UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: February 2023

Module Number: CE 3201 **Module Name: Concrete Technology**

[Three Hours]

[Answer **ALL questions**, each question carries twelve marks]

Q1. a) List out four different types of cements and discuss how their properties enhance the quality of fresh concrete.

[2 Marks]

b) Discuss the field test used in the construction site to identify quality of cement and river sand.

[2 Marks]

c) Discuss the importance of using chemical admixtures in concrete. List out four benefits of using chemical admixtures for fresh and hardened states of concrete.

[2 Marks]

d) Discuss the advantages and disadvantages (if any) of the use of blended cement in concrete and how it improves durability of reinforced concrete structures against corrosion.

[2 Marks]

e) Explain the procedure of performing the following laboratory tests. The answer should include test procedure, instrument/equipment use, measurement(s) and outcomes of the test. Use neat sketches to support the answer.

i.) Slump cone test
ii.) Concrete Cube Test
iii.) Split Tensile Test in concrete sample
iv.) Air Content in fresh concrete sample

[4 Marks]

Q2. a) Identify a list of items in formwork system of a slab panel. Use neat sketches to elaborate the answer.
Discuss any additional safety precautions that should be taken when assembling formwork systems.

[3 Marks]

b) Compare advantages and disadvantages of use timber formwork and steel formwork.

[2 Marks]

c) List out four probable reasons for formwork failures and precautions that can be taken to ensure proper function of a formwork.

[3 Marks]

d) Identify the common actions need to be taken after an accident occurs in construction site.

[2 Marks]

e) Identify the problems associated with the Contractors when improving Health and Safety in construction projects.

[2 Marks]

Q3. a) Discuss the mechanism of steel corrosion due to chloride attack.

[2 Marks]

b) Figure Q3 shows a view of a reinforced concrete column of an overhead water tank, deteriorated due to corrosion.

i.) Briefly explain how you would investigate the severity of the corrosion of reinforcement bars.

ii.) Describe any retrofitting technique that can be applied to mitigate corrosion effects and to strengthen the column to satisfy the required strength capacities.

[4 Marks]

c) "Concrete provides better fire resistance compared to any other building material. It does not burn; it cannot be set on fire like other materials in a building."

Briefly explain the statement with possible reasons.

[3 Marks]

d) Discuss the importance of fire safety engineering in designing of a concrete structure and the fire performance evaluation methods of existing concrete structures.

[3 Marks]

Q4. Cracking of concrete can be due to either structural issue or durability issue and can happen starting from the early stage of the concrete cast or latter stage of the structural use.

a) Identify, explain a responsible mechanism, and methods to mitigate the early stage (plastic stage) of cracking in concrete structures.

[3 Marks]

b) Identify and explain three mechanism of concrete cracking caused by different mechanism of deterioration of concrete in reinforced concrete structures.

[3 Marks]

c) There are common solutions to improve durability of concrete for different deterioration mechanisms. Reducing permeability of concrete is one common method to improve durability of concrete against most of the deterioration mechanisms. Explain how permeability of concrete can be reduced and contributed to enhance the durability performance of the concrete.

[3 Marks]

d) Permeability and porosity of concrete are two terms often used interchangeably. Explain the meaning of two terms and their difference to each other.

[3 Marks]

5. It has been found from an initial study that 28 days compressive strength of concrete for a given crushed coarse aggregate (20mm maximum aggregate size) and river sand at Water/Cement (W/C) ratio of 0.5 is 42.5 MPa. Percentage of sand passing the 600 μm sieve has been found as 30% from the total aggregate content. Specific gravity of the coarse and fine aggregate mix can be assumed as 2.65.

Note: Attach the pages 5 and 6 of the question paper along with your answers clearly showing all the references taken for the calculation.

a) Calculate the target strength for a characteristic strength of 50 MPa concrete.

Note:-

Target strength is the mean strength of the concrete at which no more than 5% of test specimen fall below the required characteristic strength of concrete.
Considering the general variability of the concrete mixing and the materials, it is safe to assume standard deviation of the concrete mix to be 4 MPa with strength determined using more than 20 samples which is the case for this particular case.
Compressive strength of concrete cube test is assumed to follow standard normal distribution and the value of 95% confidence interval for standard normal distribution is equal to 1.64.

[2 Marks]

b) Find mix proportions for the calculated target strength in part (a) for a required slump of 60-180 mm. Assume that both the fine and coarse aggregates are in saturated surface dry condition (SSD).

Note:-

Following tables, charts and instructions are extracts from the British method of mix section are provided.
Trial water contents for the different workability requirements are given in Table Q5.1.
Trend of change of compressive strength to free water/cement ratio is given in Fig. Q5.1.
Variation of fresh concrete density against water content for different values of specific density of fine and coarse aggregate mix is shown in Fig. Q5.2.
Fig. Q5.3 indicates content of fine aggregate as a percentage of total aggregate content depending on the water/cement ratio, workability requirement, maximum size of aggregate and fineness fraction of fine aggregate used in the mix.
Water content for crushed and uncrushed aggregate mix should be calculated as 1/3 of the water requirement of the coarse aggregate and 2/3 of the water requirement of the fine aggregate.

