

A review on Experimental Study of RC Beam Column Junction

Parshva Sanghvi¹, Dr. Tarak Vora², Prof. Husain Rangwala³

^{1,2,3} Department of Civil Engineering, Marwadi Education Foundation Group of Institution, Rajkot, Gujarat, India

Abstract

For any RCC or Steel structure, Connections are the most critical elements, because in past major collapse of structure took place because of connection failure. Connections plays a vital role in transferring forces from one element to another element. Therefore, it is very important to assess the performance of connections used in structure. Various designs have been investigated for estimating the effectiveness of different types of beam column junctions of RCC Structure at different Scales. Failure behaviour of the specimen has been verified by comparing the results with Analytical validation using Software.

Keywords: Structural Health Monitoring, Exterior, Interior and Corner RCC Beam Column Connection

I. INTRODUCTION

SHM (Structural Health Monitoring) is a process in which certain strategies are implemented for determining the presence, location and severity of damages and the remaining life of structure after the occurrence of damage. This term is usually referred to aerospace, civil and mechanical engineering infrastructure [1]. It is the continuous measurement of the loading environment and the critical responses of a structural system or its components. Health monitoring is typically used to track and evaluate the performance, symptoms of operational incidents due to deterioration or damage as well as health during and after extreme events. Damage identification is the basic objective of SHM. Monitoring Metrics measures Acceleration, Strain, Climatic Conditions, Curvature, Displacements, Load, Tilt/Slope, Scour and many more, which thereby identifies Corrosion, Cracking, Strength, Tension, Location of rebar/delamination, etc.

Strain gauges are widely used in Structural Health Monitoring (SHM) systems because they are inexpensive, easy to install, and sensitive enough to detect the potential danger of collapse of a building or structure. However, off-the-shelf equipment for the strain gauges is usually either wired to the sensors or wireless with very limited range, which significantly increases the total cost as well as restricting the performance of the deployment [4].

The main objective after the study was to identify Systematic damage at various levels with different damage patterns and damage sequences. The basic Steps in damage diagnosis used were: Collection of data, Feature Extraction and classification of damage. The Only Drawback was the requirement of Full-Scale Analysis and Field Testing [18,19], which was overcome in other proposals [15]. Uniform guidelines for evaluating joint tests to determine the joint characteristics (stiffness, resistance, elastic limit and rotation ability) are given as a basis both for the calibration of new joint models and for checking existing ones in comparison with test results [2].

The contribution of this paper is to present a strain-based structural health monitoring system that can diagnose structures and be easily extended to large buildings at low cost. In the paper, researchers proposed a structural health monitoring system based on wireless sensor nodes equipped with inexpensive strain gauges. The performance of the system is not limited, because multi-hop deployment is possible [4].

The Reviews are based on of the different points like location is either on corner and exterior beam column joints and their behavior, support conditions of beam-column joints; i.e, both ends hinged and fixed, stiffness variation of the joint [6,7].

II. EXPERIMENTAL ANALYSIS

Experimental analysis of different beam column junction is studied in various literatures. The performance of the beam-column joint was analyzed using acoustic emission technique to check performance of the structure when the beam subjected to vertical point load at 530 mm away from the column surface as shown in Fig.1. The dimensions of the elements considered are as follows: 1) beam with 300 mm x 200 mm x 600 mm, 2) column with 200 mm x 200 mm x 1200 mm. From the compressive strength test of five cubes at 28 days, the average compressive strength of 40.05 N/mm² was obtained. The result of visual observation and acoustic parameters are determined to identify the damage in form of crack modes in beam column junction. From the result of the experimental study observed that, the b value of acoustic parameter and cumulative signal strength served as a effective tool to identify crack growth and formation of micro cracks. [5].



