High Performance Concrete Engineering

Final Exam (Nov 13th 6pm-8:00pm)

Name: /

Total 10 problems (100 marks)

1. 8.25 liters of naphthalene superplasticizer with a specific gravity of 1.21 and a solids content of 30% have been used in order to obtain the desired slump. What is the volume of water that should be deducted from the mixing water content of high strength concrete? **[5 marks]**

2. Provide some practical solutions when concrete mix is stuck in a ready-mix truck at job sites. **[5 marks]**

3. Compare the characteristics of ITZ in normal weight concrete and lightweight concrete. **[5 marks]**

4. Explain why lightweight concrete can enhance thermal properties. **[5 marks]**

5. Below paragraph is from the actual project bidding (입찰) guideline in Singapore which Samsung C&T had applied.

DESIGN AND CONSTRUCTION OF SEWER TUNNELS FOR THE DEEP TUNNEL SEWERAGE SYSTEM PHASE 2 PROJECT – CONTRACT T-08

2-3-3 - TUNNEL AND RELATED WORKS

2.3 Design of Tunnel and Related Works

2.3.1 The Contractor shall ensure that the design of the tunnel linings is fully compatible with his proposed method for the construction of the tunnel. This construction method shall be subjected to the acceptance of the S.O.

2.3.2 The design of the tunnel linings shall take into account inter alia of the required life span (100 years), the proposed use, the ground conditions, proximity of the tunnels to other underground infrastructures and adjacent structures, the sequence and timing of construction.

As a concrete engineer in the Samsung C&T, suggest competitive winning strategy to this bidding. **[10 marks]**

6. A concrete sample is exposed to low humidity. Plot the evolution of the stress caused by the shrinkage assuming that a) the sample is unrestrained, and b) the sample is restrained and concrete is viscoelastic. **[10 marks]**

7. Place a Kelvin unit in series with a dashpot: (a) draw a creep curve, (b) what is the value of the initial elastic strain curing a creep test? (c) what is the asymptotic value (점근선값) of the strain during a creep test? (d) draw a relaxation curve, (e) is there a long-term permanent deformation if the load is removed? **[20 marks]**

8. Below crack patterns were observed in precasted concrete segment before the structure in service or in loading. a) What would be the potential cause of these crack pattern? b) How can we prevent these cracks? **[10 marks]**

9. If the tensile strength of concrete at early age is 1.5 MPa, draw potential crack pattern (cracking shape or crack length) of below concrete element (L/H=2) considering the variation of degree of restraint. **[10 marks]**

Maximum temperature difference = 55 ℃

Elastic modulus = 10 GPa

Creep coefficient = 0.5

Coefficient of thermal expansion = 10×10^{-6}/℃

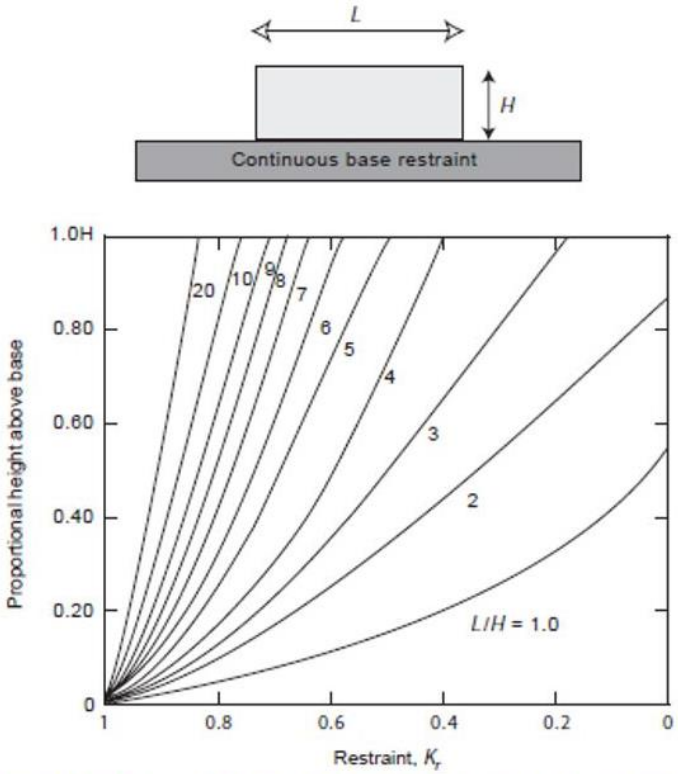

Figure 4-18 Degree of tensile restraint at center section. (Source: ACI Committee 207, Cooling Mass Concrete, 1998.)

10. Below equations are the creep compliance ***J*** defined in ACI and FIB, respectively. Discuss how they differently use Young's modulus and quantitatively compare its result. Use $E_c=0.85E_{ci}$ if necessary. **[20 marks]**

FIB:

$$J(t,t') = \frac{1}{E_{ci}(t')} + \frac{\phi(t,t')}{E_{ci}}$$

ACI:

$$J(t,t') = \frac{1}{E_c(t')} + \frac{\phi(t,t')}{E_c(t)}$$