University of Asia Pacific
Department of Civil Engineering
Final Examination – Fall 2023
Program: M.Sc. Engineering (Civil)

Course Title: Structural Design of Pavement | Course Code: CE 6505
Time: 3 hours | Credit Hour: 3:00 | Full Marks: 100

1. a) Explain with figures the three-dimensional finite element model. (6)
   b) Describe different types of Joints in Rigid Pavements. (6)
   c) Explain the Pavement Design Steps as per Road Note No. 31. (6)
   d) Write short notes on (i) Warping and (ii) Curling (6)
   e) Describe the pavement life cycle. (6)

2. A 4-lane Highway is to be designed to replace an existing one. The present AADT is 5000 vehicles. Determine the design ESAL for the peak direction if the design life is 20 years. The vehicle composition and growth rate of different vehicles are as follows: (10)
   Passenger Car (1000 lb/axle) = 20% (Growth rate 8%)
   2 axle single unit truck (6000 lb/axle) = 35% (Growth rate 5%)
   3 axle single unit truck (8000 lb/axle) = 15% (Growth rate 4%)
   2 axle single unit truck (11000 lb/axle) = 30% (Growth rate 3%)
   The percentage of trucks in the Design Lane is 45% and SN is 4.

3. Design a suitable pavement of an asphalt mixture surface using the AASHTO method for a minor highway with a structural coefficient of 0.3 for the surface course. The CBR-value of the base, sub-base, and subgrade is 25, 35, and 2.5 respectively. The drainage quality of the base and sub-base layers is good with 5% saturation and quick draining occurs in the surface course. Use a reliability level of 75%. Consider the value of design ESAL as calculated in Q2. The resilient modulus of the base course and sub-base course is 25000 lb/in^2 and 5000 lb/in^2 respectively. (20)

4. Design a rigid pavement for a two-lane residential street using the PCA method in such a way that the assumed pavement thickness is adequate for fatigue analysis. Assume subbase-subgrade K value 180 lb/in^3 and concrete modulus of rupture 670 lb/in^2. The pavement has asphalt shoulder on both sides of the road with doweled joints. The traffic data are as follows: (15)

Single axle	Expected Repetitions
25	21,320
42.5	42,870
45	2,000
Tandem axle	**Expected Repetitions**
55	930,700
102	15,000
110	1500

5. Figure 1 shows a pavement structure consisting of two layers. Two circular loads of 24-inch diameter are applied on the top layer. The pressure on the circular area is 50 psi. The elastic modulus of the different layers is shown in the figure. Determine the vertical stress, at point A which is located 25 inches below the center of both circles. Also, find out (a) the thickness of the full-depth pavement when the elastic modulus of the layer is 1,20,000 psi. If a surface treatment is applied on a granular base with an elastic modulus of 30,000 psi, (b) what is the thickness of the base course required? (15)

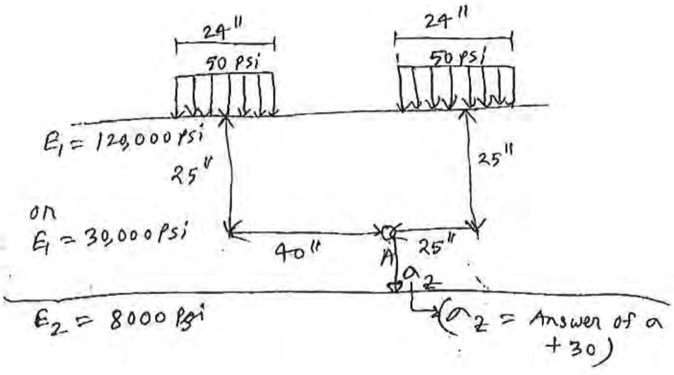

Figure 1

6. Mean monthly temperatures at a given paving project are September 50°F; October 32°F; November 24°F; December -3°F; January 14°F; February 16°F; March 22°F; April 25°F; and May 40°F. Calculate the freezing index. Is this value likely to be different from the freezing index calculated from the mean daily temperature? (10)

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: Master of Science in Civil Engineering

Course title: Environmental Hazard and Disaster Management
Course code: CE 6006
Time: 3 hours
Full marks: 50

Answer all questions.