Figure 1 RC beam column junction test setup and mapping of crack produced [5]

The effect of addition of micro concrete on the behaviour of RC exterior beam column connection under the reversed cyclic loading was experimented as shown in Fig. 2. A cross section of $120\text{mm} \times 120\text{mm}$ and $120\text{mm} \times 150\text{mm}$ for column and beam elements respectively were considered. HYSD bars of 8 mm diameter (Fe500) were used as main bars in both column and beam. A lateral tie of 6 mm diameter mild steel bars at 25 mm c/c spacing was used in the special confinement zone of the column and in remaining part 50 mm c/c is used. The shear reinforcement in beam was 6 mm diameter bar having spacing of 25 mm c/c used. The result of the experimental results shows that for the hysteresis loops from the cyclic loading, the specimen exhibited a greater energy dissipation capacity. Also observed that specimens presented a lower degradation of stiffness which is desirable property in earthquake like situations. [8]

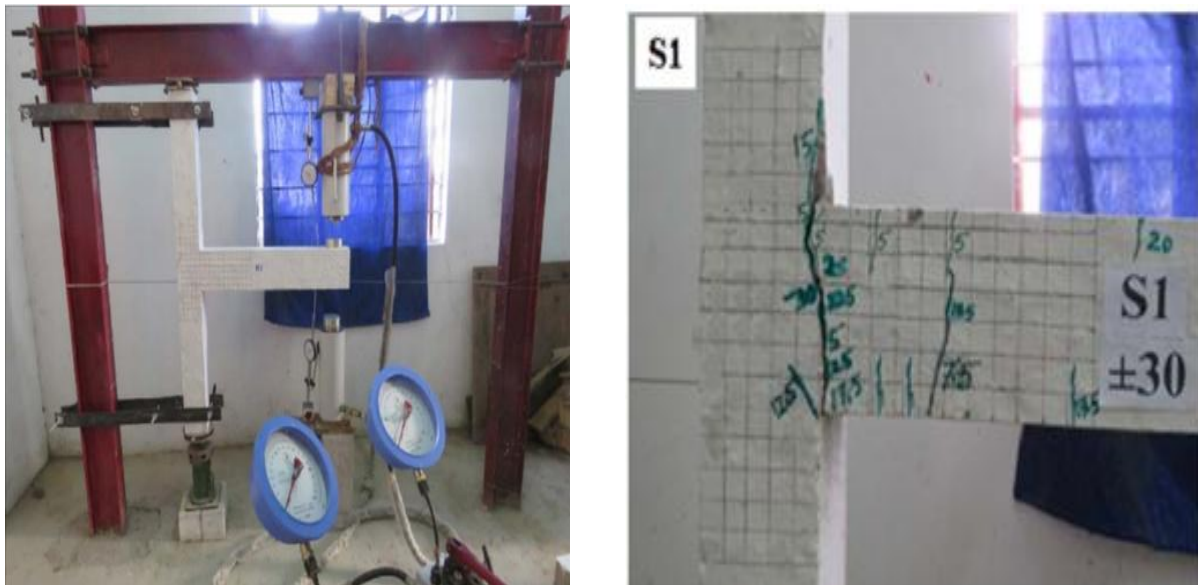


Figure 2 RC beam column junction test setup and failure junction [8]

The experimental study of beam column specimen of $1/5^{\text{th}}$ scale having scaled dimension of beam s $120\text{mm} \times 170\text{mm}$ with 450 mm length and column of $120\text{mm} \times 230\text{mm}$ with height of 600 mm. The load is applied in to and fro cycle and deflection measured from every 3 kN by using LVDT. Specimen is failed at ultimate load of 23 kN. From this experimental work the structure behaviour is measured important parameters was worked out such as load vs deflection as shown in Fig. 3, ductility, energy absorption, stiffness degradation etc. Maximum energy absorbed during the 7^{th} cycle was 123.75 kN-mm [9].

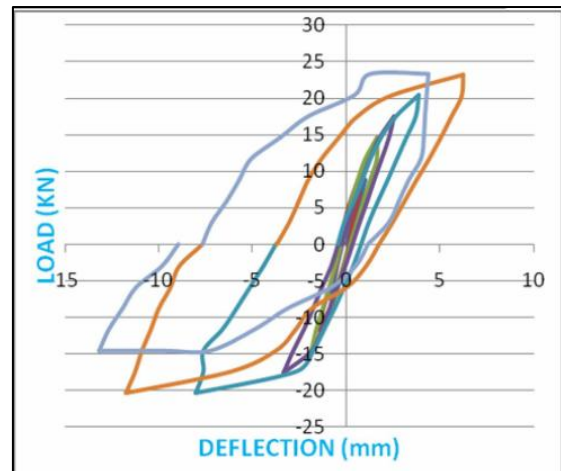


Figure 3 RC beam column junction test setup and load vs deflection behaviour [9]

In one of the study the behaviour of exterior beam column junction with transverse reinforcement detailed as per IS: 456 and IS: 13920 was compared. Different four scaled models are tested under a reverse cyclic loading. The results indicates that as per IS: 13920 for joint design assure the beam failure take place before the failure of joint [10].

