

High Strength Reinforced Concrete Beams with Exposed Main Steel

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Summary

As part of our longstanding experimental and theoretical works on maintenance and repair of concrete structures, this paper addresses some aspects of the most common repair technique in which, in the course of applying the repair materials, the concrete cover and steel-concrete bond over certain (shear dominated) regions of the damaged simply supported reinforced concrete (RC) beams are removed prior to the application of the repair material. In particular, much emphasis will be placed on verifying a previously reported simple (hand-based) lower bound predictive model (by Raoof and Senussi) for RC beams made of normal strength concrete, with exposure of main steel located within the shear dominated regions, when dealing with RC beams made of high strength concrete. To this end, use will be made of some recently obtained large scale test results by the present authors, which cover concrete cube compressive strengths of up to 110 MPa.

Keywords: Reinforced concrete; beam; patch repair; high strength concrete; normal strength concrete; ultimate strength; shear strength; bending stiffness, bridges; buildings.

1. Introduction

Since the 1980's, there has been an explosion of interest in developing economical, functional and safe methods for maintenance, repair and upgrading of structures as built. The financial implications of such works can often be considerable, and factors such as time and potential disruptions to the users of the structures in the course of remedial action can be of prime importance.

As regards reinforced concrete (RC) structures, it is now well-established that concrete can suffer from a wide variety of types of deterioration resulting in the main from chemical attack. Much effort has (over the last three decades or so) been made to investigate the causes of these chemical attacks and their effects on concrete and steel reinforcement on a material level and also on the means of reducing or eliminating such decay. Prevention is undoubtedly the best cure for the problem. In the meantime, however, many structures built in the last three or four decades will continue to deteriorate and a substantial number are in need of urgent repairs. There is currently also a pressing need for upgrading (strengthening) of R.C. structures. The repair industry is expanding rapidly, predominantly in the U.S.A. and Europe, but also now in the Middle East and other parts of the world.

Until the early 1990's, there was very little publicly available (and systematic) works reported on determining the effect(s) of exposing the main reinforcement (during patch repairs) on the RC beam's overall structural characteristics such as load-deflection, ultimate load-carrying capacity and modes of failure. Obviously, once the main reinforcement is exposed during repair, it no longer acts compositely with concrete and the normal assumption of plane-section bending behaviour does not generally apply. As originally mentioned by Cairns and Zhao [1], although the need to ensure structural stability of a member during removal of concrete is mentioned in many texts, no detailed