Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## (ONLINE)
## SEMESTER II
## SESSION 2019/2020

| | | |
|---|---|---|
| COURSE NAME | : | CIVIL ENGINEERING MATERIALS |
| COURSE CODE | : | BFC10502 |
| PROGRAMME CODE | : | BFF |
| EXAMINATION DATE | : | JULY 2020 |
| DURATION | : | 4 HOURS |
| INSTRUCTION | : | ANSWER **ALL** QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

**Q1** (a) Cement paste is a mixture of water and cement which hardened through hydration process. It is the main binder concrete matrix. Briefly discuss the importance of water cement ratio in concrete mixture.

(5 marks)

(b) You are assigned to initiate a construction site in a highly humid and highland area. One of your task is to provide temporary storage for cement bags for your construction site. Discuss the major threat from the surrounding environment to the quality of stored cement and propose cautious measures to ensure the quality of the cement remained.

(10 marks)

(c) Illustrate the dimensions of your proposed temporary cement storage shelter.

(10 marks)

**Q2** (a) Most of offshore structures such as top module and jacket were constructed by using steel members. Explain **THREE (3)** reasons of using steel in offshore structure.

(6 marks)

(b) National Glulam Timber Board of Malaysia appointed you as consultant to promote the use of timber in Malaysia. One of your task is to produce a brochure of the advantages of Malaysian timber in construction industry. Propose **FIVE (5)** main points to be included in the brochure.

(10 marks)

(c) As a consultant engineer that working for a developer, you are required to propose a construction material for a double stories bungalow. The bungalow is to be constructed facing an open beach and next to a high speed railway train line.

(i) Explain **TWO (2)** environmental effects to be considered in proposing construction material for the bungalow.

(4 marks)

(ii) Propose suitable **TWO (2)** construction materials based on environmental effects mentioned in Q2(c)(i). Justify your construction materials selection based on durability factor and long term integrity effect on structure.

(5 marks)

**Q3** (a) The quality of fresh and hardened concrete are influenced by physical properties of aggregate. Define **FIVE (5)** physical properties of aggregate.

(5 marks)

(b) Name and briefly explain the chemical compound of Portland cement based on the abbreviation given.

(i) $C_2S$
(ii) $C_3S$
(iii) $C_3A$
(iv) $C_4AF$

(8 marks)

(c) **Table Q3(c)** shows raw data for aggregates sieve analysis datasheet. Calculate and complete the sieve analysis datasheet in **Table Q3(c)**. Rewrite **Table Q3(c)** in your answer script.

(12 marks)

**Q4** (a) You are assigned to conduct concrete mixing in the laboratory. Prior to concrete mixing, you need to calculate the quantities of cement, water, fine aggregate, and coarse aggregate per trial mix of 0.08 $m^3$. Calculate mix design in the DoE Concrete Mix Design Form that is suitable for a normal weight concrete with no admixture. The following information should be used for the mix design. Please rewrite the essential values from DoE form in your answer script.

Target mean compressive strength = 35 MPa at 28 days
Cement strength class 42.5
Defective rate = 10% (k=1.28)
Standard deviation = 8 $N/mm^2$
Slump required = 10-30 mm
Max. Aggregate size = 20 mm
Specific gravity of aggregates = 2.65
Coarse aggregate CRUSHED
Fine aggregate UNCRUSHED (38% pass 600 micros)
Maximum allowable free-water/cement ratio = 0.55
Minimum allowable cement content = 275 $kg/m^3$.

