UNIVERSITY OF RUHUNA

Faculty of Engineering

End Semester 3 Examination in Engineering: March 2021

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

[Three Hours]

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

Q1. a) Discuss the reasons why fire safety engineering is an important aspect in designing tall buildings and the methods that can be used to improve the fire resistance of concrete structures.

[3 Marks]

b) Discuss three main parameters that need to be considered in determining the fire resistance of concrete elements in a multi storied building.

[3 Marks]

c) Identify four types of accidents that can be occurred in the construction industry and explain their nature of occurrence.

[3 Marks]

d) Discuss the awareness of the legal aspects and safety polices, which are applicable in the construction industry, and practicing by the contractors.

[3 Marks]

Q2. a) Explain the responsibilities of Civil Engineers towards improving efficiency of workmanship, health and welfare facilities in construction sites.

[3 Marks]

b) List out four investigative tools (two for each destructive and non-destructive) available for detail investigation of quality in reinforced concrete structures by the engineers. Your answer should include reliability, accuracy and easiness of the testing for the reinforced concrete structures.

[3 Marks]

c) Explain the principal measurements of two of the non-destructive tests listed in part Q2. (b) and how those measured data can be used in predicting a quality of the reinforced concrete.

[3 Marks]

d) It was noted that non-destructive test results carried out are not much reliable due to many reasons. Discuss how you could improve quality of measurements in non-destructive testing in the field.

[3 Marks]

Q3. As a construction engineer attached to a reputed company in Sri Lanka, you have been asked to design a slab formwork system for an apartment complex in Rathnapura District where heavy rain and landslides are expected during rainy season.

a) How do you identify importance of designing of the formwork and what are the main parameters to be considered in designing of the slab formwork in a multi storied building? Discuss four parameters for the above requirement.

[3 Marks]

b) Sketch a clear diagram of slab formwork indicating all essential elements. Identify suitable materials and appropriate section sizes for the above each element. Justify your selections based on the appropriateness for the above site.

[3 Marks]

c) What are the necessary legal measures that should be carried out by a contractor after an accident occurred in a construction site?

[3 Marks]

d) What are the precautions or measures that can be taken to improve the safety, health and welfare aspects in a local construction site? Give three considerations for each aspect.

[3 Marks]

Q4. Due to its proximity to the sea, corrosion of steel reinforcement is one of the main durability concerns of reinforced concrete structures in Sri Lanka

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

[2 Marks]

b) List out methods that can be employed to mitigate reinforcement corrosion in highly corrosive environments.

[2 Marks]

c) Name two other mechanisms of deterioration of reinforced concrete and explain one of them.

[3 Marks]

d) Discuss the advantages and disadvantages (if any) of the use of blended cement in concrete as a measure to improve durability of reinforced concrete structures against reinforcement corrosion.

[3 Marks]

e) Explain the advantages of using advance composite materials (i.e. FRP) as reinforcing materials of concrete.

[2 Marks]

Q5. It has been found from an initial study, that 28 day compressive strength of concrete made from crushed coarse aggregate (20mm maximum aggregate size) and river sand at water to cement ratio (W/C) of 0.5 is 48 MPa. The percentage of river sand passing the 600 μm sieve is about 50%. Specific gravity of the coarse and fine aggregate mix is 2.65.

a) Calculate target strength for Grade 35 concrete.

Note:-
Target strength is the mean strength of the concrete at which no more than 5% of test specimen fall below specified 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.
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.

[1 Mark]

b) Assuming that both the fine and coarse aggregates are in the saturated surface dry condition (SSD), find mix proportions for the calculated target strength in part (a) that has workability equivalent to 30-60 mm slump measured using the standard slump cone test.

Note:-
Following tables, charts and instructions are extracted 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 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 indicate content of fine aggregate as a percentage of total aggregate depending on the water/cement ratio, workability requirement, maximum size of aggregate and fineness ratio of fine aggregate used in the mix.
Water content of the mixed aggregate 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.

