First Semester Examination
2021/2022 Academic Session

February/March 2022

EAS153 – Civil Engineering Materials

Duration : 2 hours

Please check that this examination paper consists of **ELEVEN (11)** pages of printed material including appendix before you begin the examination.

Instructions : This paper contains **SIX (6)** questions. Answer any **FOUR (4)** questions.

All questions **MUST BE** answered on a new page.

1. (a). Asbestos was found to be harmful and can cause serious illness. It can be replaced by other materials in building construction. Identify **TWO (2)** suitable materials that can be used to replace asbestos in EACH of the following building components.

   i) Asbestos roof
   ii) Asbestos wall
   iii) Asbestos pipe
   iv) Asbestos insulator
   v) Asbestos flooring

[10 marks]

(b). Endogenous trees are not recommended to be used as structural component. List **TWO (2)** examples of endogenous trees and explain the reasons they are not recommended to be used as structural component.

[5 marks]

(c). Explain **FIVE (5)** timber characteristics that are improved after the seasoning process.

[10 marks]

2. (a). **Table 1** shows the data of load and displacement from a steel tensile test conducted at USM School of Civil Engineering.

i) Plot a graph and include all the phases of elastic and plastic regions.

ii) Determine the yield value and the ultimate stress. The area of steel is 77.19 mm^2.

iii) Identify either this is a mild steel or a high tensile steel.

[17 marks]

Table 1

	Load (kN)	Displacement (mm)
1	0	0
2	9.0018	1.9053
3	29.0042	5.2585
4	39.0706	6.9787
5	40.9015	7.5121
6	43.4168	8.8338
7	42.6343	9.4465
8	40.5825	10.5185
9	42.1287	27.6783
10	45.6548	40.0574
11	47.2344	52.0901

b) Explain the differences between fired clay brick, concrete masonry unit, stone block and green brick in term of based material, size, colour and manufacturing process. Answer your question in a tabular form.

[8 marks]

3. (a). Discuss the effects of water/cement ratio on the strength of concrete.

[5 marks]

(b). Calculate the amount of cement, water, fine aggregate, and coarse aggregate per trial mix of 0.005 m^3 of concrete. Use the data listed below: **(use the tables and graphs provided in the appendix and submit them together with your answer).**

- Characteristic compressive strength (f_c) = 30 N/mm^2 at 28 days, with a 2.5% defective rate
- Standard deviation = 8 N/mm^2
- Portland cement strength class 42.5
- Slump required = 10–30 mm
- Maximum aggregate size = 20 mm granite??
- Fine aggregate: 70% passing 600 μm sieve river sand??
- Specific gravity of aggregate = 2.6
- Maximum free-w/c ratio = 0.55
- Minimum cement content = 290 kg/m^3
- Maximum cement content = not specified.

[20 marks]

4. (a). List **FIVE (5)** methods to assess the workability of fresh concrete. Choose one method which is suitable to assess the workability of Self-Consolidating Concrete.

[6 marks]

(b). Slump is the measure of concrete consistency and fluidity. Explain the indication of true slump, shear slump and collapse slump in the slump test with the aid of suitable sketches.

[6 marks]

(c). In designing concrete structures, normally the maximum aggregate sizes adopted are within ranges of 10 mm to 20 mm. Discuss **TWO (2)** effects of increasing size of aggregate to more than 20 mm on the strength of concrete.

[5 marks]

(d). In construction, the use of high strength concrete is normally associated with high rise buildings and bridge structures.

i) Explain the requirements of high strength concrete for these types of structures.

[2marks]

ii) Describe the potential problems that may arise from the use of high strength concrete in the concrete structures.

[6 marks]

…6/-

5. The construction of a new high rise reinforced concrete building for commercial, office, and residential purposes has been planned in the area of George Town, Pulau Pinang. The mass concrete foundation of the planned high-rise building requires special cement with low heat evolution and high sulphate resistance characteristics. Select between the two Portland cements A and B with oxide compositions given in **Table 2** that better meets the requirements for the construction of the mass concrete foundation of the high-rise building. Justify your response with detailed discussion based on the compound compositions of the cements. Use the given Bogue's equations.

(25 marks)

Table 2 : Oxide compositions of cement

Oxide	**Content (%)**	
	Cement A	**Cement B**
CaO	61	63
SiO_2	24	20
Al_2O_3	4.3	6
Fe_2O_3	4.6	3
MgO	1.5	1.5
Alkalis	1	2
SO_3	1	1
Insoluble residue	0.5	1
Loss on ignition	1.1	2
Others	1	0.5

Bogue's Equations

$C_3S = 4.07(CaO) – 7.60(SiO_2) – 6.72(Al_2O_3) – 1.43(Fe_2O_3) – 2.85(SO_3)$

$C_2S = 2.87(SiO_2) – 0.754(3CaO.SiO_2)$

$C_3A = 2.65(Al_2O_3) – 1.69(Fe_2O_3)$

$C_4AF = 3.04(Fe_2O_3)$

6. (a). **Table 3** gives the gradation of two samples of sands A and B in term of weight retained on the relevant sieves. Determine the fineness modulus for each sand sample. Based on the fineness modulus values, explain which sand will require greater water content when used in concrete, assuming the quantity and characteristics of other materials used to be the same.