(25 Marks)

**– END OF QUESTIONS –**

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**TABLE Q3(c): Sieve Analysis Datasheet**

| BS 410 Sieve (mm) | Weight of Aggregate Retained (g) | Percentage Retained (%) | Cumulative Percentage Retained (%) | Cumulative Percentage Passing (%) |
|---|---|---|---|---|
| 5.00 | 0 | | | |
| 2.36 | 31 | | | |
| 1.16 | 41 | | | |
| 0.60 | 43 | | | |
| 0.30 | 45 | | | |
| 0.15 | 34 | | | |
| Pan | 6 | | | |

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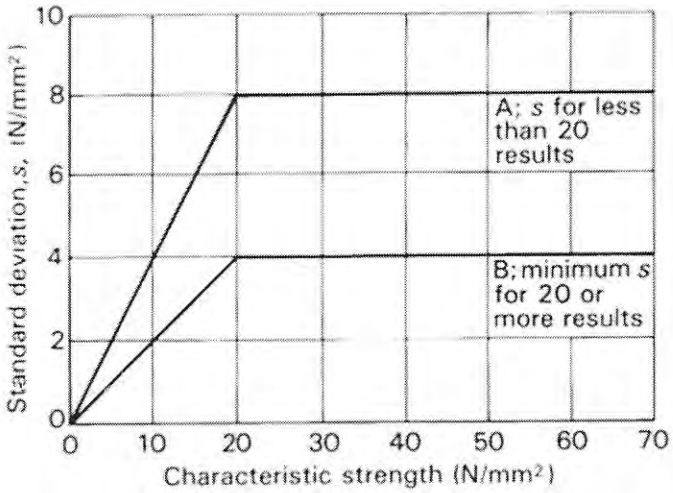


Figure 3
Relationship between standard deviation and characteristic strength

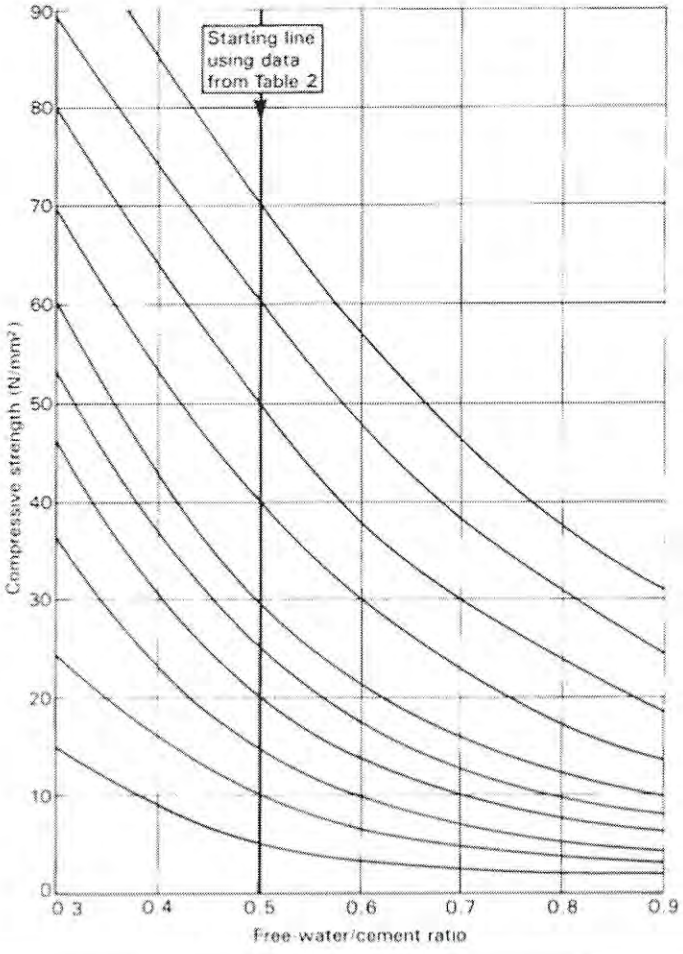


Figure 4
Relationship between compressive strength and free-water/cement ratio

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

| Cement strength class | Type of coarse aggregate | Compressive strengths ($N/mm^2$) 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 $N/mm^2$.
$1\ N/mm^2 = 1\ MN/m^2 = 1\ MPa$. (N = newton; Pa = pascal.)