[6 Marks]

c) Calculate the amendments to water and the aggregate contents if the following additional information on the moisture content of aggregates are provided.

Moisture absorption for SSD condition of fine aggregate (river sand) is 1.5%.
Moisture absorption for SSD condition of coarse aggregate is 0.45%.
Natural moisture content of fine aggregate (river sand) is 4.25%.
Natural moisture content of coarse aggregate is 1.5%.

Note:-

All above percentages are expressed with reference to the bone dry weight of the aggregate.

[4 Marks]

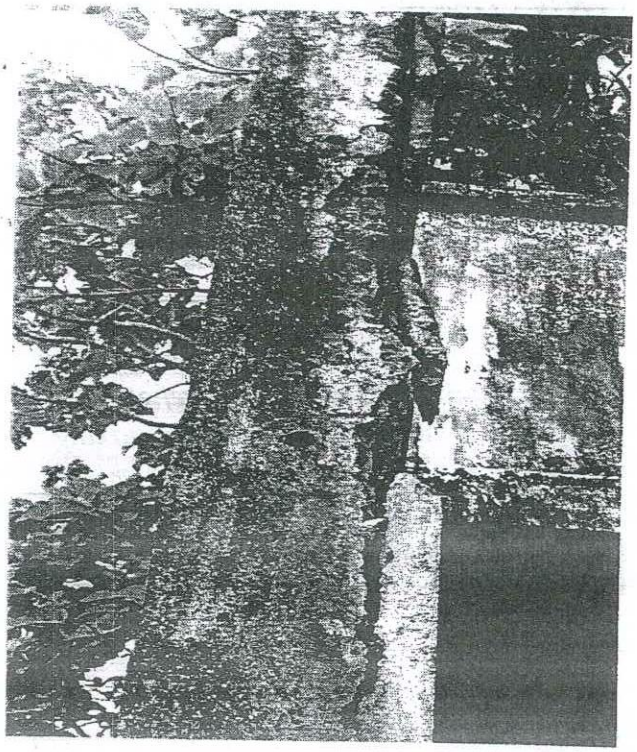

Fig. Q3 Deteriorated reinforced concrete column of an overhead water tank

Table Q5.1 Trail water contents to achieve different workability requirements

Slump (mm)		0-10	10-30	30-60	60-180
Vebe time (s)		>12	6-12	3-6	0-3
Maximum size of aggregate (mm)	Type of aggregate				
10	Uncrushed	150	180	205	225
	Crushed	180	205	230	250
20	Uncrushed	135	160	180	195
	Crushed	170	190	210	225
40	Uncrushed	115	140	160	175
	Crushed	155	175	190	205

