(University of Choice)

# MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

**MAIN CAMPUS**

## UNIVERSITY SPECIAL / SUPPLEMENTARY EXAMINATIONS

## 2021/2022 ACADEMIC YEAR

## 2ND YEAR SEMESTER ONE EXAMINATIONS

## FOR THE DEGREE OF BACHELOR OF BUILDING TECHNOLOGY IN CIVIL AND STRUCTURAL ENGINEERING

**COURSE CODE: BTB 231**

**COURSE TITLE: CONCRETE TECHNOLOGY**

**DATE: 26TH JULY 2022 TIME: 3 P.M – 5 P.M**

**INSTRUCTIONS:**

1. This paper consists of **FOUR** questions.
2. **ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS.**
3. Marks for each question are indicated in the parenthesis.

MMUST observes ZERO tolerance to examination cheating

## Question ONE (30 Marks)

a) Define the following terms as used in concrete technology. **[4 Marks]**
   i. Aggregates
   ii. Cement
   iii. Admixtures
   iv. Concrete

b) What is a structural material? Briefly explain why concrete is regarded as a structural material. **[2 Marks]**

c) Explain any **THREE** advantages of using concrete as a structural construction material. **[6 Marks]**

d) Describe any FOUR qualities of a good concrete. **[2 Marks]**

e) Highlight **FOUR** types of impurities in sand. **[2 Marks]**

f) Briefly describe the bulking phenomenon in sand and state **THREE** effects of bulking of sand on concrete. **[3 Marks]**

g) Highlight any **FOUR** properties of a good cement for use in concrete production. **[2 Marks]**

h) Design a concrete mix using the following data:
28 days mean target strength = 40 MPa, Risk factor K = 1.64, Standard deviation S = 8 $N/mm^2$. The maximum size of coarse aggregate = 20mm, Aggregate type = **uncrushed** 50% Fine aggregate passes through the 600-micron sieve, Slump range 60-180, 25 mm cover to reinforcement, specific gravity of aggregate = 2.6, ordinary Portland cement of 42.5 MPa and exposed to a moderate environmental condition. **[9 Marks]**

**NB: Use the tables, curves and figures attached at the end of the question paper.**

## Question TWO (20 marks)

a) Describe the TWO main classification (classes/types) of aggregates, giving one example in each case. **[3 Marks]**

b) Briefly describe the following properties of coarse aggregates. **[5 Marks]**
   i. Size
   ii. Shape
   iii. Surface texture
   iv. Specific surface
   v. Soundness

c) Highlight **THREE** factors that affect the bulk density of coarse aggregates. **[4.5 Marks]**
d) Highlight any **THREE** precautionary measures to be undertaken in storing of cement. **[3 Marks]**
e) Highlight **THREE** reasons why accelerator admixtures would be added to concrete to enhance the early strength development. **[3 Marks]**
f) State THREE quality requirements of aggregates. **[1.5 Marks]**

**Question THREE (20 marks)**

a) What is Fresh concrete? What is the importance of plastic state of fresh concrete during construction period? **[3 Marks]**
b) Briefly describe the process of determining the concrete slump (Slump – Test). **[7 Marks]**

c) What is workability of concrete? State **TWO** ways of increasing workability without compromising the strength of the concrete. **[3 Marks]**
d) Describe how the following factors affect workability of concrete. **[3 Marks]**
   i. Water content
   ii. Cement content
   iii. Aggregate size
e) Highlight **FOUR** main requirements which form the basis of selection and proportioning of mix ingredients during the mix design of concrete. **[4 Marks]**