**Table 3 Approximate free-water contents ($kg/m^3$) 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 |

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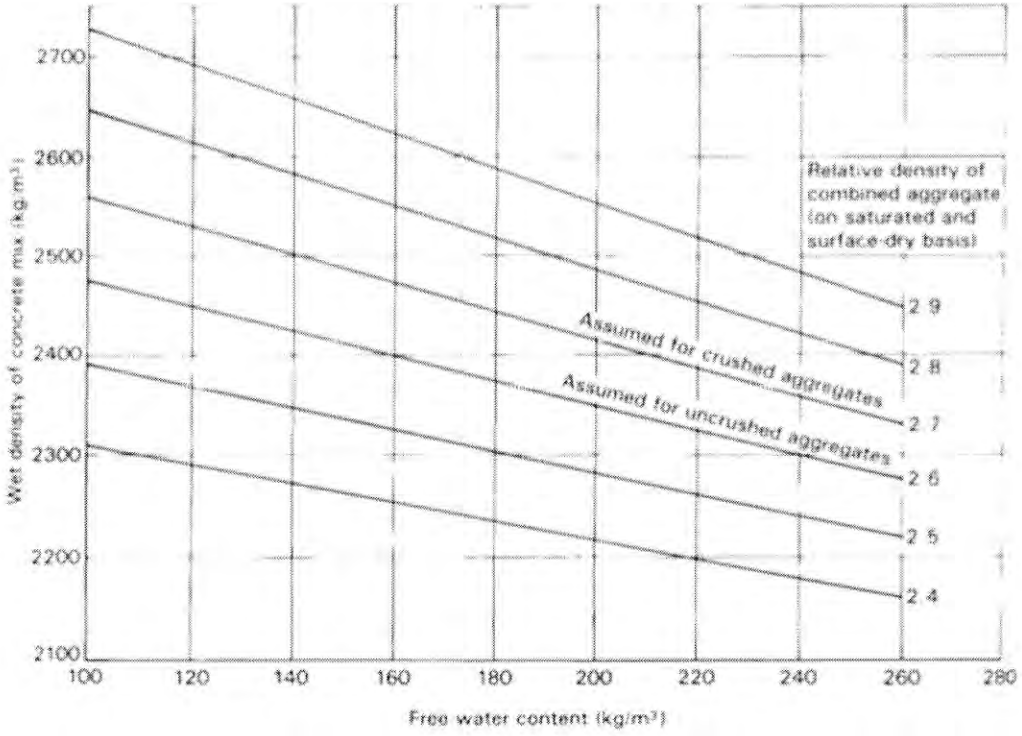


