Aalto University
School of Engineering

Department of Civil Engineering

CIV-E2020 Concrete Technology L **EXAMINATION** **18.01.2019**

No literature allowed in the examination!
Use the same numbering style in your answer!
Write on every examination paper:
- Course code, name and date of the exam
- Your name, student number and department

Question 1. (15 p)

1.1 Describe the clinker minerals of Portland cement and their main effects on fresh and hardened concrete properties.

1.2 Describe the role of nucleation model in cement hydration. Which other phenomena a similar nucleation process can be observed?

1.3 Explain the following pore size distribution of hardened concrete: (i) capillary pores, (ii) gel pores, (iii) trapped air (air voids) and (iv) entrained air.

Question 2. (12 p)

2.1 Describe the deterioration mechanism of alkali-silica reaction (ASR) and explain the possible prevention methods (aggregate choice and concrete mix composition).

2.2 Concrete shrinkage:
a) What are the factors affecting the concrete shrinkage?
b) What are the deferent types of concrete shrinkage?

Question 3. (15 p)

3.1 Discuss the effect of water–cement ratio on the quality of **hardened** concrete. Explain why this effect happens.

3.2 Under what condition is an **air-entraining agent** needed? Why? Discuss how the air-entraining agent performs its function and support your answer with sketch.

3.3 What is the difference between a hydraulic and pozzolanic reaction? Give examples of a pozzolanic and a hydraulic mineral admixture.

Question 4. (14 p)

Batching report of a ready-mix concrete station gave the following values (kg):

- Cement: 1088 kg
- Aggregate R0/4: 1652 kg
- Aggregate R0/8: 1098 kg
- Aggregate R8/16: 2702 kg
- Added water: 468 kg

A batch report gives the weighed masses of the raw materials, the values differ slightly from the mix design. The batch size according to the mix design was 3.0 m^3.

The measured air content was 5.0%.

The moisture contents (dried at 105 C) were: 3.0% for R0/4, 2.5% for R0/8 and 1.0% for R8/16.
Water absorptions of the all the aggregate fractions were 0.5%.
Densities of all the aggregate fractions were 2.67 kg/dm^3 and cement 3.15 kg/dm^3.

Calculate (i) the **actual composition** of the mix (kg/m^3), (ii) the **effective water**-cement ratio, (iii) the density of the fresh concrete (kg/m^3) and (iv) the actual volume of the batch (dm^3).

Question 5. (14 p)

The initial temperature of concrete was +15 °C right after the casting. The temperature was monitored during the following 28 days and the monitoring measurements were:

0h	6h	12h	24h	2d	3d	4d	5d	6d	7d	8d
+15 °C	+18 °C	+30 °C	+22 °C	+14 °C	+8 °C	+5 °C	+5 °C	+5 °C	+5 °C	+5 °C

(h = hours, d = days)

- The concrete compressive strength class was C30/37
- Cement CEM I 52.5N was used

Calculate using the Sadgrove equation $\Delta T_{20} = \left(\frac{T+16}{36}\right)^2 * \Delta t$

a) At what time did the concrete reach its freezing strength?
b) At what time did the concrete reach its disassembly strength of the moulds? The construction load was 1.5 MN/m^2 and the design load 2.5 MN/m^2
c) What was the compressive strength of cylindrical concrete specimens at the age of 7d?