UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, DECEMBER 2001, 2-1/2 HOURS

CIV 514F - CONCRETE CONSTRUCTION

Examiner - R.D. Hooton

Name: _____
PRINT **(Last)** **(First)**

Student No.: _____

Students may only use Neville's Properties of Concrete Textbook (with no significant, personally added inserts. Marked up or unauthorized texts are subject to removal) and non-programmable calculators.

Answer all questions on the exam paper.
Point form answers are sufficient.
Use the backs of sheets if necessary.

#	MARK
1	/25
2	/23
3	/20
4	/12
Total	/80

QUESTION 1. (5 parts)

a) What is the prime consideration for design of any concrete exposed to severe sulphate solutions, regardless of materials selection? How can this be achieved in practice? Also, what cementitious materials options would you consider?

(4 marks)

b) A 3 year old concrete wall was cored and found to be carbonated to a depth of 8 mm. Estimate the age at which the carbonation depth will each 25 mm. Assume that the environmental exposure will remain the same over the remaining time period. .

(4 marks)

QUESTION 1. (Continued)

c) Why are sprayed-on membrane-forming curing compounds only partially effective in providing optimum conditions for curing with concretes at lower w/cm? (Assume temperature is not a variable).

(5 marks)

d) List at least 3 reasons why a well cured concrete containing 35% ground granulated blastfurnace slag would be superior to a similar portland cement concrete for:

(6 marks)

i) General durability concerns

ii) Specifically for resistance to chloride ingress.

QUESTION 1. (Continued)

e) What are the three main criteria that must be satisfied to obtain concrete that is resistant to cyclic freezing and thawing when critically saturated? Briefly explain why each is important.

(6 marks)

QUESTION 2. (5 parts)

a) If the maximum aggregate size in air entrained concrete is reduced from 20 mm to 10 mm, does the total air content have to be increased or decreased to maintain adequate freeze/thaw resistance? Explain why?

(4 marks)

b) According to Powers, the capillary pore volume fraction (p) is affected by W/C and degree of hydration (m). Capillary discontinuity of portland cement pastes occurs when p is less than 0.30.

(5 marks)

For W/C's of 0.40, and 0.80, what degrees of hydration are required to achieve capillary discontinuity?

Use the following equation: $$p = \frac{W/C - 0.36\ m}{W/C + 0.32}$$

Also comment on the likelihood of achieving capillary discontinuity in each case, assuming the ultimate degree of hydration m* (ie. The highest possible value) is given by:

$$m^* = \frac{1.031\ W/C}{0.194 + W/C}$$

QUESTION 2. (Continued)

c) Why is the required size of a test cylinder related to the maximum size of the coarse aggregate?
(4 marks)

d) List 5 factors that need to be considered when interpreting raw compressive strength data from concrete cores taken from a structure?
(5 marks)

QUESTION 2. (Continued)

e) If you were given a concrete core from the surface of a slab-on-grade (100 mm diameter by 200 mm deep), how would you test it if the client wanted to know the depth of the curing-affected zone? Is a strength test a good option? If you don't know the exact test procedure, discuss the properties you would want to obtain and conceptually how you could discern this depth.

(5 marks)

QUESTION 3. (4 parts)
(20 marks)

You have been retained by a large project design firm to come up with recommendations for special materials, concrete mix designs and curing specifications for concrete to be supplied for the following projects. In each case, list the design considerations, alternatives, and precautions you would take for each of the four specific environmental exposures listed.

a) A massive concrete gravity dam in the vicinity of Timmins, Ontario. The coarse aggregate will have to be crushed from the rock being excavated on site.

b) A multi-storey parking garage in Toronto.

QUESTION 3. (Continued)

c) A residential slab-on-grade in Arizona. The air is warm and it has a low relative humidity. The soil has a high sodium and magnesium sulphate content.

d) The water-line concrete for a bridge pier along Lake Ontario.

QUESTION 4.

(12 marks)

A ready-mixed concrete company is supplying the new airport terminal with a 35 MPa concrete which develops 8.5 MPa @ 1 day, 20.0 MPa at 3 days, and 29.5 MPa at 7 days when cured at 23 °C.

