
UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2004/2005 Academic Session

October 2004

EAS 662/4 – Structural Retrofitting Technology

Duration: 3 hours

Instructions to candidates:

1. Ensure that this paper contains **THREE (3)** printed pages before you start your examination.
2. This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions only. Marks will be given to the **FIRST FOUR (4)** questions put in order on the answer script and **NOT** the **BEST FOUR (4)**.
3. All questions **MUST BE** answered in English.
4. All questions **MUST BE** answered on a new sheet.
5. All questions carry equal marks.
6. Write the answered question numbers on the cover sheet of the answer script.

1. (a) Explain how patched accelerated corrosion could occur and describe a suitable technique to overcome or reduce the risk of it occurring. Use appropriate sketches to aid your explanation.
(10 marks)
- (b) With the aid of appropriate sketches, explain how galvanic and impressed current cathodic protection systems work.
(12 marks)
- (c) Explain why impressed current cathodic protection is not recommended for corrosion damage prestressed concrete structure or prestressed concrete structural elements.
(3 marks)
2. (a) Sulphate attack is one of the problems normally encountered in existing concrete structures in this country, especially those exposed to marine environment, ground and groundwater, as well as structures in industrial areas. Explain in detail how sulphate attack occurs and causes damaging effects to concrete structures.
(8 marks)
- (b) Discuss the measures that could be taken to prevent or reduce the risk of occurrence of sulphate attack.
(5 marks)
- (c) You are required to assess the sulphate resistant performance of several cementitious repair materials. Suggest three tests that could be used and describe how the sulphate resistant performance of the repair materials could be assessed using one of the tests suggested.
(5 marks)
- (d) A reinforced concrete school building located in Grik, Perak has been reported to undergo reinforcement corrosion 20 years after construction. The cracks appear to be uniform and run approximately in the direction of the reinforcement. Explain the probable cause of the corrosion problem. Describe in detail the mechanism of reinforcement corrosion at work.
(7 marks)
3. (a) The durability and long-term performance of concrete could be improved by giving consideration to aspects related to materials selection, mix proportions, construction practices, compliance requirements and maintenance. Discuss how more durable concrete structures could be produced by taking into account the five aspects listed.
(20 marks)
- (b) Describe the concept of performance based specifications for concrete and compare with what is being practiced currently.
(5 marks)

4. (a) Explain **FIVE (5)** reasons for structural appraisal/assessment. (5 marks)
- (b) A structural appraisal has to be carried out onto an existing reinforced concrete structure which is undergoing reinforcement corrosion. Suggest five testing techniques that could be used in the appraisal process. For each test suggested, explain why it is required. (10 marks)
- (c) An experimental investigation has been performed in an attempt to assess the waterproofing efficiency and performance of three types of surface treatments, namely; epoxy, silane and sodium silicate upon exposure to chloride environment. The results of the tests performed are given in Table 1.0.

Table 1.0 : Mass of concrete specimens exposed to NaCl (gram)

Exposure period (months)	Surface treated			Controlled (Untreated)
	Epoxy	Silane	Sodium silicate	
0	2445*	2430*	2430*	2420*
1	2450	2448	2450	2465
3	2457	2457	2463	2483
6	2460	2485	2468	2493
12	2462	2505	2472	2510

* Note: Dry mass before exposure to NaCl

From the test results given in Table 1.0, calculate the water absorption for all specimens and determine the waterproofing efficiency index for the treated specimens. Use an appropriate table for your answer. Compare and discuss the waterproofing efficiency performance of the surface treatments for the duration of the test period. Use an appropriate graph for the comparison.

(10 marks)

5. (a) Defects and deterioration of concrete normally manifest themselves in the form of cracks. Describe how plastic shrinkage crack and early age thermal contraction crack occur. Lists the steps that could be taken to reduce the risk of thermal contraction crack occurring. (5 marks)
- (b) Crack can normally be repaired using a suitable resin. Describe the required characteristics of a resin to be used in repair of structural cracks. Explain the processes involved in crack repair. Use suitable sketches in your explanation. (5 marks)
- (c) Jacketing is one of the techniques commonly used in the repair and strengthening concrete structural elements. Describe the processes involved in jacketing for the purpose of repair and strengthening of corrosion damaged reinforced concrete columns of a jetty. Use a suitable sketch to aid your explanation. Discuss the important properties of the repair material to be used in the repair process. (15 marks)