**Question FOUR (20 Marks)**

**a)** What is hardened concrete? **[1 Marks]**

**b)** Briefly **describe** the following properties of hardened concrete. **[3 Marks]**

   i. Compressive strength

   ii. Durability

   iii. Shrinkage

**c)** What is formwork? **[1 Marks]**

**d)** Highlight **FIVE** qualities of a good formwork **[5 Marks]**

**e)** Highlight **FOUR** basic requirements of formwork. **[4 Marks]**

**f)** Describe **THREE** factors that determines the removal time of formwork. **[3 Marks]**

**g)** Describe **THREE** classes/types of loads that are being supported by formwork.

**[3 Marks]**

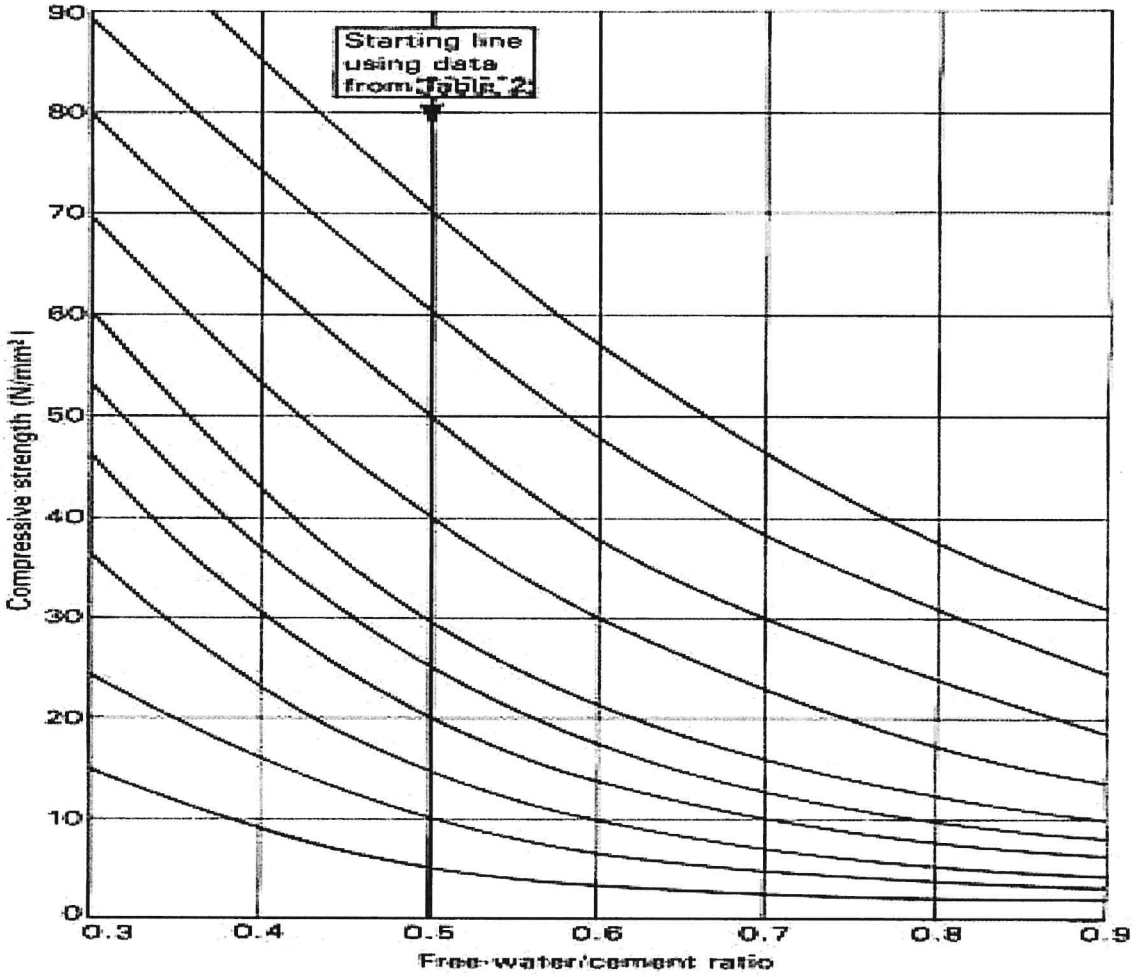


**Figure 4: Relationship between compressive strength and free water/cement ratio**

**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 |

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.

**Table 4: Minimum cement content (kg/m³) for various exposure conditions of concrete.**

| Concrete structure exposure | Reinforced concrete Minimum aggregate size (mm) | | | Non-reinforced concrete Maximum aggregate size (mm) | | |
|---|---|---|---|---|---|---|
| | 40 | 20 | 10 | 40 | 20 | 10 |
| Mildly-protected from the heat and exposed to little rain, except for short periods of time while under construction. | 220 | 250 | 290 | 200 | 220 | 270 |
| Intermediate-sheltered from the rain and mid-water reservoir for long periods of time. Concrete used for structures immersed in the water. | 260 | 290 | 340 | 220 | 250 | 300 |
| Aggressive-exposure to sea water, rain and direct sun and so forth interchangeably. | 320 | 360 | 410 | 270 | 310 | 360 |