**FIGURE 5** Relationship between concrete density and free-

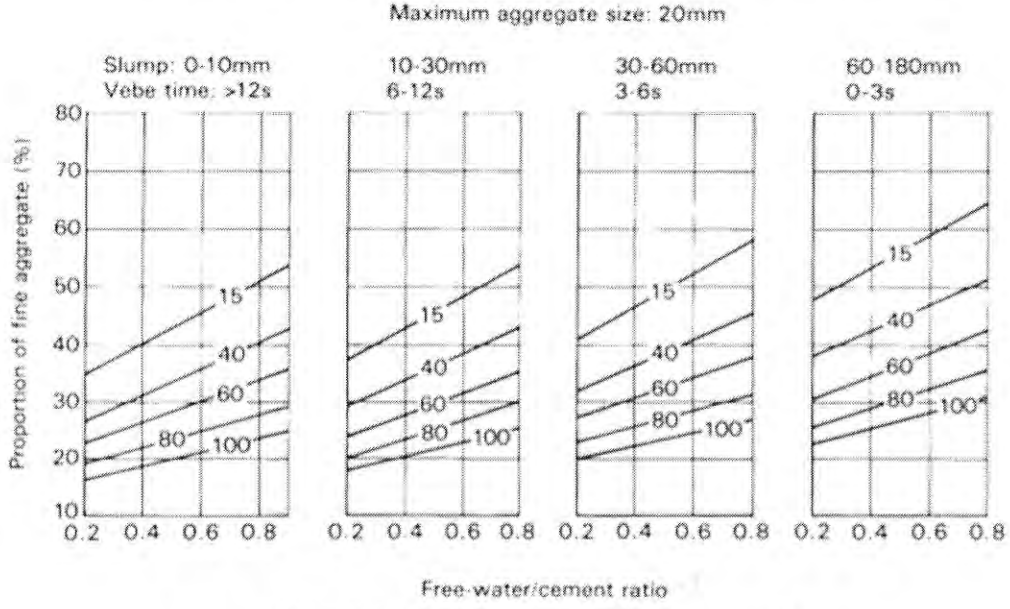


**FIGURE 6** Proportion of fine aggregate

Name: _____ Matric No: _____

## Concrete mix design form

| Stage | Item | | Reference or calculation | Values |
|---|---|---|---|---|
| 1 | 1.1 | Characteristic strength | Specified | ..... N/mm² at ..... days<br>Proportion defective ..... % |
| | 1.2 | Standard deviation | Fig 3 | ..... N/mm² or no data ..... N/mm² |
| | 1.3 | Margin | C1<br>or<br>Specified | (k = .....) ..... × ..... = ..... N/mm²<br>..... N/mm² |
| | 1.4 | Target mean strength | C2 | ..... + ..... = ..... N/mm² |
| | 1.5 | Cement strength class | Specified | 42.5/52.5 |
| | 1.6 | Aggregate type: coarse<br>Aggregate type: fine | | Crushed/uncrushed<br>Crushed/uncrushed |
| | 1.7 | Free-water/cement ratio | Table 2, Fig 4 | ..... |
| | 1.8 | *Maximum free-water/ cement ratio* | *Specified* | ..... Use the lower value [ ] |
| 2 | 2.1 | Slump or Vebe time | Specified | Slump ..... mm or Vebe time ..... s |
| | 2.2 | Maximum aggregate size | Specified | ..... mm |
| | 2.3 | Free-water content | Table 3 | ..... [ ] kg/m³ |
| 3 | 3.1 | Cement content | C3 | ..... ÷ ..... = ..... kg/m³ |
| | 3.2 | *Maximum cement content* | *Specified* | ..... kg/m³ |
| | 3.3 | *Minimum cement content* | *Specified* | ..... kg/m³ |
| | | | | use 3.1 if ≤ 3.2<br>use 3.3 if > 3.1 [ ] kg/m³ |
| | 3.4 | Modified free-water/cement ratio | | ..... [ ] |
| 4 | 4.1 | Relative density of aggregate (SSD) | | ..... known/assumed |
| | 4.2 | Concrete density | Fig 5 | ..... kg/m³ |
| | 4.3 | Total aggregate content | C4 | ..... − ..... − ..... = ..... kg/m³ |
| 5 | 5.1 | Grading of fine aggregate | Percentage passing 600 µm sieve | ..... % |
| | 5.2 | Proportion of fine aggregate | Fig 6 | ..... % |
| | 5.3 | Fine aggregate content | C5 | ..... × ..... = [ ] kg/m³ |
| | 5.4 | Coarse aggregate content | C5 | ..... − ..... = [ ] kg/m³ |

| Quantities | Cement (kg) | Water (kg or litres) | Fine aggregate (kg) | Coarse aggregate (kg) 10 mm | 20 mm | 40 mm |
|---|---|---|---|---|---|---|
| per m³ (to nearest 5 kg) | ..... | ..... | ..... | ..... | ..... | ..... |
| per trial mix of ..... m³ | ..... | ..... | ..... | ..... | ..... | ..... |

Items in italics are optional limiting values that may be specified (see Section 7).
Concrete strength is expressed in the units N/mm². 1 N/mm² = 1 MN/m² = 1 MPa. (N = newton; Pa = pascal.)
The internationally known term 'relative density' used here is synonymous with 'specific gravity' and is the ratio of the mass of a given volume of substance to the mass of an equal volume of water.
SSD = based on the saturated surface-dry condition.