1. "Strengthening disaster risk governance to manage disaster risk" and "Enhancing disaster preparedness for effective response and to *Build Back Better* in recovery, rehabilitation and reconstruction" are two of the four priorities of actions of the Sendai Framework for Disaster Risk Reduction: 2015-2030.

   a) Explain why strengthening disaster risk governance to manage disaster risk at the national, regional and global levels is of great importance for effective and efficient management of disaster risk. 6

   b) Explain why enhancing disaster preparedness for effective response and to *Build Back Better* in recovery, rehabilitation and reconstruction at the national, global and regional levels is important for effective and efficient management of disaster risk. 6

   c) On February 29, 2024, a massive fire erupted in a seven-storey shopping mall located in Bailey Road, Dhaka, that killed 46 people. Do you agree that a lack of understanding about disaster risk and the absence of disaster risk governance contributed to this disaster? Justify your answer. 8

2. Outline the *Modified Mercalli Intensity Scale* for measuring the severity of an earthquake hazard. 7

3. Do you think that desertification hazard contributes to climate change and increase ecological and social vulnerabilities around the world? Justify your answer. 8

4. Explain six pillars of the climate change action plan adopted by the *2009 Climate Change Strategy and Action Plan* of Bangladesh. 7

5. Explain different types of landslides. 8

University of Asia Pacific
Department of Civil Engineering
Final Examination (Fall 2023)
Program: M.Sc. Engineering (Civil)

Course Title: Principles of Earthquake Engineering
Credit Hour: 3.0
Time: 3 Hour

Course Code: CE 6701
Full Marks: 60

---

1. What is seismic hazard analysis? Explain briefly the deterministic and probabilistic methods of seismic hazard analysis. **(2+5)**

2. Briefly explain the following: i) Earthquake catalog; ii) Attenuation law; iii) Isoseismal map. **(2+2+2)**

3. Estimate the SDE and SSE based on cumulative intensity-frequency relation determined at the site for the following data: **(20)**
   (a) Annual intensity-frequency relation, $\log(\nu) = a - bI$ which are defined by co-efficient a and b.
   (b) Maximum possible epicentral macro-seismic intensities, I_{max}.
   (c) Attenuation values ΔI of intensities for distance of the seismoactive zones to the site.

Seismic zone	a	b	I_{max}	ΔI
1	1.57	0.516	X	1.0
2	0.055	0.335	X	1.3
3	0.387	0.372	XI	2.2
4	0.392	0.326	X	0.5
5	1.203	0.506	IX	1.3

4. (a) What is liquefaction? How to measure the factor of safety against it? What are the possible countermeasures to avoid liquefaction of foundation soil? **(2+2+3)**
   (b) Measure the factor of safety and liquefaction potential index at a depth of 6 meters for the site soil of a proposed construction for a 7.5 magnitude earthquake producing a PGA of 0.2g. Consider the water table at 1 m below the ground level. The soil is coarse sand with a saturated unit weight of 20 kN/m^3. The field SPT-N and D_{50} values with depth are given below. **(20)**

Depth	N - value	D_{50}
1.5	2	0.8
3	3	0.9
4.5	4	1.1
6	6	0.5

Appendix

$$L = \frac{\tau_{max}}{\sigma_v'} = \frac{\alpha_{smax}}{g} \frac{\sigma_v}{\sigma_v'} r_d$$

for $0.04\,\text{mm} \leqslant D_{50} \leqslant 0.6\,\text{mm}$

$$R = 0.0882\sqrt{\frac{N}{\sigma_v' + 0.7}} + 0.225 \log_{10}\frac{0.35}{D_{50}}$$

for $0.6\,\text{mm} \leqslant D_{50} \leqslant 1.5\,\text{mm}$

$$R = 0.0882\sqrt{\frac{N}{\sigma_v' + 0.7}} - 0.05$$

$$r_d = 1.0 - 0.015Z$$

$$F_L = \frac{R}{L}$$

$$F = 1 - F_L$$

$$W(Z) = 10\text{-}0.5Z \ (Z \text{ in metres})$$

$$I_L = \int_0^{20} FW(Z)\,\mathrm{d}Z$$

$I_L = 0$:	Liquefaction risk is very low
$0 < I_L \leqslant 5$:	Liquefaction risk is low
$5 < I_L \leqslant 15$:	Liquefaction risk is high
$15 < I_L$:	Liquefaction risk is very high

