

Experimental Study on Properties of Corroded CFRP Reinforced Concrete Column under Repeating Load

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ABSTRACT

This paper discusses the use of carbon fiber reinforced polymers (CFRP) wraps as the protection and strengthening techniques for reinforced concrete structures. Four reinforced concrete columns were wrapped with single layer of CFRP sheets before the corrosion initiation. The corrosion was induced by means of an impressed direct current. The properties of the specimen were studied through the different wrapping schemes and corrosion degrees under the axial pressure and cycle bending loads supplied by the material test system (MTS). Results showed that the application of CFRP sheets was efficient in protecting RC columns from corrosion. It was found that the corrosion degree related to the areas of CFRP wraps, while the fatigue life and the ductility of specimens strongly connect with wrapping scheme and corrosion damage.

KEY WORDS: CFRP; corrosion resistance; RC column; repeating load; cycle bending load; MTS.

INTRODUCTION

The corrosion of concrete and steel is considered to be the major deteriorative factor of durability of concrete infrastructure facilities such as bridges, buildings, marine and waterfront constructions. It pushes engineers to keep seeking new ways of rehabilitating aged structures and building new constructions. Although various solutions like epoxy coating, cathodic protection, increased concrete cover and polymer concrete have been tried in the past, few of them have provided long-term solutions.

Excellent mechanical properties have promoted the use of fiber reinforced polymers (FRP) for structural applications (Malvar 1998a). So in the last ten years, upgrading of existing concrete structures by externally bonded FRP sheets have been increasingly adopted in many countries. They have been used to retrofit parking garages, marine and industrial structures (Watson 1998), highway bridges, and reinforced concrete piers (Warren 1997, 1998, 2000; Malvar et al. 1995, 1996; Malvar 1998b). Three types of continuous fiber sheets such as carbon, glass and aramid fiber textiles are mostly used. They are bonded on the surface of existing concrete structures with epoxy. Carbon fiber reinforced

polymer(CFRP) material have higher stiffness and enhanced durability characteristics compared to other composites and have been frequently used on concrete structures.

There are two main reasons why the corrosion of the reinforcing steel may affect the performance of RC columns. First, the corrosion of reinforcing steel results in an increase in volume, which can result in cracking, spalling, or delamination of concrete. Second, it causes a reduction of the cross-sectional area of the steel. FRP wraps may be beneficial in controlling corrosion by reducing the diffusion rate of oxygen and moisture into the concrete (Bonacci 2000; Debaiky et al. 2002). The mechanical restraint due to the confinement effect of FRP wraps causes accumulation and densification of the corrosion products at the steel-concrete interface, which may stifle the corrosion reaction and thus retard the corrosion process (Hearn and Aiello 1998; Lee et al. 2000). However, FRP wraps may maintain the moisture inside the concrete, as observed in previous studies (Berver et al. 2001; Pantazopoulou et al. 2001). This will reduce concrete resistivity and thus increase corrosion activity. Also, many durability studies have pointed out that the performances of composite materials can be altered in different conditions. Moisture and wet environment is known to cause some of the most severe damages (Springer, 1998). These studies indicate that there is a need for assessing the affection of protection and durability of FRP reinforced concrete structures.

The objective of this on-going experimental study discussed the use of CFRP wraps as protection and strengthening techniques for reinforced concrete structures. For investigating the effects of wrapping type on the corrosion protection, two wrapping schemes were applied. Additionally, the effects of fabric orientation and the corrosion degree were also considered. To discuss the mechanical properties, four CFRP reinforced concrete columns were tested under repeating load which implied by MTS.

EXPERIMENTAL PROCEDURE

Description of Test Specimens

The present experimental program consisted of four reinforced concrete columns with identical foursquare cross sections of 200×200 mm. The height of the columns was 1000mm. The specimen was a vertical cantilever column fixed to a bottom base beam, as shown in Fig. 1. The base beam of the specimen, fixed to the test platform, was strong enough to provide a fixed end for the column. The transverse steel