First Semester Examination
Academic Session 2019/2020

December 2019/January 2020

EAS662 – Structural Retrofitting Technology

Duration : 2 hours

Please check that this examination paper consists of **FIVE (5)** pages of printed material before you begin the examination.

Instructions : This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions.

All questions must be answered in English.

Each question **MUST BE** answered on a new page.

(1). (a). The concrete components of an industrial wastewater treatment plant exhibit distinctive damage in the form of expansion and cracking several years after its operation commenced. Strength test on several core samples extracted from the affected members indicates some reduction in strength in comparison to the strength value from construction data.

(i). With justification, identify the most probable deterioration mechanism at work.

(ii). Suggest and discuss further test or analysis that could be performed to aid in confirming the deterioration mechanism at work and its extent.

(iii). Explain the mechanism of deterioration leading to the observed phenomena.

(iv). Explain the measures that could be taken to avoid or reduce the risk of similar problem occurring.

[20 marks]

(b). Explain the carbonation induced corrosion phenomenon of steel in concrete based on the following illustration.

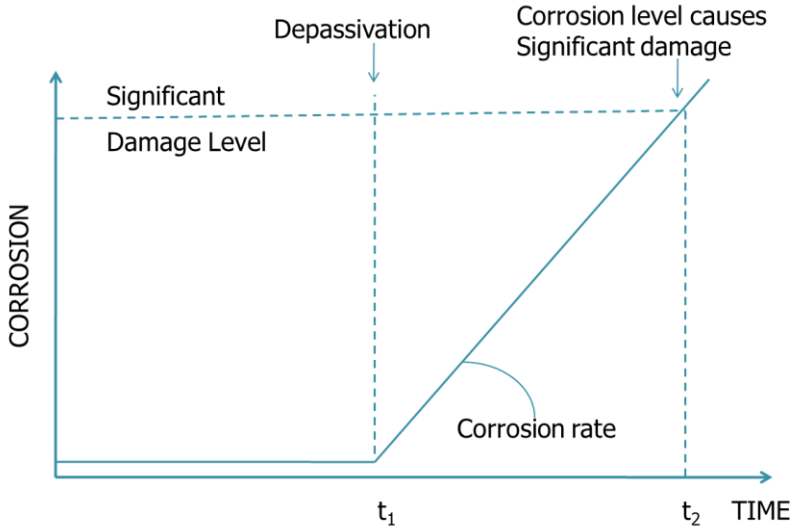

Figure 1: Graphical illustration of corrosion of steel in concrete

[5 marks]

(2). (a). Describe the deterioration mechanism frequently affecting concrete structures in marine environmental exposure. Explain why the parts of concrete structures situated in the tidal and splash zones are mostly affected.

[6 marks]

(b). Suggest and explain relevant compliance tests that can be adopted to better ensure the durability performance of concrete structures exposed to marine environment.

[6 marks]

(c). Identify suitable chemical and mineral admixtures that can be used to better ensure superior durability performance of concrete structures in marine environment. Discuss in detail how their combined use could bring about superior durability performance of concrete structures in marine environment.

[13 marks]

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(3). (a). The piers of a marine port have been observed to undergo corrosion of reinforcement and requiring appropriate rehabilitation work.

(i). Identify **FIVE (5)** important properties that the repair material to be used for rehabilitating the affected piers should have in order to ensure effective and durable repair work. Provide justification for each one.

[5 marks]

(ii). It has been recommended that conventional concrete repair work is carried out and a suitable electrochemical technique is applied to restore the affected structural members and to prevent recurrence of rebar corrosion in the future, respectively. Suggest an appropriate electrochemical technique that can be applied. Explain the whole repair process of the affected piers using pre-placed aggregate grouting technique, together with concomitant application the selected electrochemical technique. Include appropriate sketches to aid your explanation.

[20 marks]

(4). (a). Acoustic Emission (AE) technology is used to safeguard against catastrophic failures, to assess structural integrity and to enhance safety in a wide range of structures. Define AE and discuss briefly phenomena that take place as AE wave propagates along the structure, including its advantages and limitations.

[10 marks]

(b). Structural condition assessments are within the practice of professional engineering, and fall into two categories which are the preliminary assessments and detailed assessments. Reasons of structural condition assessments of buildings include as assessment may be ordered by an authority, a change in ownerships, or to accommodate an expansion or modification or change of occupancy or use. Often in these cases, no reason for concern is known at the outset. Where no indications of structural concern are found, a preliminary assessment maybe sufficient. Discuss the preliminary assessment by proposing the best practices that can be implemented when dealing with structural condition assessment.

[15 marks]

(5). Kuala Perlis jetty was built in 1959, and after 60 years of service, four of the piers have severe structural damage such as reinforcement corrosion and concrete spalling. From the assessment report conducted by the consultant, the reinforcement of the pier has reduced in its diameter and need to be replaced.

(a). As a lead contractor of the project, you have been requested to propose the method statement to repair the piers by using Fiber Reinforced Polymer Jacketing (FRP). Use a suitable sketch in your answer.

[15 marks]

(b). If the affected piers are to be repaired using reinforced concrete jacketing method, provide a method statement to repair the piers. Use a suitable sketch in your answer.

[10 marks]

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