

8:45 – 9:45 am

All 12 questions are of equal value

Name: _____ Student ID: _____

1. Give at least two economic factors for material selection and state why each is important.
2. On a chart of stress versus strain, show the mechanical behaviour of an elastoplastic material. Schematically show the behaviour for unloading in the case of an initial load in the plastic range. Label the permanent and elastic deformations.
3. You test 3 mortar cubes, the results are 31, 28 and 30 MPa. The expected value is 40 MPa. Comment on the results in terms of accuracy, precision and bias.

4. You have been asked to determine if a fine aggregate is suitable for concrete. You sieve a 500 gram sample and find the results shown in Table 1. Sketch the particle size distribution on the chart below. What type of gradation does this aggregate have? Does this aggregate fall within specification, if not what would you do to improve the situation?

Table 1: Sieve analysis

Sieve size (mm)	Cumulative % passing
10	100
5	97
2.5	78
1.25	23
0.630	20
0.315	18
0.160	5
Pan	0



5. Describe the procedure for determining the specific gravity of a coarse aggregate.

6. The photo below shows deterioration of concrete bridge piers typical of the Montreal area. What material issues lead to this type of deterioration?



7. In the cement test report below, identify the raw material source for each of the six listed oxides.

Chemical Analysis (%)

Alkalies (Na ₂ O equi.).....	0.90
Loss on ignition (≤ 3.0 %)	2.2
Insoluble residue (≤ 1.5 %).....	0.4

Physical Tests

Fineness:blaine	403 m ² /kg
residue 45 μ (≤ 28 %)	5 %

Autoclave expansion (≤ 1.0 %)	0.02 %
(A3004-B5)	

Expansion in water (≤ 0.020 %)	0.009 %
(A3004-C5)	

Question 7

SiO ₂	20.6
Al ₂ O ₃	4.6
Fe ₂ O ₃	2.7
CaO	62.6
MgO (≤ 5.0 %)	2.0
SO ₃	3.4

Setting Time:

Initial (≥ 45 and ≤ 375 minutes)	147 min.
Final.....	247 min.

Mineralogical Composition:

C ₃ S	54
C ₂ S	19
C ₃ A.....	8
C ₄ AF	8

Compressive Strength:

3 days (≥ 14.5 MPa)	27.5 MPa
7 days (≥ 20.0 MPa)	34.9 MPa
28 days «November 09» (≥ 26.5 MPa)	42.2 MPa

8. The above cement test report is for Type GU cement, how would be mineralogical composition (cement compound) differ in a) Type HE cement, b) Type HS cement? For what type of cement would the fineness change and would it be lower or higher?

9. What chemical admixture(s) would you use in each case? Why?

a) Concrete placed during cold temperatures.

b) Concrete placed in a cold climate.

c) Concrete with tightly spaced reinforcing.

10. What type of supplementary cementing material is most often used in Quebec? How does this material affect the early age strength of concrete?

11. Given the following tables and charts, describe how the maximum required water to cement ratio is determined for the following scenarios (state if air entrainment is required). Give the w/c.

a. A new sidewalk slab outside the Hall Building (minimum compressive strength 15 MPa).

b. An underground metro tunnel in soil that contains 1.45% soluble sulphate. ($f'_c = 25$ MPa).

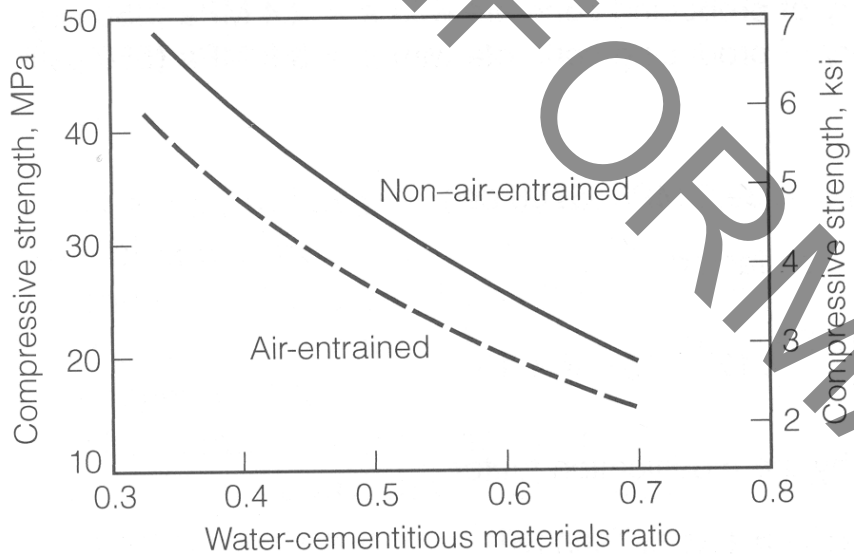


TABLE 7.4 Requirements for Concrete Exposed to Sulfates in Soil or Water*

Sulfate Exposure	Water-Soluble Sulfate (SO ₄) in Soil, Percent by Weight**	Sulfate (SO ₄) in Water, ppm**	Cement Type***	Maximum Water-Cementitious Material Ratio by Weight	Minimum Design Compressive Strength, f'_c , MPa (psi)
Negligible	Less than 0.10	Less than 150	No special type required	—	—
Moderate****	0.10–0.20	150–1500	II, MS, IP(MS), IS(MS), P(MS), I(PM)(MS), I(SM)(MS)	0.50	28 (4000)
Severe	0.20–2.00	1500–10,000	V, HS	0.45	31 (4500)
Very Severe	Over 2.00	Over 10,000	V, HS	0.40	35 (5000)

*Adopted from American Concrete Institute (ACI 318), 1999.

**Tested in accordance with the Method for Determining the Quantity of Soluble Sulfate in Solid (Soil and Rock) and Water Samples, Bureau of Reclamation, Denver, 1977.

***Cement Types II and V are in ASTM C150 (AASHTO M85), Types MS and HS in ASTM C1157, and the remaining types are in ASTM C595 (AASHTO M240). Pozzolans or slags that have been determined by test or severe record to improve sulfate resistance may also be used.

****Sea water.

TABLE 7.3 Maximum Water-Cementitious Material Ratios and Minimum Design Strengths for Various Exposure Conditions*

Exposure Condition	Maximum Water-Cementitious Material Ratio by Mass for Concrete	Minimum Design Compressive Strength, f'_c , MPa (psi)
Concrete protected from exposure to freezing and thawing, application of deicing chemicals, or aggressive substances	Select water-cementitious material ratio on basis of strength, workability, and finishing needs	Select strength based on structural requirements
Concrete intended to have low permeability when exposed to water	0.50	28 (4000)
Concrete exposed to freezing and thawing in a moist condition or deicers	0.45	31 (4500)
For corrosion protection for reinforced concrete exposed to chlorides from deicing salts, salt water, brackish water, seawater, or spray from these sources	0.40	35 (5000)

*American Concrete Institute (ACI 318), 1999.

12. Bonus: For the LEED system, give one category of obtaining points towards certification.

FOR INFORMATION