[15 marks]

Table 3 : Grading of Sand

Sieve Size	Weight Retained (g)	
	Sand A	Sand B
10 mm	0	0
5 mm	0	0
2.36 mm	0	63.1
1.18 mm	2.7	137.0
600 µm	10.1	112.1
300 µm	259.2	84.9
150 µm	173.1	48.8
Pan	8.9	9.1
Total	454	455

(b) A concrete mixture is required to be used in the construction of a mass concrete foundation of a bridge. Select **ONE (1)** suitable combination of admixtures from the provided list that you think could be used together with Portland cement and other concrete ingredients so as to facilitate placing and compaction in the heavily reinforced mass concrete foundation, as well as to reduce the heat development within the mass concrete foundation in order to reduce the risk of occurrence of thermal contraction cracking. Justify your selection with detailed discussion.

i) Fly Ash
ii) Superplasticiser
iii) Silica fume
iv) Metakaolin
v) Ground granulated blast-furnace slag

[10 marks]

APPENDIX

Table 2 Approximate compressive strengths (N/mm²) of concrete mixes made with a free-water/cement ratio of 0.5

Cement strength class	Type of coarse aggregate	Compressive strengths (N/mm²) Age (days) 3	7	28	91
42.5	Uncrushed	22	30	42	49
	Crushed	27	36	49	56
52.5	Uncrushed	29	37	48	54
	Crushed	34	43	55	61

Throughout this publication concrete strength is expressed in the units N/mm².
1 N/mm² = 1 MN/m² = 1 MPa. (N = newton; Pa = pascal.)

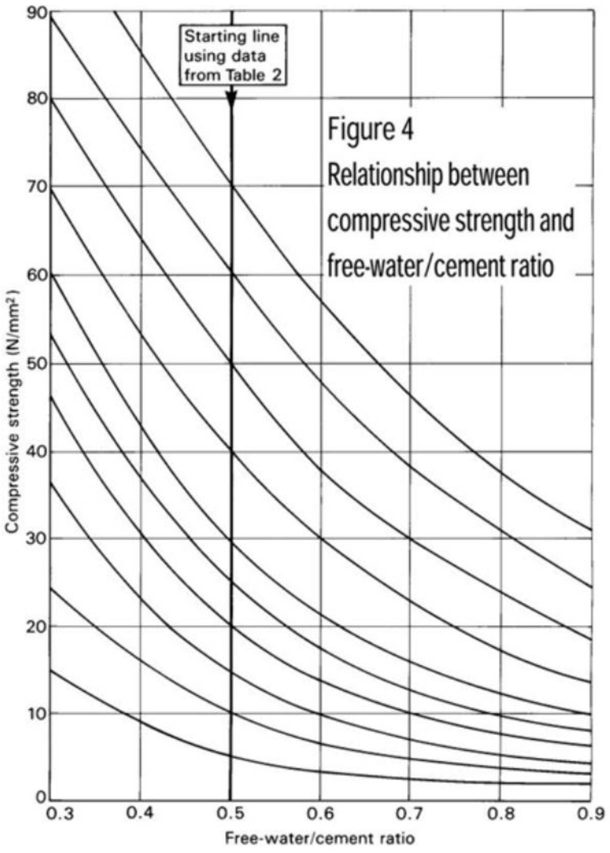
Table 3 Approximate free-water contents (kg/m³) required to give various levels of workability

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

Note: When coarse and fine aggregates of different types are used, the free-water content is estimated by the expression:

$$^{2}/_{3}\, W_f + {}^{1}/_{3}\, W_c$$

where W_f = free-water content appropriate to type of fine aggregate
and W_c = free-water content approporiate to type of coarse aggregate.