The proper anchorage is essential to enhance the performance of the junctions. The beam column junction are tested with different anchorage length as per ACI-352 (mechanical anchorages), ACI-318 (conventional bent hooks) and IS-456 (conventional anchorage). Also the joints are detailed with cross bars and without confinement. In all specimen were in identical size in which beam sizes were 200 mm×300 mm and the column were 300 mm×200 mm. The length of the beam was 1200 mm from the column face and the height of the column was 1500 mm. The specimen is tested under reverse cyclic loading as shown in Fig. 4. The failure pattern for different specimen is also shown in Fig. 4. The result and failure pattern comparison of different specimen shows that the mechanical anchorage in combination with cross bar is effective for beam column junction yielding. [13].



Figure 4 Test setup and crack pattern of RCC beam column junction [13]

The beam column junction is proposed with core reinforcement and the results are compared with Ordinary moment resisting frame and Special moment resisting frame as per IS: 13920. The three different joint detailing i.e. CMR, OMR and SMR are as shown in Fig. 5 respectively. The specimens are tested under reverse cyclic loading. The result shows that the first crack is initiated was 7.36 kN, 7.27 and 8.6 kN whereas 11.25 kN, 14.2 kN and 15.1 was ultimate load for OMR, SMR and CMR specimens respectively. Also ductility factor for core reinforcement was 46% and 19% higher than OMR and SMR specimens. In similar specimen the energy dissipation, joint rotation, relative stiffness were also studied and observed that core reinforcement are performed better than other joints. [14]

