Birzeit University

Faculty of Engineering and Technology
Department of Civil and Environmental Engineering

ENCE 436 Reinforced Concrete Design II

Final Exam Tuesday, June 22, 2021

For all questions, fc' = 28 MPa, fy = 420 MPa, $\gamma_{concrete}$ = 24 kN/m^3 (2.4 t/m^3)

Q1. Referring to the layout shown, assume that beams are used on all column lines. The slab is solid with a thickness = 30 cm. For the slab, use d = (h – 4) cm in all calculations. All long beams have b = 60 cm and h = 90 cm (d = 81 cm). All short beams have b = 50 cm and h = 70 cm (d = 61 cm). All columns are 50 cm x 50 cm. The service DL = 1.0 t/m^2, and the service LL = 0.5 t/m^2 (w_u = 2.0 t/m^2). Assume that the direct design method limitations are satisfied. Assume α_f for all beams exceeds 4.

a) (10 points) Using the direct design method, determine the longitudinal moments for Frame A.

b) (15 points) Determine the lateral moments at Location 1 assuming the longitudinal moment at that location equals 100 t.m.

c) (10 points) Determine the lateral moments at Location 2 assuming the longitudinal moment at that location equals 100 t.m.

d) (5 points) Check the adequacy of the slab for shear.

Q2. Referring to the layout shown, assume no beams are used anywhere. The slab is solid with a thickness = 35 cm. All columns are 80 cm x 80 cm. The service DL = 1.0 t/m^2, and the service LL = 0.5 t/m^2 (w_u = 2.0 t/m^2). For the slab, use d = (h – 4) cm in all calculations.

a) (10 points) Using the equivalent beam method, determine the longitudinal moments for Frame A. For simplicity, assume the exterior ends are pinned.

b) (10 points) Check punching shear for an interior column. Ignore shear transfer of bending moment.

c) (20 points) Check punching shear for an exterior column. Consider shear transfer of bending moment. Take the end moment to be 0.3 Mo determined using the direct design method. Assume the edge of the slab is aligned with the exterior face of the edge column as shown on the layout.

Q3. (20 points) Design a short, rectangular column to support an ultimate load Pu = 700 t applied at an eccentricity of 40 cm. Reinforcement is to be distributed along all faces. Use ρ_g of approximately 2%, b = 70 cm, Φ 28 longitudinal bars, and Φ 10 ties. The dimension "h" is to be determined to the nearest 5 cm. Draw a section of the column showing the main reinforcement, layout and spacing of the ties, and check the longitudinal bar spacing. Do not check the capacity.