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: Master of Science in Civil Engineering

Course Title: Theory and Design of Structural Concrete | Course Code: CE 6203
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 100

QUESTION 1 [20 MARKS]

The modern construction of Civil Engineering project is sometimes required solution beyond code of practices. The value of "β_1" of stress block (flexural design) stated in the design codes (ACI/BNBC) is for the maximum concrete strength of 56 MPa. However, a construction project has to use 60 MPa concrete for particular flexural members. Thus, the value of "β_1" is required to be considered for 60 MPa concrete from existing research which is beyond code of practices. Moreover, the design stress of concrete stated in BNBC 2020 might be changed as $0.9f_c'$ instead of $0.85f_c'$. As a structural engineer, develop design theories for **flexure** (ultimate moment) and **shear** using limit state approach of **ACI/BNBC** and **Euro Code (EC2)** for that particular material considering those issues. [20 Marks]

QUESTION 2 [20 MARKS]

The girder of an elevated express way would be constructed using simply supported RC structures as shown in **Figure 1**. The girder is subjected to uniformly distributed 60 kN/m dead load (including self-weight) and 20 kN/m live load. The design should comply the requirements of limit state approaches (strength, deflection) of BNBC 2020 and EC2. The strength of concrete could be used as 60 MPa for design. Propose an optimal size of the girder using a void (100 mm x 300 mm) at centre of the section, **design** the girder for maximum mid-span bending moment in accordance to BNBC 2020 and EC2. Assume required consideration (data) for optimal size of the girder. [20 Marks]

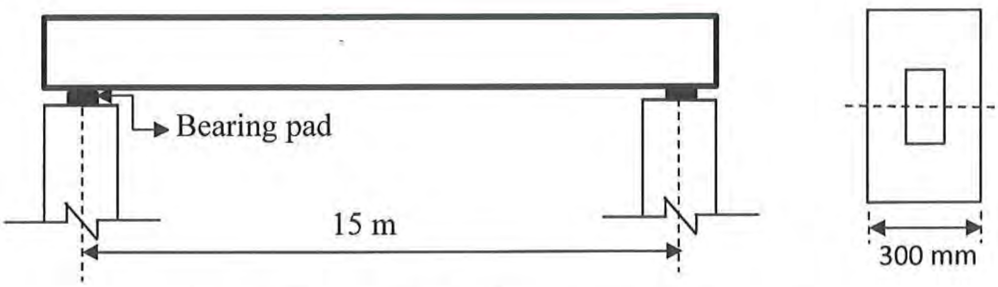

Figure 1. Girder of an elevated expressway

QUESTION 3 [15 MARKS]

The floor plan of a 10-storeyed RC residential building (live load 2 kN/m^2) is shown in **Figure 2**. Propose a solution to have the minimum required thickness of the slab "S2". Design the **short span** of slab panel **"S2"** for **support moment** (as shown in **Figure 2**) with the **minimum thickness** considering safety and environmental issues of BNBC 2020. The slab is contineous, support moment at contineous edge of the slab is subjected to analysis of contineous slab. Required data has to be assumed in design. Shear force co-efficient is 0.5. [15 Marks]

QUESTION 4 [15 MARKS]

The ground floor column **"C1"** of the project stated in **Question 3 (Figure 2)** has to be designed. The column is subjected to 800 kN-m moment on its critical axis due to lateral load. Propose a solution for **optimal design** of the column. Dimension of the column is required to be minimized as much as possible in accordance to the provisions of BNBC 2020. [15 Marks]