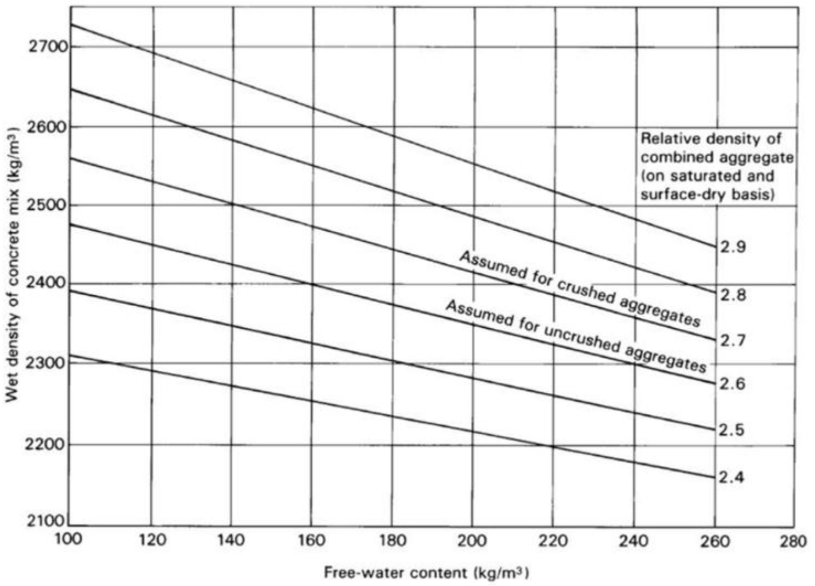


Figure 5 Estimated wet density of fully compacted concrete

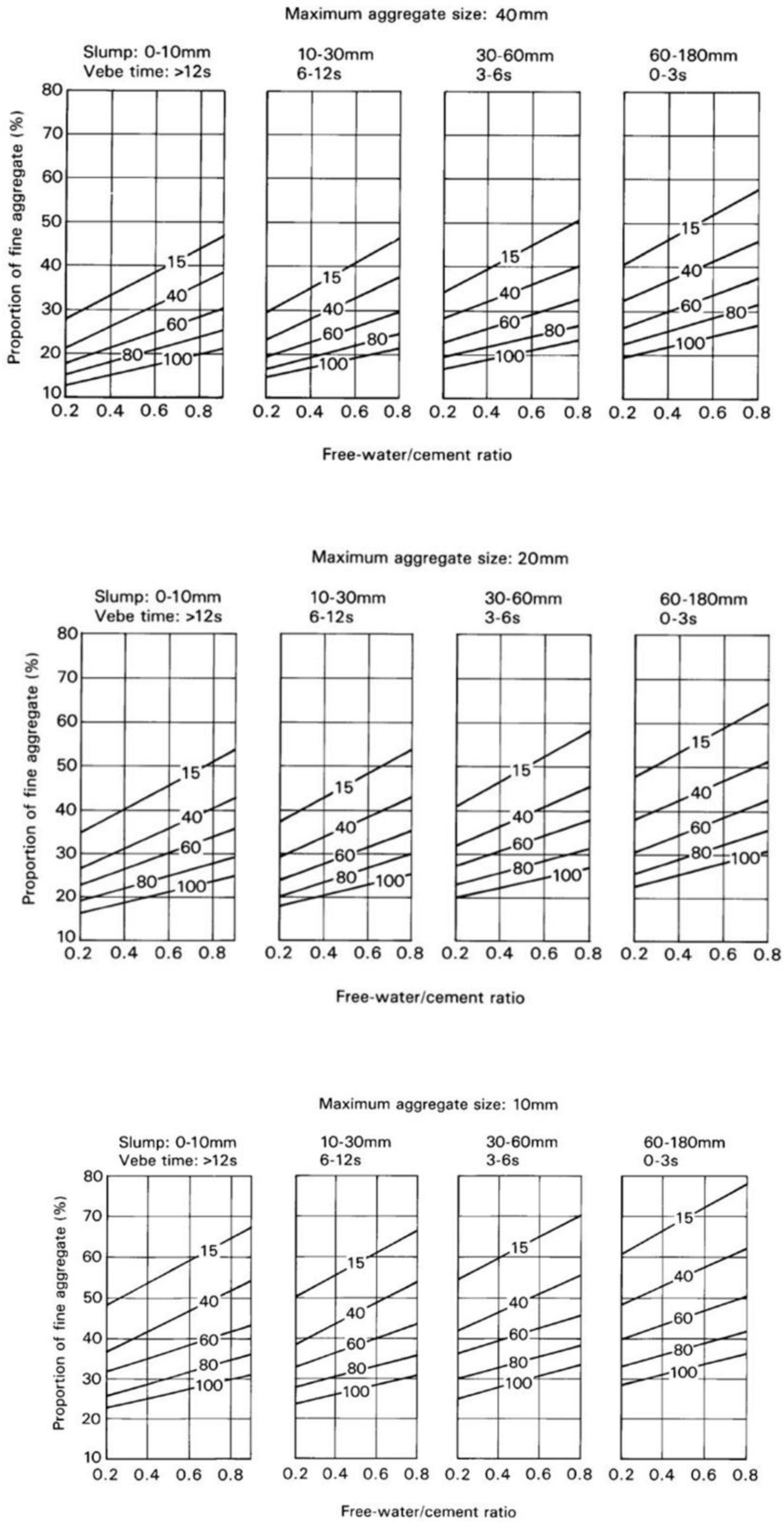


Figure 6 Recommended proportions of fine aggregate according to percentage passing a 600 μm sieve

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