There are 3 questions with 65 total points possible. Show all work to receive full credit. If you cannot determine the answer for a problem that is needed for another question, assume a reasonable value and continue.

1. The beam below is a W24 × 131. As shown, the factored load, \( P_u \), creates bending about the strong axis. The axial load, \( C_u \), is also factored. The beam braced laterally at the point of the load. This bracing is sufficient to prevent flexural buckling and lateral torsional buckling, both about the weak axis. Assume \( C_b = 1.0 \). Neglect the self-weight of the beam in your calculations.

\[
P_u = 168 \text{ kip}
\]

\[
C_u = 40 \text{ kip}
\]

(a) (16 points) When this beam is input into RISA-2D, the “max bending check” (neglecting \( P-\delta \) effects) is 1.00. Verify this.

(b) (4 points) If you were to include \( P-\delta \) effects, would the “max bending check” increase or decrease? Explain.

(c) (5 points) If you were to actually calculate \( C_b \), would the “max bending check” increase or decrease? Explain.

2. (20 points) Six A325-N bolts are used for the bearing connection shown below. The centroid of the bolt group is shown (C). Determine the required bolt size based on the bolt shear limit state only. You need only check the bolt you feel will control, but be sure to explain why you think that bolt will control the design. The following equations should be helpful:

\[
p_{mx,i} = \frac{M_{yi}}{\sum d_i^2} \quad p_{my,i} = \frac{M_{xi}}{\sum d_i^2}
\]

\[
P_u = 39^k
\]
3. The three-plate moment connection shown below is constructed just like the connection we designed in class, and the one you analyzed for your homework. The beam is a W21 × 50 that has a factored moment of $M_u = -268 \text{ kip} \cdot \text{ft}$ and a factored shear of $V_u = 79 \text{ kip}$. All plates are A36 steel ($F_y = 36 \text{ ksi}$, $F_u = 58 \text{ ksi}$). Plate 2 is connected to the girder using four bolts as shown. All bolts for the connection will be $\frac{7}{8}"$ diameter A325-X.

(a) (10 points) Assume the shear tab (Plate 2) will be welded to the column using an E70XX electrode along both sides of the plate from top to bottom. Based on strength requirements, what is the minimum size of the weld? Neglect the eccentricity of the loading.

(b) (10 points) Considering the limit state of bearing only, how thick does Plate 2 need to be?