UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: August 2018

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

[Three Hours]

[Answer all questions, each question carries twelve marks]

Q1. a) Discuss 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, among the contractors.

[3 Marks]

Q2. a) As a construction engineer attached to a reputed company in Sri Lanka, 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?

[3 Marks]

b) Sketch a clear diagram of slab formwork indicating all essential elements. Identify suitable materials and appropriate section sizes for above each element.

[3 Marks]

c) Discuss occurrence of three type of formwork failures in construction sites and preventive actions should be taken by site management to overcome such failures.

[3 Marks]

d) What are the necessary checks that should be carried out during the following stages of formwork processes? Write down at least two checks for each process.

i) Planning of formwork system for a construction project
ii) Assembling of formwork system for a construction project
iii) Dismantling of formwork system after completion of the project

[3 Marks]

Q3. a) Defect prevention should be a collaborative effort of both the designer and the contractor. Explain the responsibilities of each towards the defect free structure.

[3 Marks]

b) Defects are initially identified by thorough visual observations of the structure. List five investigative tools (both destructive and non-destructive) available for the engineer for detail investigation of defects in concrete structures.

[3 Marks]

c) Explain the principal measurements of three of the non-destructive tests listed in Part (b) and how those measured data can be used in predicting quality of the concrete.

[3 Marks]

d) Occurrence of honeycomb is one of the frequent defects in reinforced concrete structures. What are the main reasons for formation of honeycombs and discuss how you repair such defects?

[3 Marks]

Q4. a) Name three cement types available in the market and identify them in terms of their compositions.

[3 Marks]

b) Explain how the use of pozzolanic material can improve the durability characteristics of concrete.

[3 Marks]

c) Cracks sustained along the reinforcement, chipping of concrete and falling off of concrete are common features of corrosion damage in reinforced concrete structures. Explain methods to establish possible vulnerability of corrosion damage in existing structures.

[3 Marks]

d) Explain the method to restore the structural performance of structures subjected to corrosion damage highlighting key consideration of the repair in terms of material selection, selection of repair dimensions and surface preparation.

[3 Marks]

Q5. It has been found from an initial study that 28 days compressive strength of concrete for a given crushed coarse aggregate (20 mm maximum aggregate size) and the manufactured sand (quarry dust) as fine aggregate at W/C ratio of 0.5 produces an average strength of 48 MPa at 28 days. Percentage of manufactured sand passing the 600 μm sieve is 40% from the total fine aggregate content. Specific gravity of the coarse and fine aggregate mix can be assumed as 2.65.

a) Calculate target strength for Grade 40 concrete.

Note:-
Target strength is the mean strength of the concrete at which no more than 2.5% 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 8 MPa.
Compressive strength of concrete cube test is assumed to follow standard normal distribution and the value of 97.5% confidence interval for standard normal distribution is equal to 1.96.

[1 Mark]

b) Find mix proportions for the calculated target strength in Part (a) for a required slump of between 30-60 mm. For this calculation assume that both the fine and coarse aggregate are in saturated surface dry (SSD) condition.

Note:-
Following tables, charts and instructions are extract from the British Method of Mix 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.

[3 Marks]

c) For a given day it is found that the natural moisture content is 0.85% for the coarse aggregate and 1.5% for the sea sand. Assuming that the moisture absorption for the SSD condition of the two aggregate (i.e coarse and fine) is 0.5% and 0.98%, respectively. Find the adjusted mix proportions.

[3 Marks]

d) Due to extra roughness of the crushed fine and crushed coarse aggregate it is found that the above proportions have not been able to produce the required workability and that the workability of the mix was between 0-10 mm.

i Explain the means to adjust the above mix to obtain the desired workability without altering target strength.

[2 Marks]

ii Calculate the new trial mix proportions according to the explanations in Q5(d) (i).

