



Application of MCDM methods in selection of proper mix design for repairing deteriorated concrete structures

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Abstract

The premature deterioration of Reinforced Concrete (RC) structures in harsh environmental conditions (such as high humidity and thermal variation) of the marine environment especially in Persian-Gulf region, leads to reduction of service life in these structures. Existence of numerous concrete structures in Persian-Gulf region, underlines the importance of comprehensive research on this subject. Failures in the repair process have been observed mainly due to insufficient repair experience, improper selection of repair materials and incorrect repair implementation on the structures. In repair of RC structures, to achieve the most proper repair mix design, numerous materials with different physical and mechanical characteristics should be selected. In order to achieve a suitable repair, it is essential that the physical, mechanical, chemical and electrochemical properties of the repair materials and substrate concrete match properly. In current paper, the selection of proper mix design has been performed using Composite Programming with hierarchical approach. Composite Programming is one of the popular Multi Criteria Decision Making (MCDM) methods which helps experts choose the proper mix design. Moreover, due to the diversity in experimental results of tests, interval data instead of crisp data have been used to define the mechanical properties of concrete. Furthermore, to accomplish uncertainty analysis, the technique of Random Generation has been implemented on the final results.

Keywords: Repair Concrete, Proper Mix Design, Multi Criteria Decision Making (MCDM), Uncertainty Analysis

1. INTRODUCTION

In the recent years, due to the large number of deteriorated concrete structures, many repair projects have been performed. However, in many cases, the repair projects were not successful because of the improper performance of repair materials. The weakness of the repair system could be a consequence of not only the low quality of repair materials, but also lack of compatibility between repair concrete and substrate concrete. On the other hand, due to the insufficient repair knowledge, improper selection of repair materials and incorrect repair implementation on the structures, precocious failures have been observed. Thus, to achieve a suitable repair, it is essential that the physical, mechanical, chemical and electrochemical properties of the repair materials and substrate concrete match properly [1]. Multi Criteria Decision Making (MCDM) methods [2] can be used as suitable tools to incorporate different repair material properties. Composite Programming is one of the popular MCDMs methods which was used in this study to choose the proper mix design.

In order for a repair design to be successful, there are several types of criteria (such as compressive strength, chloride penetration, etc.) that need to be compared with each other simultaneously. Moreover, because of the diversity of test results, uncertainty conditions accompany with the test results of concrete and, this issue should be considered in decision procedures. In the literature, there have been few researches considering the combination of MCDM methods and uncertainty analysis.

In the field of construction engineering and management, MCDM methods have been used in different areas such as selection of proper structural systems, materials, construction equipment, etc. In the structural repairing field, Life Cycle Cost Analysis (LCCA) method [3] and Repair Index (RI) method [4] have been used for selection of proper repair methods which are respectively based on life cycle and repair performance analysis. Moreover, it should be noted that the above methods select the proper repair methods among the prevalent ones (Cathodic protection, Electrochemical treatment, Patching, Inhibitors, Hydrophobic agents). This research is focused on concrete structures in the Persian Gulf region in which harsh environmental conditions have led previous researchers to opt for Patching repair method. Hence, in this investigation, the