BEHAVIOR EVALUATION OF PRESTRESSED CONCRETE BEAM UNDER CORROSION EXPOSURE

BY

Mohamed Sayed Mohamed Moawad

A Thesis Submitted to
Faculty of Engineering at Cairo University
In Partial Fulfillment of the requirements
For the Degree of
Doctor of Philosophy
IN
STRUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the supervision of

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BEHAVIOR EVALUATION OF PRESTRESSED CONCRETE BEAM UNDER CORROSION EXPOSURE

Key Words:

Partially prestressed, Fully prestressed, Corrosion, High strength concrete

Summary:

The main objective of this investigation is to the study behavior of statically determinate prestressed concrete beams subjected to corrosion. The various parameters included the concrete compressive strength, corrosion location effect, prestressing Level, and corrosion exposure effect were investigated. In this respect, an experimental and analytical investigation was conducted on number of medium scale bonded post-tensioned concrete girders subjected to corrosion. The experimental program consisted of testing eleven beams, six of which were partially bonded prestressed, three beams fully boded prestressed and the remaining two beams are traditional beams. The beams had an overall width, depth and length 150, 400 and 4500mm respectively. Analytical investigation based on strain compatibility approach was used to predict the deformational behavior of the tested prestressed concrete beams before and after corrosion exposure. Comparison between theoretical and experimental test results was carried out. A very good correlation between the predicted and measured behavior was observed.

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DEDICATION

I would like to dedicate this thesis to my wonderful **MOTHER**, **FATHER**, and my great **WIFE** for their continuous support and everything they have done for me.

ABSTRACT

Prestressed concrete is widely used in the construction industry in buildings, bridges, towers, pressure vessels and offshore structures in numerous structures. The architectural requirements prescribe the incorporation of long span and slender elements in which the prestressed concrete is rendered the most feasible design alternative. The strength and serviceability of reinforced concrete (R.C) and prestressed concrete (P.C) elements are generally affected after corrosion exposure. The basic design objective for such elements would be life safety and collapse prevention.

The main objective of this investigation is to study the behavior of statically determinate prestressed concrete beams subjected to corrosion. In this respect, an extensive experimental and analytical investigation was conducted on number of medium scale bonded post-tension concrete girders subjected to corrosion.

The experimental program consisted of testing eleven beams, six of which were partially bonded prestressed, three beams were fully bonded prestressed and the remaining two beams are non prestressed beams. The beams had an overall width, depth and length 150, 400 and 4500mm respectively. The beams were simply supported with a clear span of 4200mm. The prestressing strand had a harped profile similar to the shape of the applied bending moment. All prestressing specimens were cast using bonded prestressing strands. The strands were stressed after the concrete had reached an age of 28 days, and then grouted with cementitous grout. The beams were tested using two concentrated loads at one-third and twice-third of span by two hydraulic jacks. The previously described set-up was provided with a corrosion located along span of beam. The beams were tested up to failure using a stroke control system after corrosion effect. The studied parameters included corrosion exposure effect, prestressing level, concrete compressive strength, and corrosion location effect. The modes of failure, ultimate load carrying capacity, deflection and strain of steel reinforcement at critical sections were monitored.

The cracking behavior of prestressd and non prestressed concrete beams was presented. Analyses and comparisons of the experimental test result were also introduced. Analytical investigation based on strain compatibility approach was used to predict the deformational behavior of the fully and partially prestressed concrete beams before and after corrosion exposure. Comparison between theoretical and experimental test results was also introduced and showed a reasonable agreement.

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