UNIVERSITY OF RUHUNA

Faculty of Engineering

End Semester 3 Examination in Engineering: July 2016

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

[Three Hours]

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

Q1.

a) Explain what is meant by alkali silica reaction, methods to mitigate effects of the reaction in the case of suspected aggregate source

[3 Marks]

b) "Early Ettringite formation is not harmful, however delayed Ettringite formation is considered harmful". Discuss the above statement explaining the instances of early and delayed Ettringite formation and its implication on the durability of concrete structures.

[3 Marks]

c) Discuss the role of Tri Calcium Aluminate and its hydride in different deterioration mechanisms namely; sulfate attack, alkali silica reaction and chloride attack.

[3 Marks]

d) Discuss the advantages and disadvantages (if any) of the use of blended cement in concrete in terms of making concrete more durable.

[3 Marks]

Q2. It has been found from an initial study that the 28 days compressive strength of concrete at W/C ratio of 0.5 for a given crushed coarse aggregate (20mm maximum aggregate size) and the sea sand (naturally weathered) is 49 MPa. Percentage passing the 600 μm sieve as a percentage of total fine aggregate content is found to be 60% for the sea sand. Consider the specific gravity of the coarse and fine aggregate mix is 2.65.

a) Calculate target strength for Grade 25 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 coarrse aggregate are in saturated surface dry condition (SSD).

Note:-
Following tables, charts and instructions extracted 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 with 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. Q 2.2.
Fig. Q2.3 indicates content of fine aggregate to be used in the mix as a percentage of total aggregate. This depends 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 (crushed and uncrushed) 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.

[3 Marks]

c) For a given day it is found that the natural moisture content is 1% for coarse aggregate and 2% for fine aggregate (sea sand). Assuming that the moisture absorption for the SSD condition of the two aggregate, coarse and fine, is 0.5% and 0.6% respectively, find the adjusted mix proportions.

[3 Marks]

d) Assume that the above mix selection has addition constraints to ensure that the cement content of the mix to be between 400 kg/m^3 and 500 kg/ m^3 and that the minimum W/C ratio of the mix to be 0.5.

i) Based on the calculation above part Q2. (b) described what limitations you would face now in selecting concrete mix for the above designation under the above constrains.

[1 Mark]

ii) Suggest mix proportions based on the above limitations and discuss what implication your selection will have on the desirable strength and workability limits of the original mix.

[3 Mark]

Q3. a) Explain the responsibilities of Civil Engineers towards improving efficiency of workmanship in construction industry.

[3 Marks]

b) List four investigative tools (both destructive and non-destructive) available for the engineer for detail investigation of quality in concrete structures.

[3 Marks]

c) Explain the principal measurements of two of the non-destructive tests listed in part Q3. (b) and how those measured data can be used in predicting quality of the 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]

Q4. Due to its proximity to the sea, reinforcement corrosion is one of the main causes of deterioration of concrete structures in Sri Lanka.

a) Discuss the influence of four factors that caused corrosion of steel reinforcement in concrete structures.

[3 Marks]

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

[3 Marks]

c) List methods of mitigating corrosion damage of reinforced concrete structures.

[3 Marks]

d) Discuss how you differentiate cracks due to alkali-silica reaction with other type of cracks in concrete structures.

[3 Marks]

Q5. a) Identify critical factors considered in formwork planning, construction of form work and dismantling of formwork. Give four examples for each case.

[3 Marks]

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

[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) 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]