[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

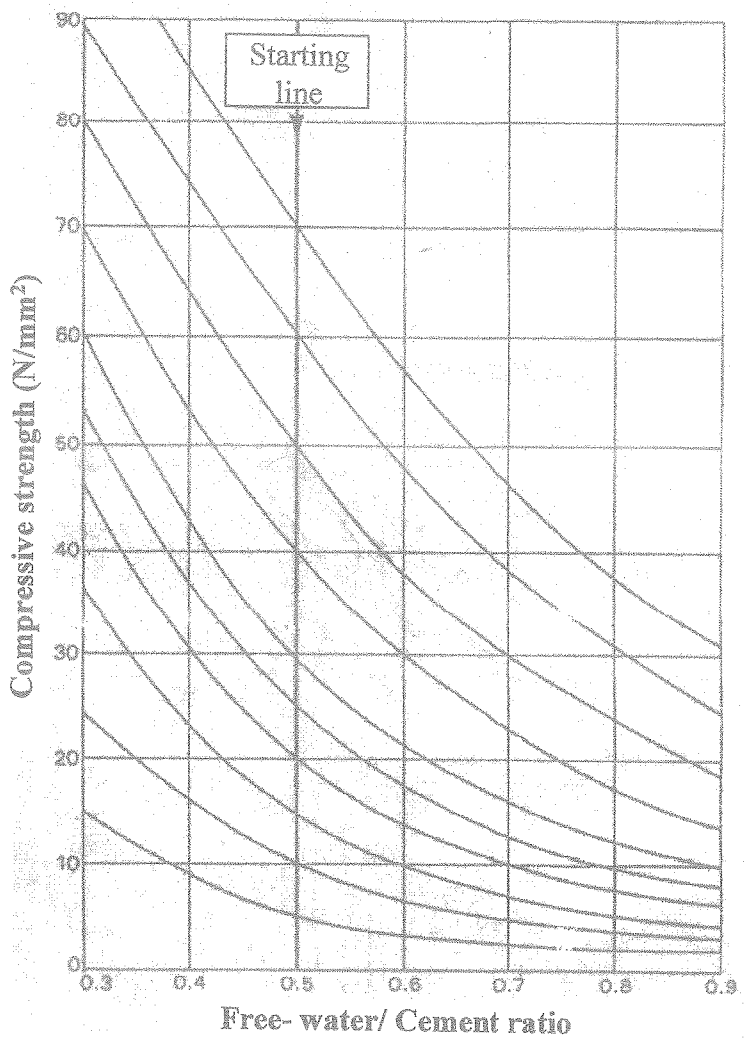

Fig. Q5.1 Compressive strength against free water cement ratio

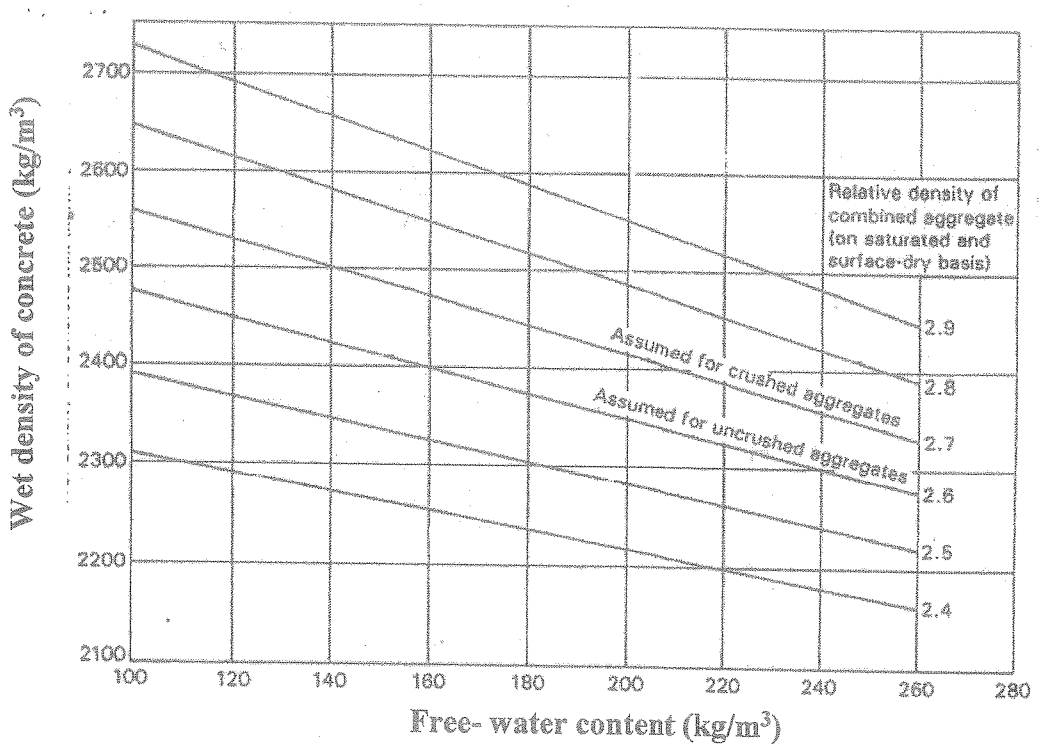

Fig. Q5.2 Wet density of concrete against the free water content for different relative density of the aggregate mix.

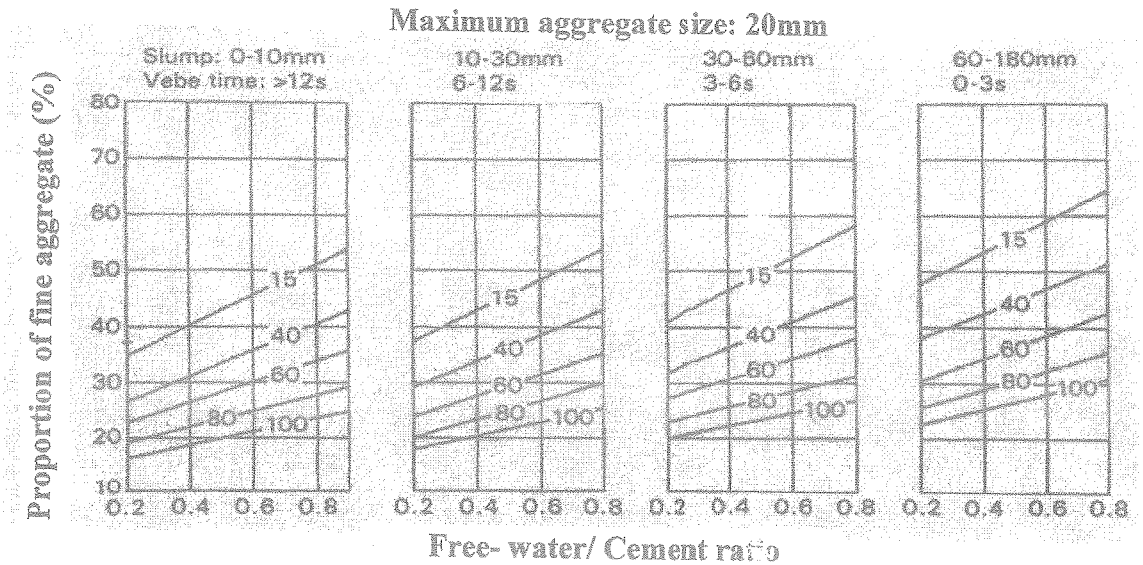

Fig. Q5.3 Fine aggregate content as a percentage of total aggregate content determined for different free water cement ratio and workability for 20mm maximum aggregate size