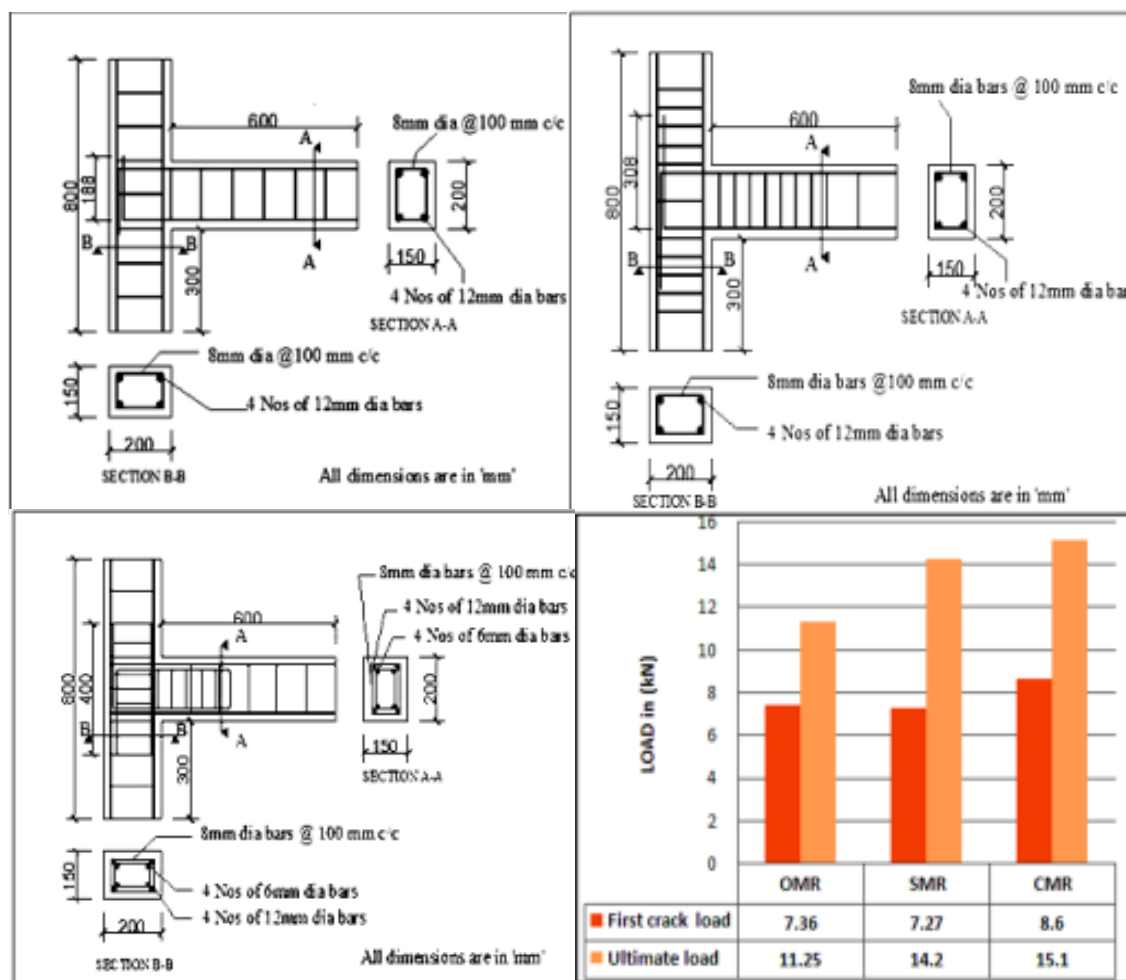


Figure 5(a) Detailing of OMR (b) Detailing of SMR (c) Detailing of CMR (d) Result Comparison [14]

The experimental study of scaled model for space junction of beam column having longitudinal beam dimensions were $200 \times 400 \times 1500$ mm, transverse beam were $300 \times 400 \times 750$ mm in both direction and column $200 \times 300 \times 1600$ mm. Shear reinforcement for the test joints, according to ACI 318 increase the load carrying capacity, the energy absorption capacity of the joint, delayed the cracks propagation, and changed the mode of failure from flexural shear near to the beam-column interface, for the traditionally reinforced specimens, to flexural failure in the beam close to the joint region. The ultimate displacement observed 54.5 mm and stiffness degradation was 83.6 %. [15]

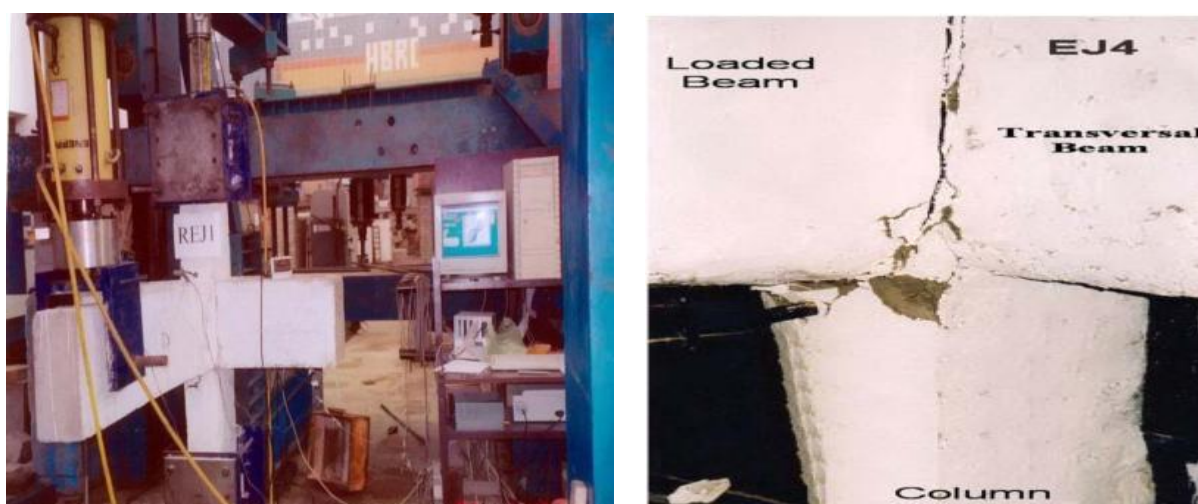


Figure 6 Test setup, crack pattern and failure of space beam column junction [15]

III. CONCLUDING REMARKS

Beam column junctions are identified as critical component in the study of the behaviour of the reinforced concrete structural elements. Damage within a junction may trigger failure of overall performance of the structure. Through this study, the experimental study of different beam column junction with variation of loading and different reinforcement

detailing is carried out from the numbers of literature survey. From the experimental study, performance of the junction is identified in terms of load vs deflection, acoustic emission, ductility, stiffness degradation etc.

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