A STUDY ON DETERIORATION AND CORROSION BEHAVIOR OF RC AND PC MEMBERS WITH INITIAL DEFECTS UNDER ENVIRONMENTAL ACTION

アムリ, ダサル

https://doi.org/10.15017/1866287

出版情報：九州大学, 2017, 博士（工学）, 課程博士

（様式２）

氏　　名　　：Amry Dasar

論 文 名　　：A STUDY ON DETERIORATION AND CORROSION BEHAVIOR OF RC AND PC MEMBERS WITH INITIAL DEFECTS UNDER ENVIRONMENTAL ACTION
（初期欠陥を有するＲＣおよびＰＣ部材の自然環境下における劣化および鋼材腐食に関する研究）

区　　分　：甲

論 文 内 容 の 要 旨

Durability of steel reinforced concrete in harsh environments is of great interest to design engineers, maintainers, researchers and infrastructure owners. The problem is how to achieve durability through careful design of the cement matrix and its microstructures, and determine the minimum concrete cover for reinforcement that meets the requirements of environmental actions. Optimal design need advances in the knowledge relevant to the durability of steel reinforced concrete in chloride environments, including: the role of supplementary cementitious materials (SCMs) in concrete durability, the methods of measuring the chloride penetration into concrete, the challenges in assessing concrete durability from its chloride ingress, and design for long-lasting reinforced concrete in chloride environments. Therefore, the aim of this study is to provide an overview related to durability assessment of RC and PC member with initial defects under environmental action. Further, this study will be contributing for necessary information because it provides a demonstration of the long-term behavior of a commonly used construction material, permitting the prediction of the behaviors of existing structures and the more informed design and study of structures to be built. The results of this study may guide engineers in the development of longer-lasting reinforcements for concrete structures.

In **Chapter 1**, the background of this study, research objective, research contribution and standing point are described. The aim of this study is to provide an overview related to durability of RC and PC member due to initial defects under environmental action. Therefore, handling and right countermeasure could be planned for the future design of long-lasting performance of RC and PC member.

In **Chapter 2**, previous study is presented to illustrate the existing body of knowledge that has been established by previous researches and to provide literature regarding to the role of chlorides for the corrosion of reinforcements. Further, concrete cracking effect to reinforcing bar corrosion is summarized. Evaluation report obtained from the long-term performance of RC and PC member are addressed and discussed.

Chapter 3 describes evaluation of deterioration progress and performance reduction of 40-year-old corroded reinforced concrete (RC) beams in natural corrosion environments. The corrosion process was natural, without acceleration by current application, admixture inclusion, or exposure to an artificial chloride environment. The mechanical performance of the beams was evaluated through four-point bending test. The corroded steel reinforcing bars were extracted for corrosion evaluation and tensile testing. A good correlation was established between crack width and cross-sectional loss under natural corrosion processes, that is, for every 1% of local cross-sectional loss in the tensile steel bars leads to

0.9% reduction in the load-carrying capacity of the RC beams. Furthermore, the relationship between deterioration progress and performance degradation with the exposure period for each deterioration stage was elucidated.

Chapter 4 describes the test that is in total seven pre-stressed concrete beams (PC) were taken out for evaluation, four beams were post-tension type (herein after abbreviated as PC-O) and three beams were pre-tension type (PC-R). The beams were categorized into two conditions in terms of pre-cracking (presence of pre-cracks) and no pre-cracking. Furthermore, evaluation of pre-stress loss was conducted through four-point bending loading test, so-called Crack Re-opening Method. Allowable pre-stress loss for pre-tensioning and post-tensioning were 25% and 20%, respectively. The total pre-stress loss for pre-tensioning type of un-cracked and pre-cracked were 22.18% and 38.21%, respectively. Whereas, for post-tensioning type, un-cracked and pre-cracked were 23.73% and 48.86%, respectively.

Chapter 5 introduces the test of reinforced concrete prisms with various crack width and concrete cover. The influencing parameters of the test are crack width, concrete cover, exposure condition and utilization of SCMs. Therefore, the aim of this study is to understand the effect of crack width, concrete cover and the exposure conditions as well, with associated supplementary cementitious materials by BFS. Corrosion rate increased with increasing in crack width particularly in OPC. However, it is suggested that by the utilization of SCMs (50% BFS), the impact of crack width can be possibility reduced. Corrosion rate decreased with increasing in concrete cover for a given concrete quality (binder type and w/b ratio) and crack width. Nevertheless, it is suggested that the corrosion rate in BFS probably was smaller than that of OPC. It is suggested that BFS cement induced a delay in penetration of chlorides ions compared to OPC. In the case that crack exists, BFS has possibility to reduce corrosion of steel bar in the crack portion compared to OPC.

Chapter 6 introduces that sea-water has a potential to be used for mixing water. The utilization of sea-water in concrete production has a potential, regardless of need for good care and proper handling. Further, sea-water as mixing water and also utilization of supplementary cementitious materials (SCMs) showed different result on corrosion activity than OPC. The following possibilities and suggestions for any further research in order to utilize sea-water in proper handling can be listed up. To study the change in transition form of steel from passive to active for corrosion due to additional chloride ion from sea-water in mixing. Therefore, thicker concrete cover was recommended when sea-water is used for mixing. Further, it is recommended the SCM utilization such as BFS which decrease the amount of chlorides ions compared to OPC in sea-water mixed concrete. In addition, it is recommended to use corrosion inhibitor of reinforced steel such as epoxy-coated rebar to protect reinforcing steel from corrosion. Also, reinforcing stainless steel bar as reinforcement also is recommended because the critical chloride ion concentration of stainless steel (SUS304-SD) is more than 15 kg /m^3. Further, concrete quality such as water to cement ratio (w/c) is important parameter.

Chapter 7 discuss an overview for durability assessment of RC and PC member due to corrosion. Necessary information for future design for long-lasting performance of structural member particularly in marine environment is summarized.

Chapter 8 conveys summary, overview of findings and conclusions, and future research.