[5 Marks]

c) For a given day it is found that the natural moisture content of the coarse aggregate is 1.0% and for river sand is 1.5%. The moisture absorption for the SSD condition of the two aggregates, coarse and fine is 0.4% and 0.8%, respectively. Calculate the adjusted mix proportions according to the natural moisture content of the coarse and fine aggregates.

[3 Marks]

d) Use answer to part (c) above to explain the different scenarios of possible variation of strength and workability of the mix in the event of no adjustments are made in relation to aggregate and water based on natural moisture content of the aggregate.

[3 Marks]

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

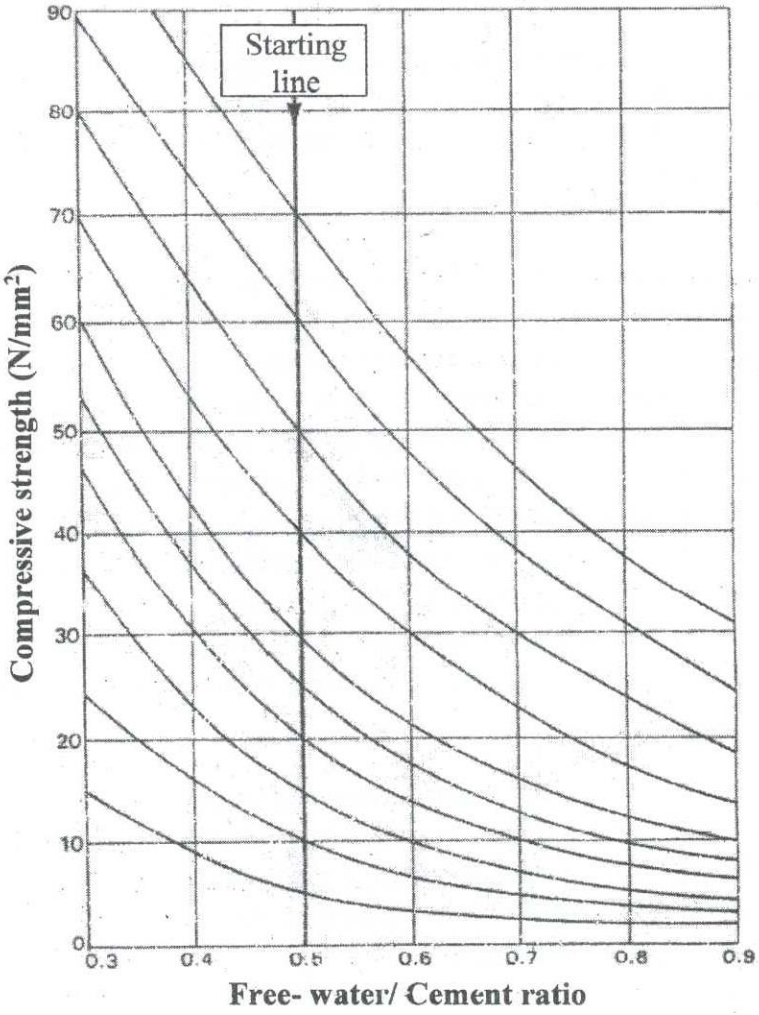

Fig. Q5.1 Compressive strength against free water cement ratio

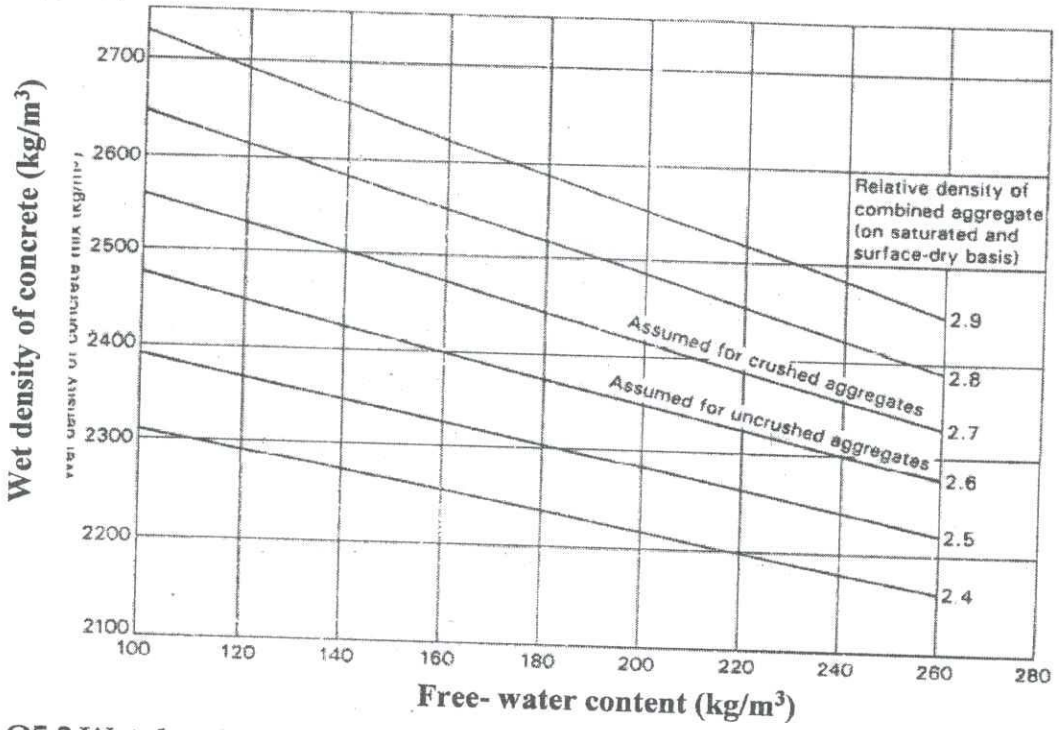

Fig. Q5.2 Wet density of concrete against the free water content for different relative density of the aggregate mix.

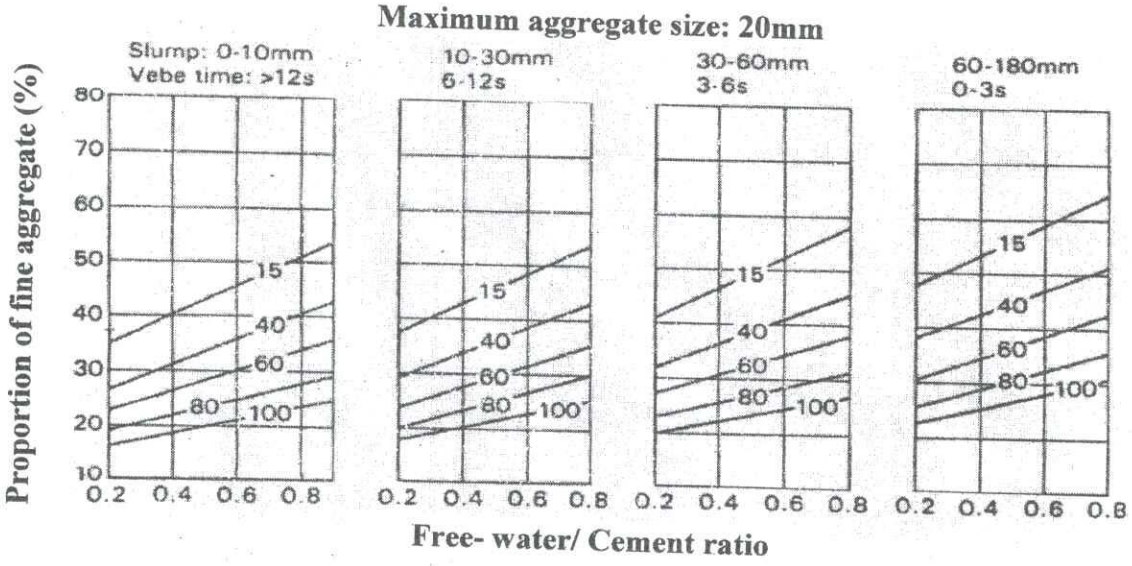

Fig. Q5.3 Fine aggregate content as a percentage of total aggregate content determined for different free water cement ratio and workability for 20mm maximum aggregate size