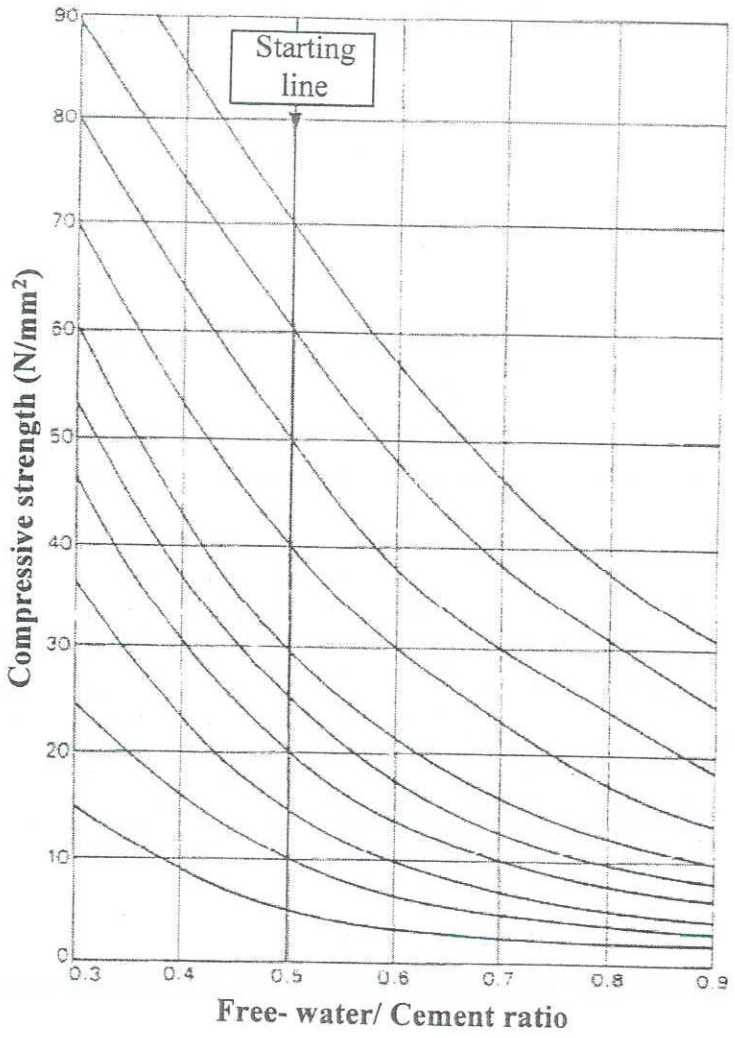

Fig. Q5.1 Compressive strength against free water cement ratio

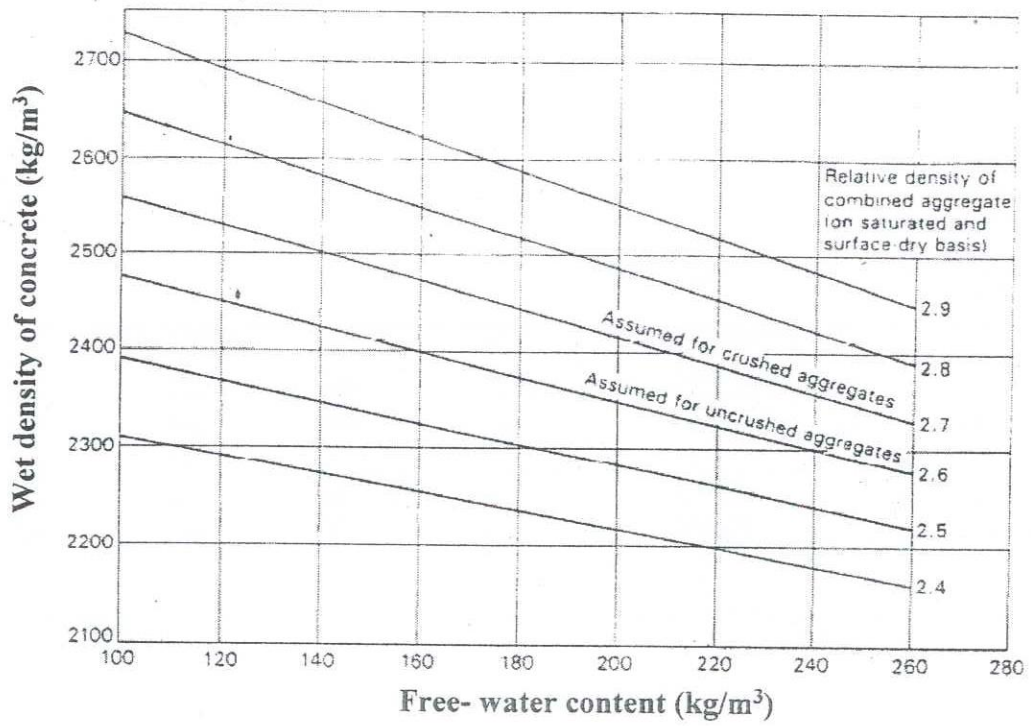

Fig. Q5.2 Wet density of concrete against the free water content for different relative density of the aggregate mix.

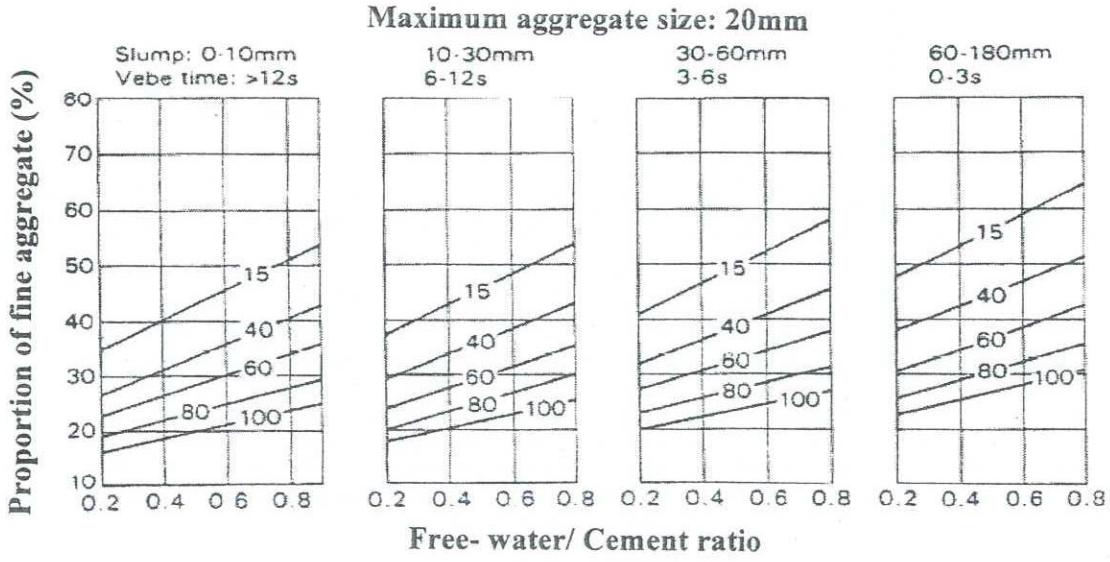

Fig. Q5.3 Fine aggregate content as a percentage of total aggregate content determined for different free water cement ratio and workability for 20mm maximum aggregate size