Answer Key: Civil Engineering Licensure Exam – Mock Exam (Day 43: Design Philosophies – Allowable Stress and Ultimate Strength)

February 24, 2025

Answer Key

Section A: Multiple Choice Solutions

1. ASD ensures: **(a) The structure remains within the elastic limit under service loads**
2. LRFD accounts for: **(a) Safety factors applied to both loads and resistances**
3. Factor of safety in ASD: **(a) The ratio of ultimate strength to allowable stress**
4. Ultimate Strength Design ensures: **(a) The structure can sustain extreme loads before failure**
5. Difference between ASD and LRFD: **(a) ASD uses a single factor of safety, while LRFD applies load and resistance factors**

Section B: Problem-Solving Solutions

1. Factor of safety in ASD:

$$FS = \frac{\sigma_{\text{allowable}}}{\sigma_{\text{actual}}} = \frac{160}{120}$$

$$= 1.33$$

2. Strength reduction factor in LRFD:

$$\phi = \frac{M_u}{M_n} = \frac{250}{300}$$

$$= 0.833$$

3. Required ultimate strength of the column:

$$P_{\text{ultimate}} = P_{\text{service}} \times \text{Factor of Safety}$$

$$= 500 \times 1.67 = 835 \text{ kN}$$

4. Factored load using LRFD:

$$P_f = 1.2P_d + 1.6P_L$$

$$= 1.2(40) + 1.6(30)$$

$$= 48 + 48 = 96 \text{ kN}$$

5. Allowable stress for ASD:

$$\sigma_{\text{allowable}} = \frac{\sigma_y}{\text{Factor of Safety}}$$

$$= \frac{250}{1.67}$$

$$= 149.7 \text{ MPa}$$