UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: March 2026

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

[Three Hours]

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

Q1 a) Explain the mechanisms of the following three sources of early age cracking: Plastic shrinkage cracking, Plastic settlement cracking, and Early age thermal cracking

[4 Marks]

b) Despite concrete being one of the most durable construction materials, there are still many durability issues related to concrete construction. Name three major durability issues of reinforced concrete and explain their mechanisms.

[4 Marks]

c) The use of pozzolanic material in concrete products has the potential to improve the durability of concrete against all forms of durability issues.

i) Identify the different cement standards available in Sri Lanka with pozzolanic compositions,

ii) Identify the common pozzolanic materials used in different cement standards

iii) Explain how the use of pozzolanic material improves the durability of concrete, potentially, against all forms of durability issues.

[4 Marks]

Q2. It has been found from an initial study that 28 day compressive strength of concrete for a given crushed coarse aggregate (20 mm maximum) and river sand at Water/Cement (W/C) ratio of 0.5 is 45 MPa.

a) Calculate the target strength for a characteristic strength of 40 MPa concrete.
Note:-
Target strength is the mean strength of the concrete at which no more than 5% of test specimens fall below the required characteristic strength of concrete.
Considering the general variability of the concrete mixing and the materials, it is safe to assume the standard deviation of the concrete is 8 MPa with strength determined using less than 20 samples which is the case for this particular mix design exercise.
The compressive strength of the 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.

[1 Mark]

b) Find mix proportions for the calculated target strength in Part (a) for a required slump range of 30-60 mm. In this part of the calculation, assume that both the fine and coarse aggregates are in saturated surface dry condition (SSD). Take the specific gravity of the coarse and fine aggregate mix as 2.65. Percentage of river sand passing the 600 μm sieve is 40% of the total aggregate content.

Note:-
The following tables, charts, and instructions extracted from the British method of mix section (DoE guideline) are provided.
Trial water contents for the different workability requirements are given in Table Q2.1.
The trend of Compressive strength against Free Water/Cement ratio is given in Fig. Q2.1.
Variation of fresh concrete density against water content for different values of specific density of fine and coarse aggregate mix is shown in Fig. Q2.2.
Fig. Q2.3 indicates fine aggregate content as a percentage of total aggregate content required for concrete, depending on the water/cement ratio, workability requirement, maximum size of aggregate (20mm in this case) 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, as indicated in Table 2.1.

[4 Marks]

c) Calculate the amendments to the water and the aggregate contents based on the following additional information on the moisture absorption for saturated surface dry conditions of the aggregate and the natural moisture content of aggregates at the time of mixing.
Moisture absorption for SSD condition of fine aggregate (river sand) 1.5%
Moisture absorption for SSD condition of coarse aggregate 0.45%
The natural moisture content of fine aggregate (river sand) 4.25%
The natural moisture content of coarse aggregate 1.5%
Note:-
All above percentages are expressed with respect to the bone-dry weight of the aggregate.

[4 Marks]

d) Concrete cast with all the above adjustments tested at 28 days was found to be 5 N/mm^2 short of the target strength and, as a result, has not achieved the required characteristic strength with the required accuracy. Explain this statement in statistical means and suggest the approach you would use to rectify the lack of strength.
(For both parts of the question, no calculations are required. For the method of rectification, use Fig. Q2.1 to elaborate your method by which the next trial mix proportion is decided)

[3 Marks]

