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Full Length Article

Investigating the efficiency of using the carbon fiber polymer on beam–column connection

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ABSTRACT

Due to the huge amount of energy induced from earthquakes, such natural hazards usually represent the most significant threat on existing and new buildings. Recently, a lot of considerable efforts were dedicated to design buildings capable of withstanding earthquakes' ground motions by utilizing lateral resisting elements, such as reinforced concrete shear walls, cores, frames, and steel bracing. Contrasting the experience gained from the previously designed guidelines and provisions for lateral resisting systems, recent studies illustrated that the existence of lateral resisting system in low-rise buildings is essential in order to resist ground motions. As such, some endeavors are directed to reinforce old buildings against seismic loads. This paper focuses on investigating the efficiency of using Carbon Fiber Polymer (CFRP) sheets on the behavior of beam–column connections considering a cantilever beam with concentrated load at its free end. In addition, to complement the published data, finite element model using the computer package ANSYS was used. The additional beam–column connections in this study are classified in 4 groups (A, B, C, and D) depending on the percentage of reinforcement at the bottom and top of the beam (%A_s). The efficiency of using CFRP was concluded; the CFRP sheet improves or decreases the efficiency of beam–column connection depending on %A_s in the beam. The paper investigates the influence of boundary condition, columns as hinged supports, and the efficiency of using CFRP. It is concluded that the CFRP sheet improves or decreases the efficiency of beam–column connection depending on %A_s in the beam.

1. Introduction

Structures collapse due to the failure of beam–column connection under the effect of the seismic actions in low-rise buildings which happen due to the absence of lateral resisting system (3–4 stories). In this case, framing action between beam and column is the only path to dissipate the earthquake (EQ) energy, which is a significant matter when such connection is not designed to withstand such energy

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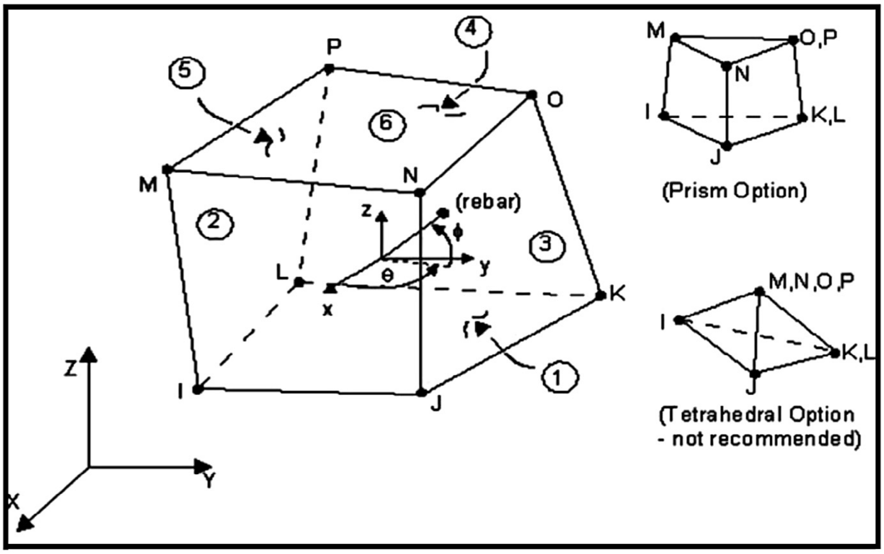

Fig. 1 – Solid 65 element (Swanson, 2007).

considering a hinged support. This research studies the effect of using Carbon Fiber Polymer (CFRP) sheets to repair beam–column connections.

Robert and Prince (2010) presented an effective rehabilitation strategy to enhance both the strength and the stiffness of the beam–column connections, in which analytical models using the computer package *ANSYS* were proposed. These models consisted of three types: C1 (IS 456–2000) which is not designed to resist *EQ*, C2 (IS13920:1993) with increased stripes, and finally C3 (IS 456–2000) to retrofit with CFRP sheets. Finally, beam–column energy absorption capacity as specified in CODE 1993 varied from *42%* to *89%*, to be higher than that as per code (IS 456–2000). On the other hand, the retrofit of beam–column connection using CFRP sheets increased its energy absorption capacity by about *114.29%*, when compared to the corresponding beam–column energy absorption capacity as specified in CODE (IS 456–2000).

The results of the experimental program (Al-Salloum and Almusallam, 2014) established the effectiveness of CFRP sheets in repairing and upgrading deficient exterior beam–column joints. The results of CFRP repaired specimen were compared with those before repairing the specimen, and in general the specimen showed a great improvement in shear resistance, and ductility of the RC joint CFRP sheets was observed. The CFRP repaired exterior joint had failure due to deboning. It was examined and observed that at higher stages of loading there was

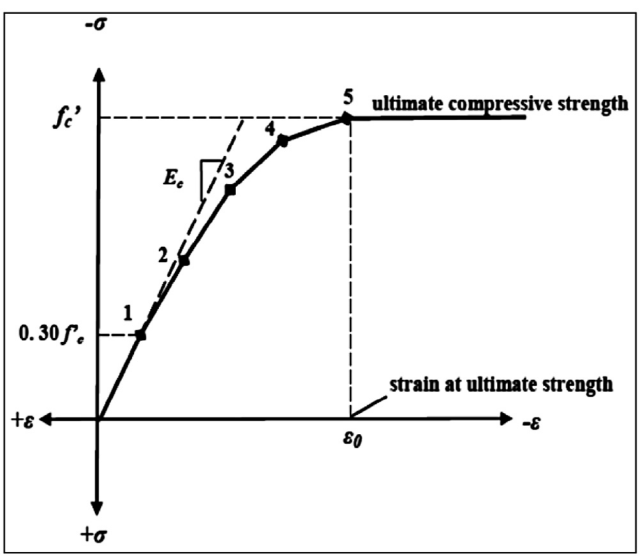

Fig. 2 – Uniaxial stress–strain curve for concrete model (ACI, 1997).

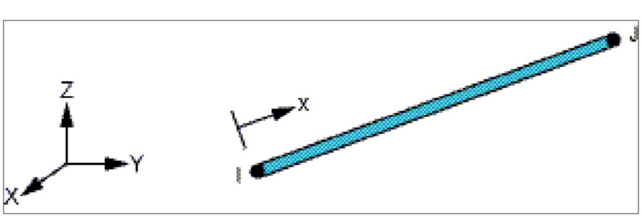

Fig. 3 – Link180 3D Spar (Swanson, 2007).

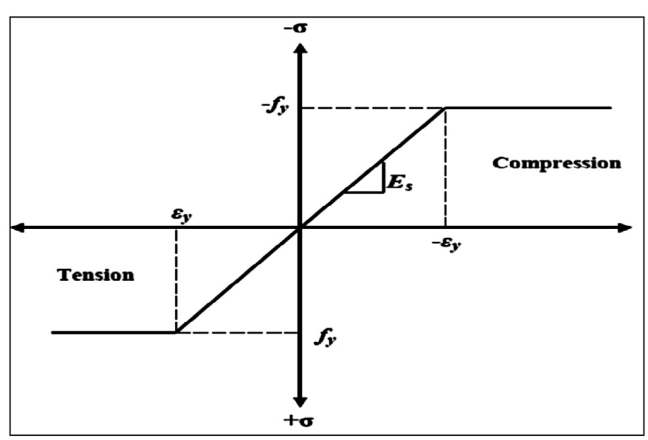

Fig. 4 – Stress–strain curve for steel reinforcement.