UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: July 2017

Module Number: CE 3202 **Module Name: Concrete Technology**

[Three Hours]

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

Q1. a) List three deterioration mechanisms that have implication on the durability of concrete structures.

[2 Marks]

b) Explain why it is considered that Delayed Eettringite Formation as a durability concern for concrete but Early Ettringite Formation is a helpful reaction in cement and concrete applications.

[4 Marks]

c) List three methods that can be commonly employed to mitigate durability threats to cement and concrete applications.

[2 Marks]

d) Explain the mechanism by which the two of the methods mentioned above improve the resistance of concrete from durability threats giving examples of potential durability issues that can be mitigated by each of the methods.

[4 Marks]

Q2. It has been found from an initial study that 28 day compressive strength of concrete for a given crushed coarse aggregate (20mm maximum aggregate size) and the river sand at W/C ratio of 0.5 produces an average strength of 42 MPa at 28 days. Percentage of river sand passing the 600 μm sieve is considered 40% from the total aggregate content. Specific gravity of the coarse and fine aggregate mix can be assumed as 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.

[2 Marks]

b) Find mix proportions for the calculated target strength in Part (a) for a required slump of between 60-180 mm. For this calculation 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 Q2.1.
Trend of change of compressive strength to 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 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 1.5% and that for sea 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.

[2 Marks]

d) Discuss the implication of the final results of the mix in terms of the workability of the mix and the strength of concrete in an instance where adjustment to water content based on the natural moisture content of aggregates have not been made. Use the answer to Part c) above to explain the different scenarios of possible variation of strength and workability of the mix in event of no adjustment are made in relation to aggregate and water based on natural moisture content of the aggregate.

[3 Marks]

Q3. a) What are the precautions or measures that can be taken to improve the safety, health and welfare aspects in a construction site?

[3 Marks]

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

[3 Marks]

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

[3 Marks]

d) Identify the problems associated with implementation of safety practices in the construction industry.

[3 Marks]

Q4. a) Explain with examples, cause of occurrence and how we can minimize wastage of materials and human recourses in local construction sites.

[3 Marks]

b) It is identified that sources of waste can be classified into four major categories: Operational waste, Design waste, Waste during material handling and Procurement waste. Briefly explain with examples how you minimize the each category of the waste.

[3 Marks]

c) Identify critical factors considered in formwork planning, construction of form work and dismantling of formwork. List two examples for each case.

[3 Marks]

d) Discuss three risk assessments undertaken for all formwork activities (listed in part Q5. (c)) at the construction site.

[3 Marks]

Q5. Sea sand is extensively used for the concrete works in the construction of Humbantota port. It is considered that sea sand is a rich source of Cl^- irons.

a) Explain what potential problems sea sand can have on the durability of reinforced concrete structures and how the Cl^- concentration of sea sand can be reduced to acceptable levels.

[3 Marks]

b) Explain what protection concrete provides against the corrosion of steel

[3 Marks]

c) Discuss the chloride attack and subsequent formation of the electro chemical cell explaining the anodic and catholic reactions

[3 Marks]

d) Other than limiting the Cl^- iron concentration of constituent material, what other methods and devices can be used in mitigating corrosion of steel reinforcement in concrete structure which is predominantly caused by external Cl^- sources (e.g. sea spray and proximity to sea).

[3 Marks]

