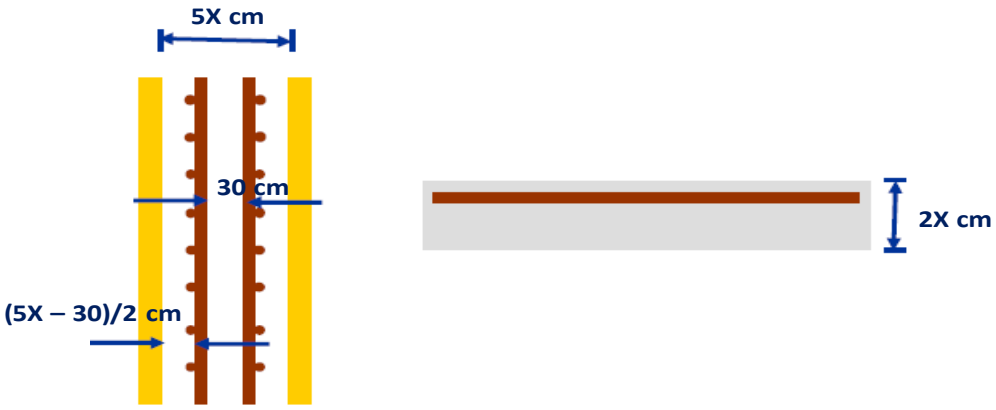

Figure 2. Reinforced concrete members: a) column and, b) slab.

PART 1: TRUSSS (15 POINTS)

1 Draw the *stress strain curve* (σ-ε) that you think would be suitable for the truss members. Do not forget to describe all the important phases and points of the curve.

2 Based on the above stress-strain curve, what's the material (i.e., type) that you selected for the truss? What would be its likely chemical bond?

3 To design the truss, you have selected members from the material above displaying a cross section of X by 20 cm (i.e., 0.X by 0.2 m), since this cross section was largely available in the market. Then, you tested a number of members in the laboratory and obtained an average failure value of 1000000N. Calculate the ultimate capacity (i.e., maximum tensile strength) of the truss' members.

P.S.: Please answer this question in MPa. It is worth noting that 1 N/m2 is 1 Pa.

4 Knowing that the deformation at the elastic limit of the material selected above for the truss is 0.002 (or 0.2%), and the modulus of elasticity is 200000 MPa, what's the yielding strength of the truss member?

5 Based on the answers 3 and 4, please provide your client with the maximum stress allowed to be applied to the truss members regarding safety considerations. Please justify.

PART 2: REINFORCED CONCRETE MEMBERS (10 POINTS)

6 Please select the distinct features below of the aggregates to be used in the reinforced concrete members (i.e., columns and slabs) of Figure 2. **Please justify all answers.**

a. Particle size distribution;
b. Type of coarse aggregate;
c. Moisture condition of the aggregates;
d. Fineness modulus of the sand;
e. Nominal maximum size of the coarse aggregate;

7 Please select the distinct features below of the concrete mixtures to be used in the reinforced concrete members (i.e., columns and slabs) of Figure 2. **Please justify all answers.**

a. Cement type and amount (estimation);
b. Use of supplementary cementing materials (type and amount, if required);
c. Use of admixtures (type and amount if required);
d. Water-to-cement ratio and design compressive strength;
e. Slump (mm);