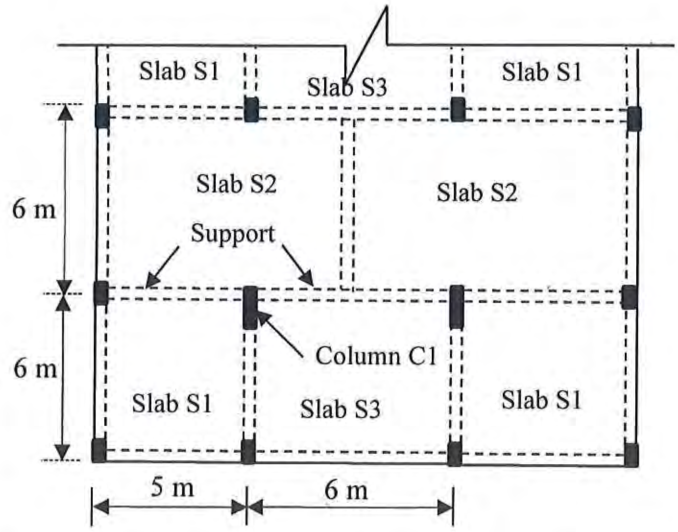

Figure 2: Floor Layout Plan of 10-Storeyed Residential Building

QUESTION 5 [15 MARKS]

The column "C1" of the project (**Question 3**) is supported by pile foundation. The maximum capacity of 600 mm diameter bore pile can be considered as 1100 kN. **Propose a solution for optimal design** of the pile cap considering all options of code (BNBC 2020). **Design the pile cap** in accordance to BNBC 2020 and strut and tie model of EC2. [15 Marks]

QUESTION 6 [15 MARKS]

The floor layout plan of the project (stated in **Question 3**) is shown in **Figure 2**. The foundation of the columns could be designed as Mat as well. Bearing capacity of the soil is 180 kN/m^2. Propose a layout plan of the mat, select a suitable panel of the mat for design. **Design a single column strip (long span)** of that particular panel of the mat in accordance to BNBC 2020. [15 Marks]

APPENDIX

Direct Design Method:

Minimum thickness of Flat Slab

Exterior Panels without Edge Beams	Exterior Panels with Edge Beams	Interior Panels
$L_n/33$	$L_n/36$	$L_n/36$

6.5.6.3.2 In an interior span, total static moment, M_o, shall be distributed as follows:

Negative factored moment: **0.65**

Positive factored moment: **0.35**

6.5.6.3.3 In an end span, total factored static moment, M_o, shall be distributed as in Table 6.6.4 below:

Table 6.6.4: Distribution of Total Factored Static Moment, M_o in an End Span

Moments	Exterior edge unrestrained	Slab with beams between all supports	Slab without beams between interior supports		Exterior edge fully restrained
			Without edge beam	With edge beam	
Interior negative factored moment	0.75	0.70	0.70	0.70	0.65
Positive factored moment	0.63	0.57	0.52	0.50	0.35
Exterior negative factored moment	0	0.16	0.26	0.30	0.65

