ALEXANDRIA UNIVERSITY
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STRENGTHENING OF R.C. BEAMS SUBJECTED TO SHEAR AND TORSION USING CFRP

A THESIS

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ABSTRACT

Beams located at the perimeter of floor slabs, which carry loads from slabs and beams from one side of the member, are typically subjected to torsional moments that are transferred from the beams to the columns. Beams deficient in resisting torsion can be strengthened using Fiber-Reinforced Polymer (FRP) composites.

Carbon Fiber Reinforced Polymer (CFRP) sheets are the most commonly used materials to strengthen reinforced concrete members due to high strength-to-weight ratio, excellent mechanical strength, and good fatigue properties. As most of the recent research efforts focus on strengthening members subjected to axial force or bending moments. There are relatively less experimental and analytical data on the use of FRP systems for shear and torsion strengthening.

In this thesis seven reinforced concrete beams with the same dimensions (1800 x 300 x 200 mm) and the same flexure and shear reinforcement were tested under combined shear and torsion with different strengthening configurations. The main objective of this study was to investigate the behaviour of reinforced concrete beams strengthened with external CFRP sheets. The main parameters of the current study were the strengthening configuration and the CFRP sheet width. Three Strengthening configurations of the CFRP strips were considered: one face bonding, C-shaped, and full wrapped. Two CFRP sheets widths were considered: 30 *mm* and 80 *mm*.

From the experimental study, it was found that the contribution of external CFRP strips to the torsional strength varied from 3.2 % to 15.7 % for one face bonding, from 21.1% to 60% for C-shaped and from 20.6 % to 61.7 % for full wrapped. This means that C-shaped configuration is sufficient.

Also a numerical analysis using ABAQUS software program was conducted by modelling the seven RC beams with and without external CFRP sheets. The finite element models were able to accurately predict the load capacities for the simulated RC beams subjected to combined shear and torsion and strengthened with CFRP composites. The results obtained using ABAQUS finite element was in good agreement with the experimental ones. From numerical study, strengthening techniques reduced the angle of twist for all strengthened beams compared with control beam, especially after cracking.

Keywords: RC Beams, Torsion, Shear, Strengthening, CFRP, Finite Element Analysis, Numerical Modelling.

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