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

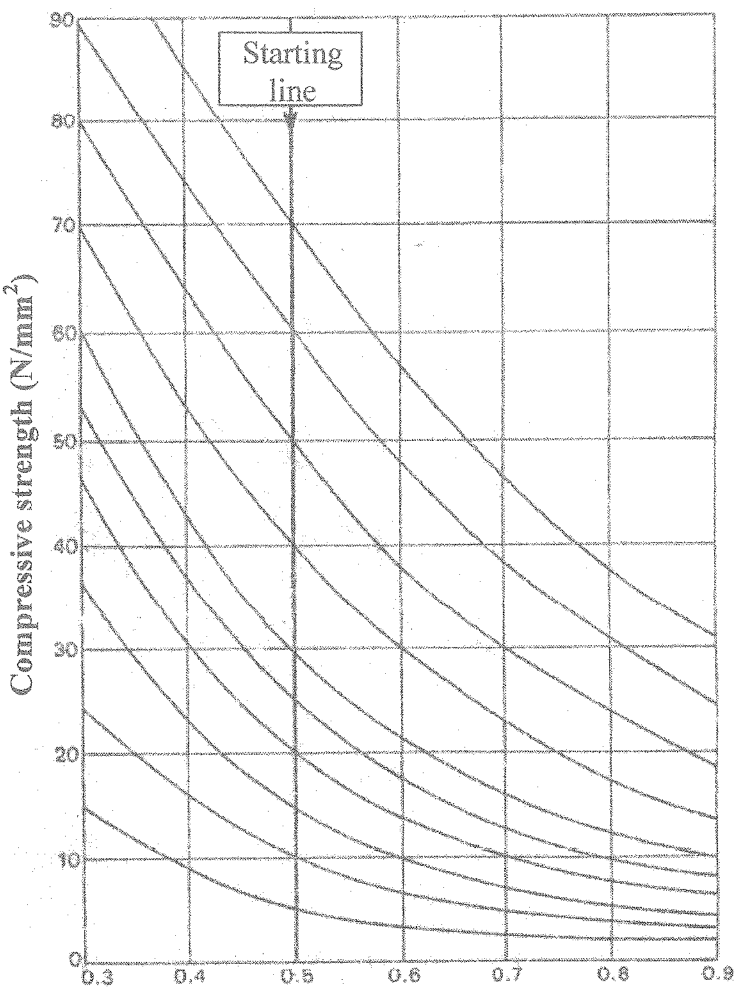

Fig. Q2.1 Compressive strength against free water cement ratio

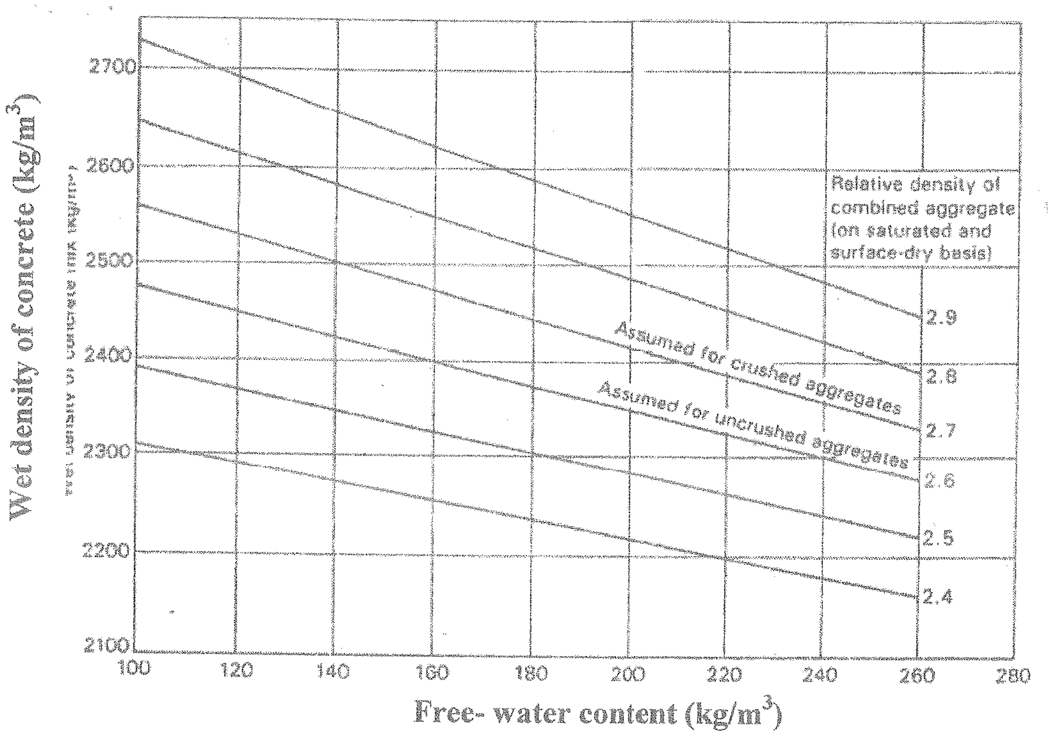

Fig. Q2.2 Wet density of concrete against the free water content for different relative density of the aggregate mix.

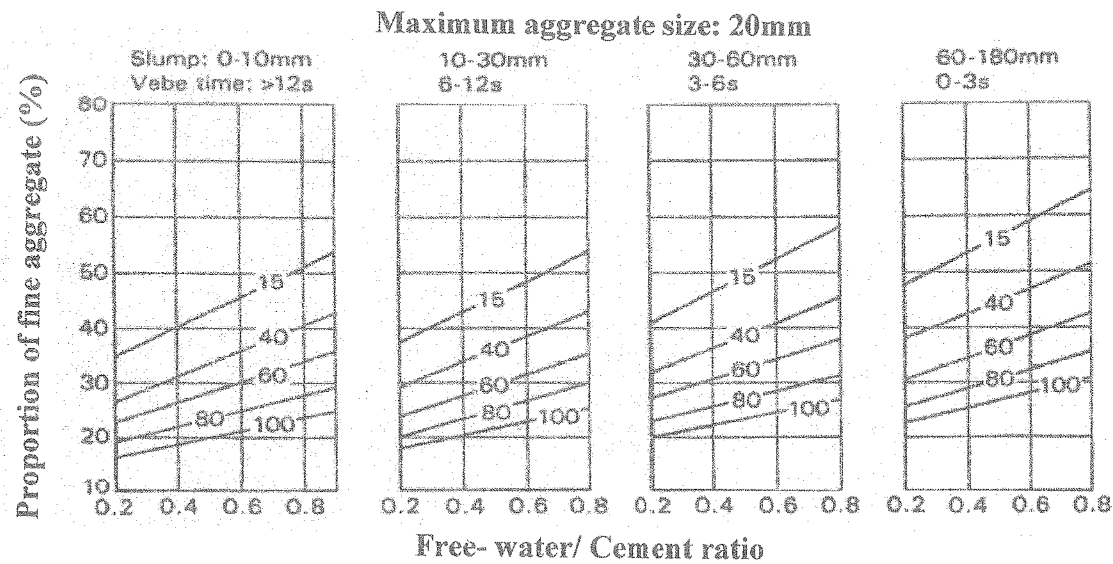

Fig. Q2.3 Fine aggregate content as a percentage of total aggregate content determined for different free water cement ratio and workability for 20mm maximum aggregate size