Table Q2.1 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

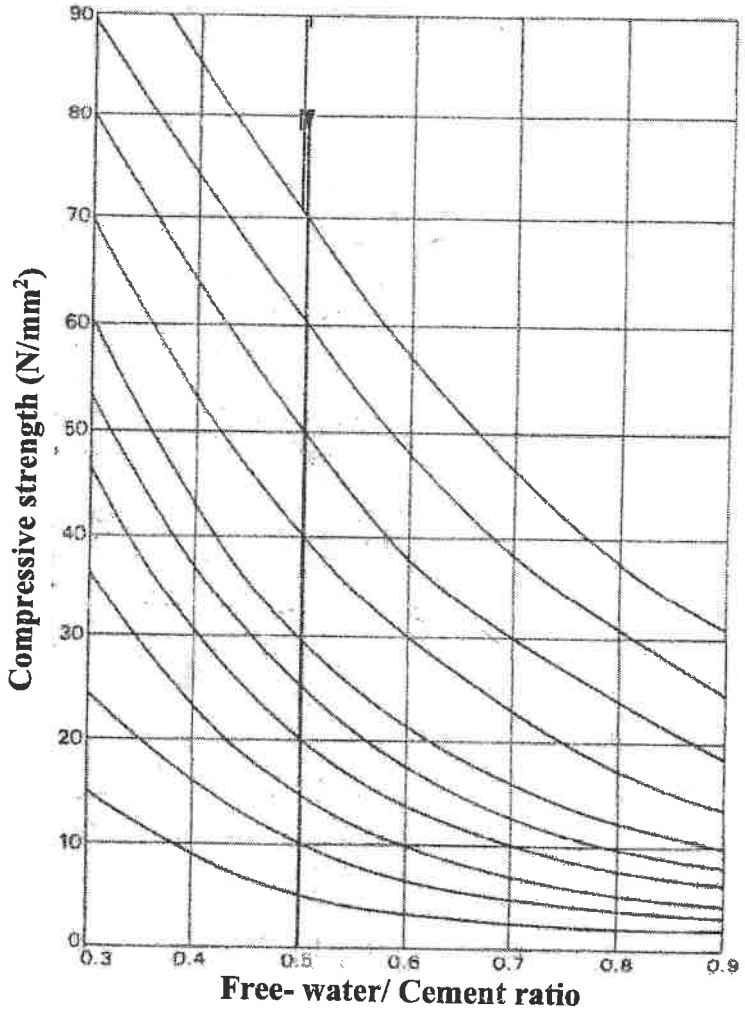

Fig. Q2.1 Compressive strength against free water cement ratio

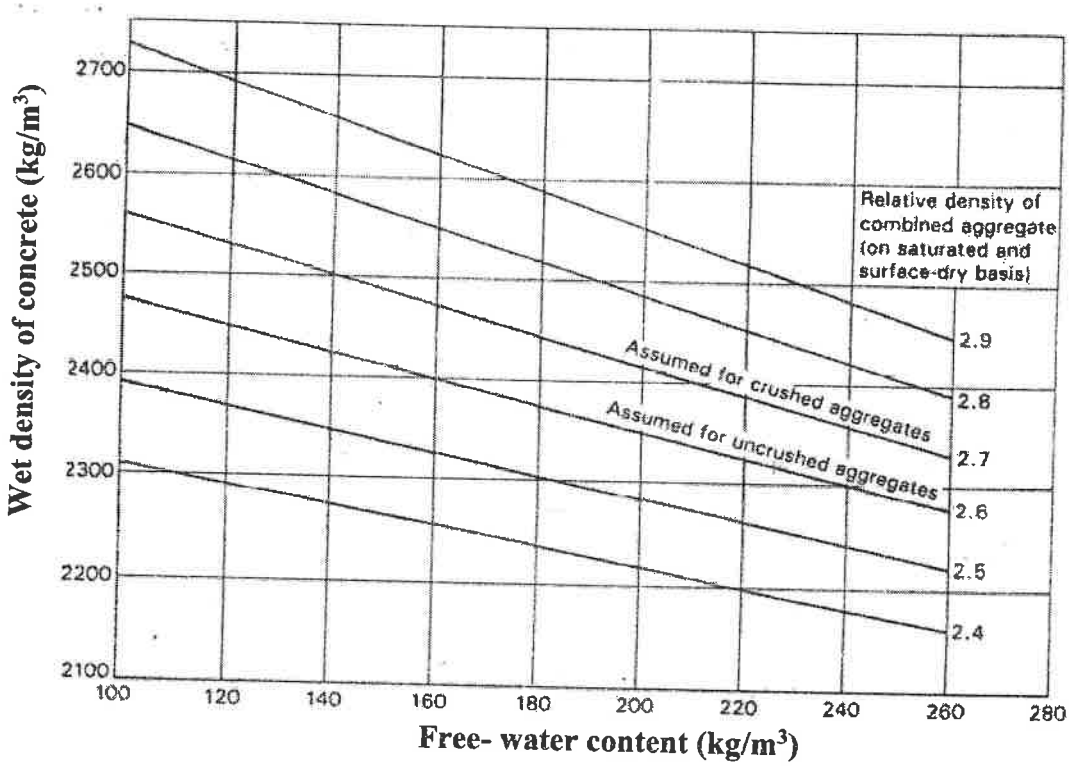

Fig. Q2.2 Wet density of concrete against the free water content for different relative densities of the aggregate mix.