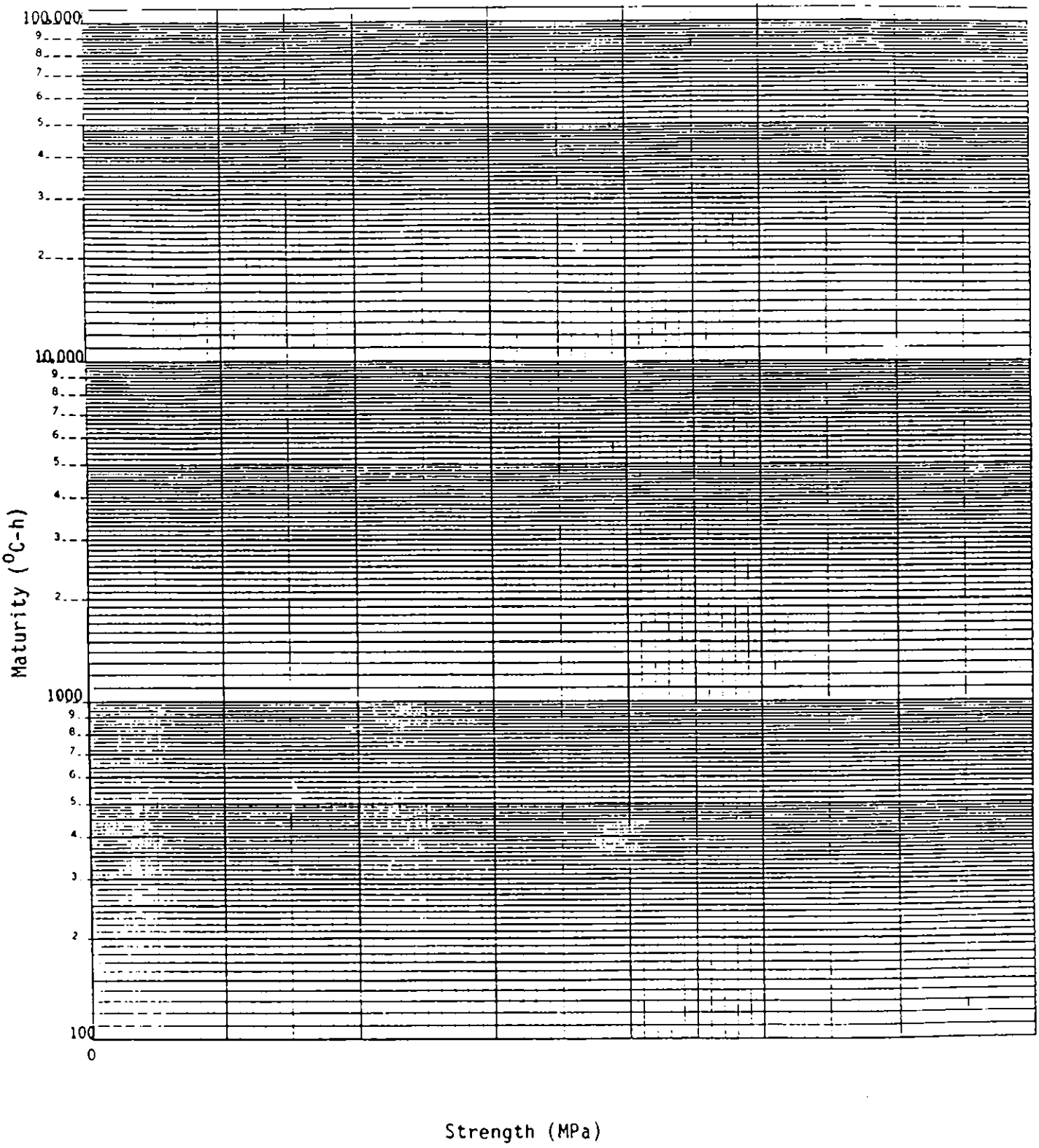
The engineer for the airport authority wants to speed up the rate of construction by heating the concrete and maintaining heaters for curing. They need to develop 15 MPa strength to safely strip the forms.

How long after set will it take to reach the required stripping strength at:

a) 23 °C?
b) 28 °C?
c) 33 °C?

(Assume a datum temperature of -10 °C.) Report results to the nearest hour.

The attached graph paper may be of use.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Maturity (°C-h)
Strength (MPa)