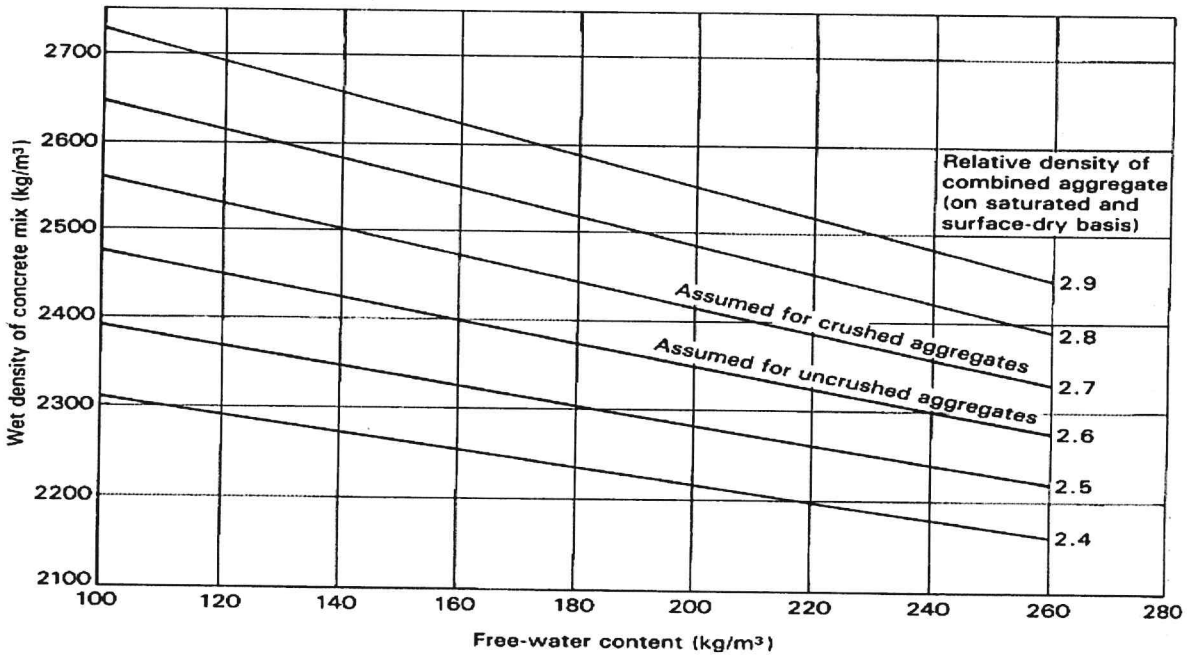


Figure 5 Estimated wet density of fully compacted concrete

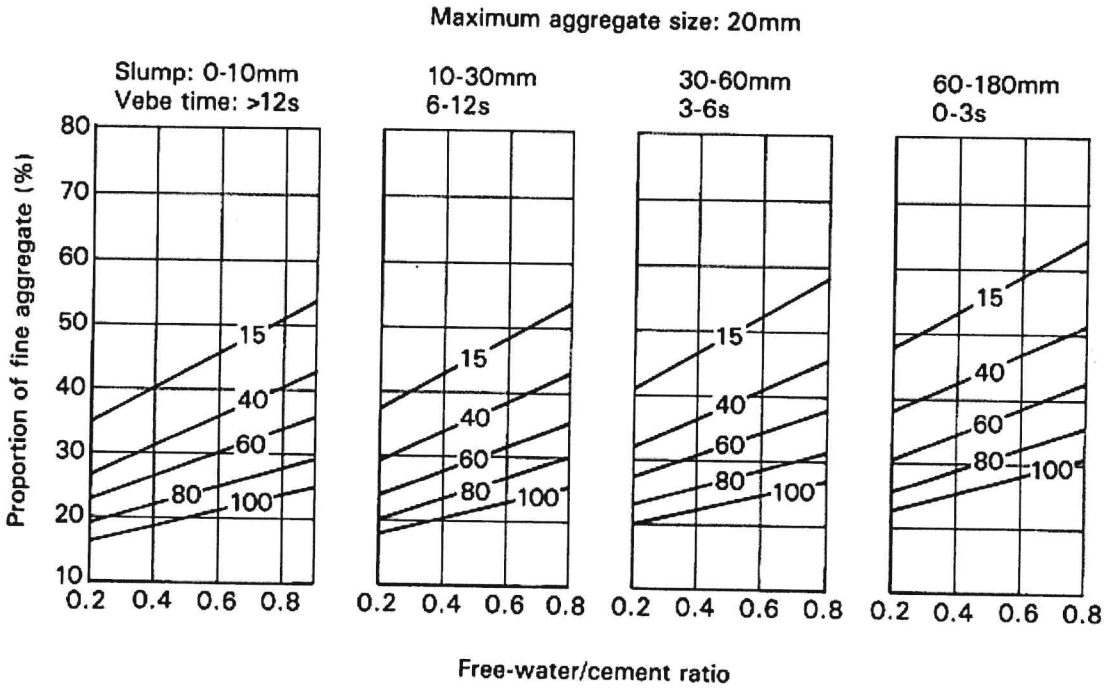


Figure 6 (continued)