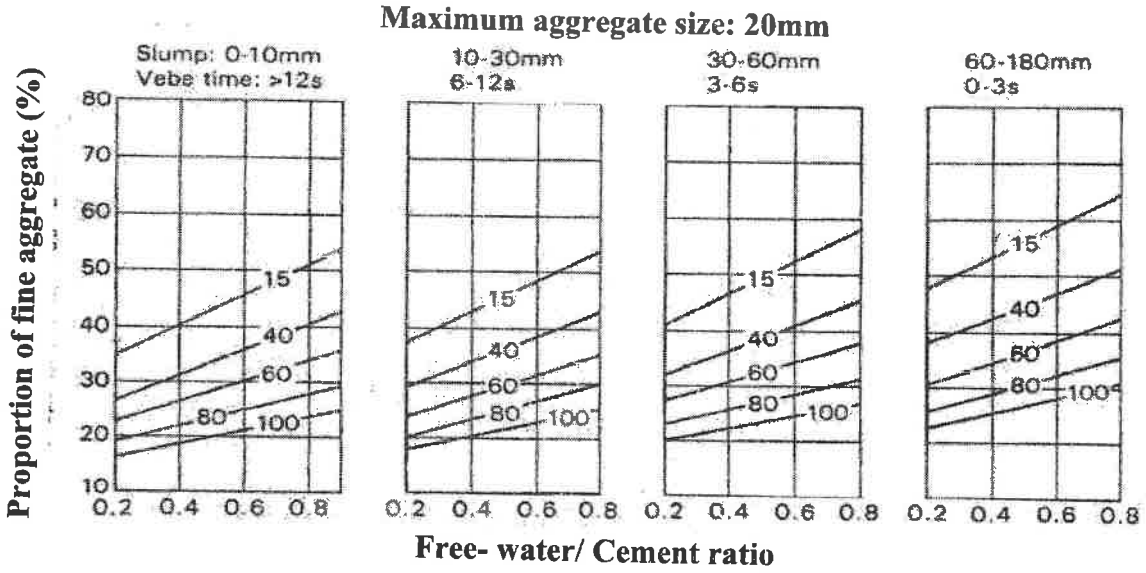

Fig. Q2.3 Fine aggregate content as a percentage of total aggregate content determined for different free water cement ratio and workability for 20mm maximum aggregate size

Q3 a) List out three types of cements and discuss their properties.

[2 Marks]

b) Discuss a field test to identify the quality and suitability of cement, sand, and coarse aggregate used in the concrete mixtures.

[2 Marks]

c) Discuss the importance of using mineral admixtures in concrete mixtures. List two benefits of using mineral admixtures for each fresh and hardened concrete state.

[2 Marks]

d) If reinforced concrete elements are exposed to the sea breeze caused severe corrosion damage, i) explain how you identify the severity of the corrosion of reinforcement bars and ii) explain how you identify a suitable retrofitting technique that can be applied to mitigate corrosion effects and strengthen the beam satisfying the required strength capacities.

[2 Marks]

e) Explain with examples, cause of occurrence and methods to minimize wastage of materials, human recourses and equipment & plants in local construction sites.

[2 Marks]

f) Discuss the common types of accidents in the construction industry and the precautionary measures that can be implemented to minimize them.

[2 Marks]

Q4. a) i) Explain the difference between shrinkage and creep deformation in concrete.

[2 Marks]

ii) Briefly explain autogenous shrinkage in concrete while clearly differentiating it from drying shrinkage.

[2 Marks]

iii) Discuss methods that can be used to minimize autogenous shrinkage in concrete.

[2 Marks]

b) i) Identify two types of spalling that may occur in concrete when exposed to fire.

[1 Mark]

ii) Compare the fire performance of ultra-high-strength concrete with that of normal-strength concrete.

[2 Marks]

iii) Describe the changes in the chemical composition and physical structure of concrete when exposed to high temperatures (above 400–500 °C). Explain how these changes affect the strength of concrete.

[3 Marks]

Q5. A contractor plans to construct a four-story reinforced concrete school building comprising columns, beams, and a 150 mm-thick slab in a hot and humid environment with a short construction schedule. In previous projects, the contractor experienced formwork deformation, excessive deflection, and difficulties in formwork removal that damaged concrete surfaces. As a civil engineer responsible for the construction works, answer the following:

a) Identify and explain briefly two factors that should be considered when selecting a suitable formwork system for this project.

[2 Marks]

b) The contractor is considering to use timber, steel, and aluminum formwork systems. Compare different formwork systems (timber, steel, and aluminum) and discuss the situations in which each system is most suitable.

[4 Marks]

c) Draw a neat sketch of a typical slab formwork system and label its main components.

[4 Marks]

d) Suggest two engineering measures that can be implemented to prevent formwork failure or excessive deformation during concrete placement.

[2 Marks]