Table Q2.1 Trial 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

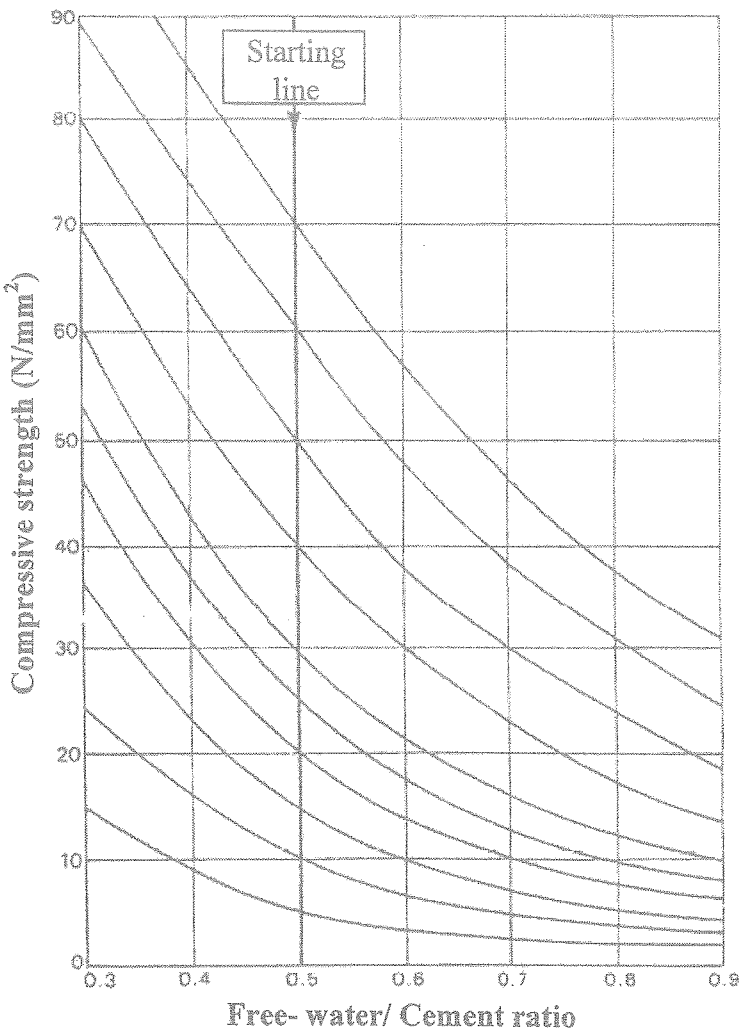

Fig. Q2.1 Compressive strength against free water cement ratio

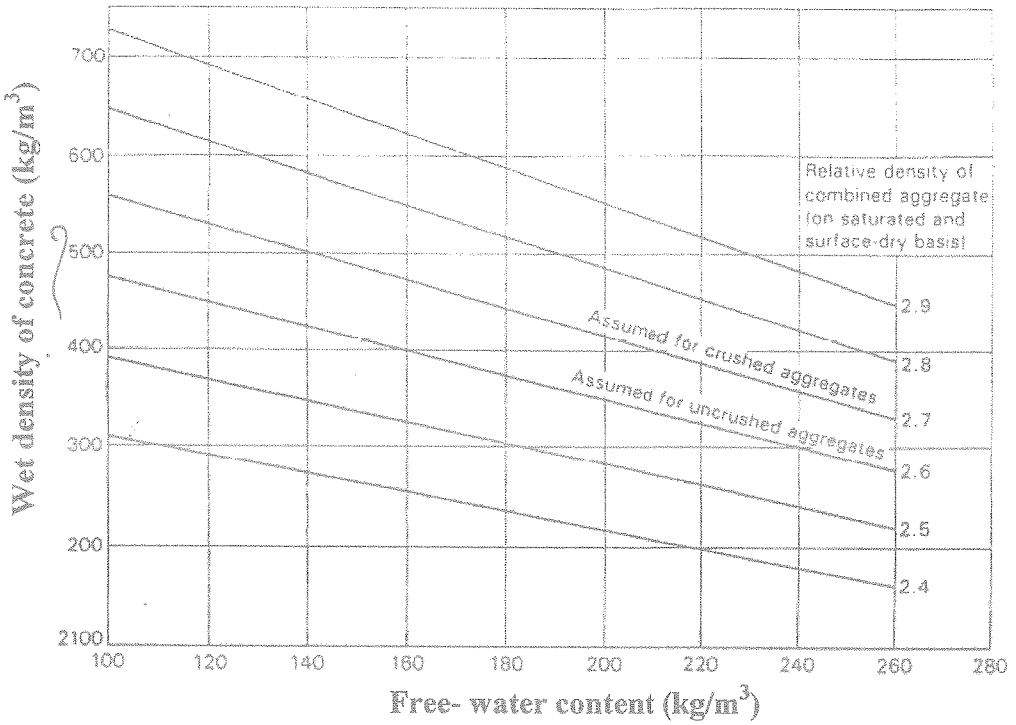

Fig. Q2.2 Wet density of concrete against the free water content for different relative density of the aggregate mix.

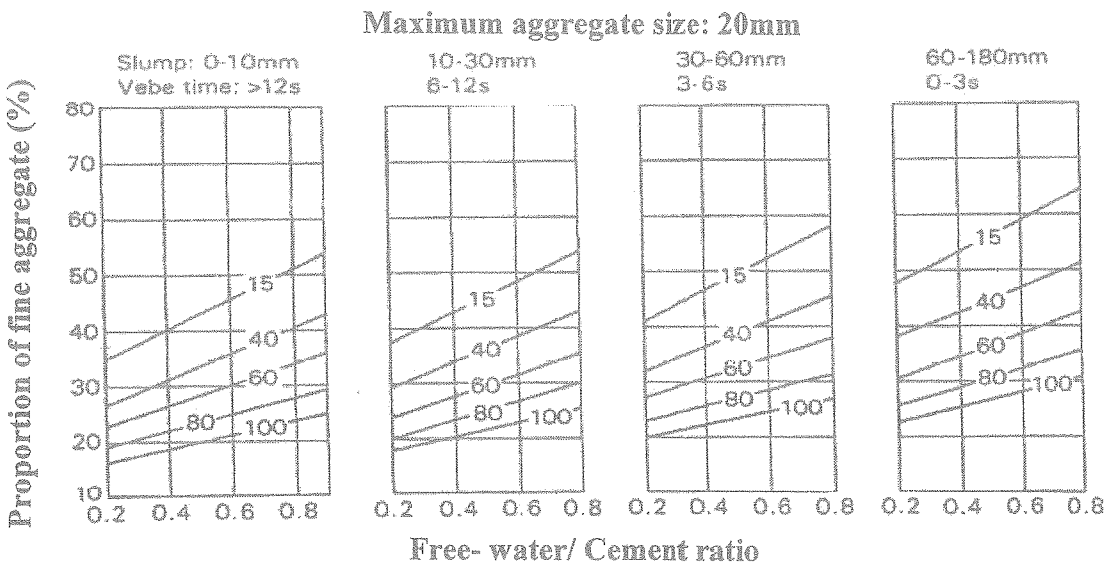

Fig. Q2.3 Fine aggregate content as a percentage of total aggregate content determined for different free water cement ratio and workability for 20mm maximum aggregate size