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COMPOSITE ACTION OF PRE-CRACKED REINFORCED CONCRETE BEAMS REPAIRED WITH ADHESIVE BONDED STEEL PLATES

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Abstract

Previous studies demonstrated that significantly cracked beams can be repaired by bonding steel plates, however, there is a lack of comprehensive information about the effect of the width-to-thickness ratio of steel plates on repaired composite beams, and the use of thicker plates to repair failed RC beams. This paper presents an assessment of the performance of pre-cracked reinforced concrete beams repaired with adhesive bonded steel plates, of varying width-to-thickness ratio, at the soffit. A total number of 12 beams were tested under a two-point static loading. Group 1 consisted of two control specimens, Group 2 comprised of five beams that were pre-cracked to 60% (serviceability load), and Group 3 consisted of another five beams that were pre-cracked to 85% of the ultimate load. Subsequently, the pre-cracked beams were repaired by bonding steel plates of 6 mm thickness and 75 – 175 mm widths, which varied in increments of 25 mm. Externally bonding steel plates to pre-cracked reinforced concrete beams increased their load capacities by more than 100%, compared to the control beams. Except for specimen PB60-175, there is generally increase in the capacity of the repaired beams with increase in the width-to-thickness ratio of the steel plates. Beams that were pre-cracked at a lower load level (serviceability load) reached higher strengths than the beams that were pre-cracked at a higher load level (85% of the ultimate load capacity). In all tested beams, the experimental moment of resistance did not reach the code-predicted moment of resistance, calculated using EN 1992-1-1.

Keywords: Flexural strength, pre-cracked reinforced concrete beams, repairing, steel plates, width-to-thickness ratio, de-bonding

1.0 Introduction

External steel plating is a convenient method for restoring and improving the flexural capacities of reinforced concrete (RC) beams, compared with other repair methods, due to the wide availability of the mild steel, ease of application, low prices of the materials used in the process, and limited disruptions to the use of the structure [1]. Despite the fact that fibre reinforced polymers (FRP) plates are now preferred in other parts of the world, because of their superior strength-to-weight ratio and corrosion resistance, they are very expensive and not readily available in South Africa, and the rest of Africa [2]. Excluding import costs, the cost of FRP can be 10 times as much as that of steel plates [3, 4]. The use of FRP also poses the increased possibility of brittle failure modes, which are undesirable in a structure. Low carbon steel has ductile stress-strain properties and high deformation capacities, which contribute to the overall ductility of the externally plated beam. In addition, the employment of epoxy glues in this technique is a convenient method of bonding the steel to the concrete. Epoxy glues have practically zero shrinkage properties at hardening [5]. The technique for repairing RC members with epoxy bonded steel plates has been extensively carried out by many researchers, since the pioneering work Fleming and King in South Africa [6] and L'Hermite and Bresson in France [7]. Since then many studies have been conducted to fully