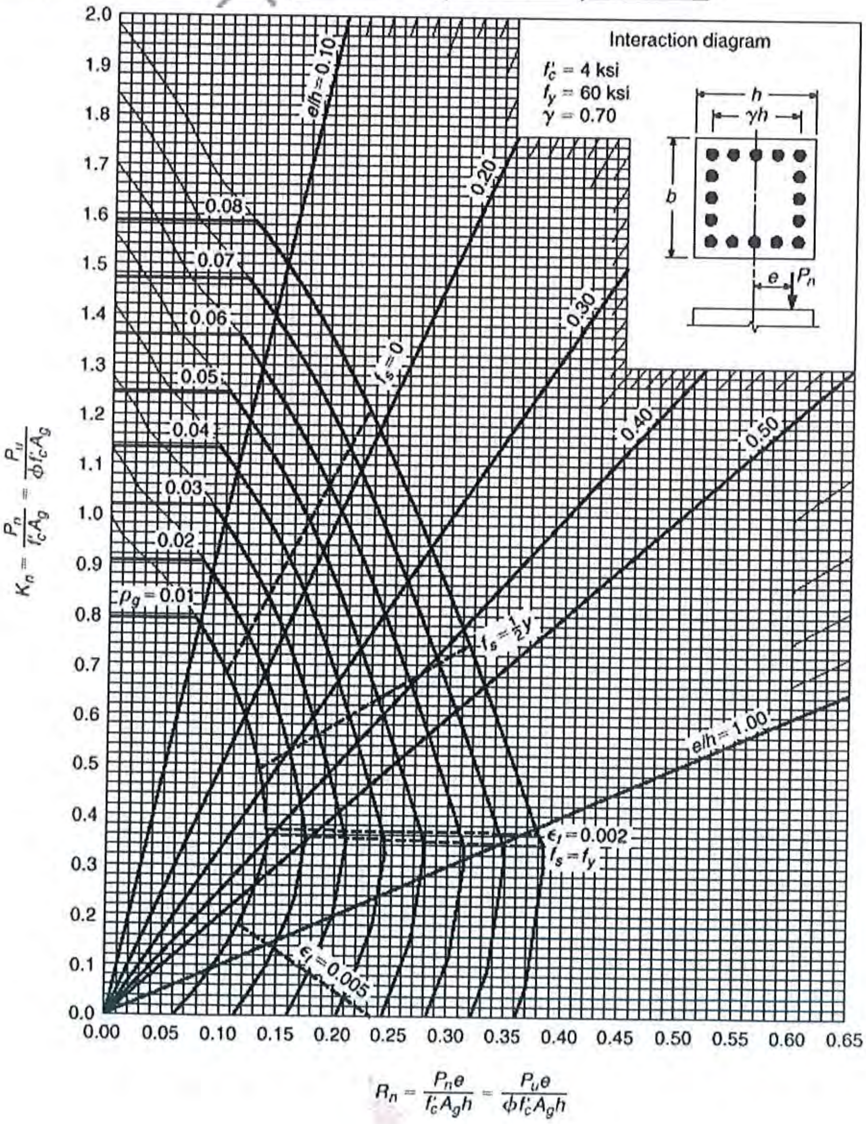

Table 6.6.8: Coefficients for Negative Moments in Slabs †

$$M_{a,neg} = C_{a,neg} w l_a^2$$

$$M_{b,neg} = C_{b,neg} w l_b^2$$

Where, w = total uniform dead plus live load per unit area

Span Ratio, $m = \frac{l_a}{l_b}$	Moment Coefficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,neg}$		0.045		0.050	0.075	0.071		0.033	0.061
	$C_{b,neg}$		0.045	0.076	0.050			0.071	0.061	0.033
0.95	$C_{a,neg}$		0.050		0.055	0.079	0.075		0.038	0.065
	$C_{b,neg}$		0.041	0.072	0.045			0.067	0.056	0.029
0.90	$C_{a,neg}$		0.055		0.060	0.080	0.079		0.043	0.068
	$C_{b,neg}$		0.037	0.070	0.040			0.062	0.052	0.025
0.85	$C_{a,neg}$		0.060		0.066	0.082	0.083		0.049	0.072
	$C_{b,neg}$		0.031	0.065	0.034			0.057	0.046	0.021
0.80	$C_{a,neg}$		0.065		0.071	0.083	0.086		0.055	0.075
	$C_{b,neg}$		0.027	0.061	0.029			0.051	0.041	0.017
0.75	$C_{a,neg}$		0.069		0.076	0.085	0.088		0.061	0.078
	$C_{b,neg}$		0.022	0.056	0.024			0.044	0.036	0.014
0.70	$C_{a,neg}$		0.074		0.081	0.086	0.091		0.068	0.081
	$C_{b,neg}$		0.017	0.050	0.019			0.038	0.029	0.011
0.65	$C_{a,neg}$		0.077		0.085	0.087	0.093		0.074	0.083
	$C_{b,neg}$		0.014	0.043	0.015			0.031	0.024	0.008
0.60	$C_{a,neg}$		0.081		0.089	0.088	0.095		0.080	0.085
	$C_{b,neg}$		0.010	0.035	0.011			0.024	0.018	0.006
0.55	$C_{a,neg}$		0.084		0.092	0.089	0.096		0.085	0.086
	$C_{b,neg}$		0.007	0.028	0.008			0.019	0.014	0.005
0.50	$C_{a,neg}$		0.086		0.094	0.090	0.097		0.089	0.088
	$C_{b,neg}$		0.006	0.022	0.006			0.014	0.010	0.003

† A crosshatched edge indicates that the slab continues across, or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.