

## Applications of FRP Projects in Egypt

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### Summary

Advanced Composite Materials, (ACM), have been used in civil engineering applications in Egypt over the last two decades. Significant progress has been made in the use of ACM in the form of fibre reinforced polymers, (FRP), to repair, rehabilitate and upgrade aging or damaged structures. Egypt has released its national code for design and application of FRP in construction fields addressing both externally bonded and internal FRP reinforcement in concrete elements. As a result, the use of FRP for repair, strengthening and retrofitting of structures have become a very well accepted practice in Egypt. The code has been issued after a series of successful rehabilitation projects and extensive studies at different research institutions in Egypt.

This paper highlights the Egyptian FRP code, which was approved by the Egyptian Authorities in December 2005 and became the first formalized design code addressing FRP in Egypt. In addition, field applications of FRP strengthening of special structures in Egypt are also presented. The paper presents selected projects utilizing ACM in the form of externally bonded FRP laminates to strengthen existing reinforced concrete structures. Historical buildings such as the Egyptian Museum and Kaitbay Fence were rehabilitated after distress/deterioration caused by corrosion of steel reinforcement and lack of maintenance. Strengthening of the dolphin piles in Abou-Kier harbour is also reported after cracking occurred due to ship hit. Design concepts and constructional details are presented for each project.

**Keywords:** Applications, Code, Composite materials, Fibre Reinforced Polymers, Historical buildings, Laminates, Strengthening.

### 1. INTRODUCTION

Egypt is challenged by the rapid deterioration of concrete structures due to corrosion of steel reinforcement. The long coasts on the Mediterranean and the Red Sea cause an adverse environment that accelerates corrosion of steel. Use of advanced composite materials, (ACM), in the form of Fibre Reinforced Polymer, (FRP) in the construction fields has received a special attention in Egypt during the last two decades. This is attested to by the issuance of first formalized Egyptian FRP code[1], which is considered to be the second stand alone FRP code to be available worldwide. A large number of research projects was carried out and a series of international conferences under the title “Middle East Symposium on Structural Composites for Infrastructure Applications”, were held regularly in Egypt every three years since 1996[2]. As a result, the use of FRP for repair, strengthening and retrofitting of structures have become a very well accepted practice in Egypt.

This paper addresses recent applications of ACM in different projects in Egypt presenting the design concepts and constructional details for use of FRP laminates to strengthen RC structures. Historical buildings such as the Egyptian Museum in Cairo and Kaitbay Fence were rehabilitated after distress/deterioration caused by corrosion of steel reinforcement and lack of maintenance. Strengthening of special projects such as the dolphin piles in Abou-Kier harbour is also reported after cracking occurred due to ship hit.