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STUDY OF BEAM COLUMN JOINTS

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ABSTRACT:

A beam-column joint has to transfer the shear forces, bending moments and other related structural response parameters efficiently. The present paper aims at studying the behavior of beam-column junction based on variations in concrete grade at junction. To increase the load carrying capacity of a joint, a higher grade of concrete is used at a joint and also up to 1.5D in the direction of beam from face of column, to shift or relocate the plastic hinge from the interface towards the beam.

The different specimens were prepared in a T-shaped mould by changing the grade of concrete at beam-column joint and these samples were tested after 7 and 28 days. The use of M20 or M25 grade of concrete at joint and up to 1.5D (D is the depth of beam) of length of beam (M15 grade of concrete in rest of mould) increases the load carrying capacity approximately to about 20% when compared with M20 or M25 grade of concrete at junction and M15 grade in the remaining mould. The most important finding is that the use of higher grade of concrete at a joint and up to 1.5D of length of beam, shifts the failure away from the beam-column interface Thus, a beam hinging mechanism is achieved which is a ductile type of failure compared to beam-column brittle interface failure and there is approximately 15-30% increase in load carrying capacity, in comparison with higher concrete grade only at a joint core. This is a simple and efficient method of preventing the beam-column joint failure.

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Key Words: Beam-Column Joint, Brittle Failure, Concrete Grade, Load Carrying Capacity, Strength

INTRODUCTION:

A joint or junction is basically the part of beam into the column and is the zone of complex stress concentrations and is prone to failure via crushing of concrete. It is not necessary that failure would only occur because of crushing of concrete at joint. There are several other structural failures that are directly related to reinforcement detailing & designing. This study is an attempt to learn the nature of beam column junction with respect to the behavior of concrete at joint and an attempt has been made to improve the efficiency of joint by adopting measures to prevent crushing of concrete at joint. "A beam-column junction has to transfer the shear forces, bending moments and other related structural response parameters efficiently and has to maintain structural integrity also and any instant of time it may also have to bear with seismic forces and as a direct consequence it forms the real blood of the structure and at any instant of time if it is not capable of transferring the structural response, then the entire structure might fail (because of concrete crushing at junction) and may lead to catastrophe."

In our project, the crushing of concrete at beam column junction and thwart of it has been given. The efficiency of the beam-column junction with and without higher concrete grade at junction has been compared and from the experimental study it has been observed that a beam-column junction with higher concrete grade is free from concrete crushing at joint and cracking occurs near top or bottom of column and on the other hand a beam-column junction with same grade of concrete throughout fails typically at top or bottom and also the junction concrete crushes leading to the real failure.

To increase the structural performance the use of high concrete grade at beam-column junction is necessary. The concept of beam column junction is not much known by the researcher or people. With the passage of time the altered beam column junction will become vital instrument. It is expected from the study that it hits the mind of structural engineers and the trend shows the large scope in it. And again the alteration in our work on beam column junction has been made.

LITERATURE REVIEW:

(SANTOS, 2018) Studied *"Influence of the stiffness of beam-column connections on the structural analysis of reinforced concrete buildings"* and observed that the reinforced concrete was performed to analyze the conventional structure of buildings in view of that the beam column relation was inflexible. So, the tentative outcomes of experiments proved the subsistence of qualified rotations in beam column junction with the relation of reinforced concrete structure which represents the partial relocation in bending moment. The significant impact on beam column association within the global stability was studied and the column bending moment of structure in reinforced concrete was also investigated. "A building was designed with rigid connections and deformable connections to identify the importance of considering the influence of the stiffness of the beam-column connections in the overall stability of monolithic and in the redistribution efforts in reinforced concrete structures. In order to determine the stiffness rotation of deformable connections, two analytical models available in literature were used, and a comparison between the results obtained by each analytical model was also performed. Based on the results, it is concluded that neglecting the influence of the stiffness of the beam-column connections on the analysis of monolithic reinforced concrete structures may result in different solutions compared to the real behavior of the structure". The obtained values of rigidity in the proposed models frequently differs from the situation of inflexible relations which recommends the modification in the selection of standards that is mainly applied in the computer programs for the purpose of structural calculation. With the advancement of technology and development of structural analysis programs the pattern of slender buildings were designed.

(Sreekumar, 2018) Studied "*Study of Beam Column Joint with Different Reinforcement Detailing State Of The Art Review*" and found that recent study on the subject of beam column junction lead to the revelation that, this particular junction of structural members is one of the most vulnerable, in terms of failure tendency. For a long time now, studies have been conducted to enhance the strength of this particular failure location. Many of these studies showed that a difference incorporated in the detailing of the joint reinforcement enhances the property of the joint. These differences can be in the form of addition of reinforcement, reduction of reinforcement or even as modification of existing reinforcement. The literature review depicted that beam column junction requires special attention for the detailing purpose. The key source of failure is the lack of capability of the joint to withstand the shear strength practiced in the juncture. Several researchers recommended new methods & technique to reach the aim of improving the fragile joint component. They tested these techniques with that of the conventional construction of the beam column joint. All of the testing revealed that the new methodologies adopted by the authors have displayed far better performance in comparison to the conventional beam column joint. These researches performed have given an insight on various methods to improve such a risky zone of failure. Each of these papers also suggest areas and scope for further study and have given suggestions on how to conduct them as well.

(Elkordy, 2017) Studied "*An Analytical Study of Improving Beam-Column Joints Behavior under Earthquakes*" and observed that the non ductile RC frames, which is a part of existing worldwide reinforced concrete which were intended to bear gravity loads before the year 1970s. The national codes identifies the variation in seismic active zones like frames did not satisfy the current design requirements mainly when lying in the seismic active zones to identified the modification. This framework was the consequences of poorer reinforcement detailing which was normally did not acquire the proper flexibility & power required to resist the predicted earthquakes. During the earthquake older reinforced concrete structure was damaged severely. The wide cracks within & around the beam column links is the key factor of damage. The shear & bond failure mechanism is governed through the beam column joints failure that is normally fragile in nature. The beam column joints part was attributed to improper shear reinforcement. Many methods & techniques of strengthening & repairing beam column joints in old reinforced concrete structure was developed mainly in earthquake prone areas. "In this paper, a finite element model for an exterior beam-column joint was presented to simulate the behaviour of such joints in older gravity load designed RC frame structures. Several specimens are studied, one for the unstrengthened case, and others represent strengthened cases with different techniques. Studied strengthening techniques include using banded joints with CFRP sheets as a proposed technique, or joints reinforced with steel jackets as observed from older research in literature". All cases were planned & investigated when pressured incrementally until it did not fail. The obtained outcomes of deformation and strain were examined and then compared with every case.

OBJECTIVES :

A.) "To study the behavior of beam-column junction"

B.) "To study the failure mode of concrete at beam-column junction"

C.) "To study the effect of using high concrete grade at beam-column junction"

D.) "To study the variations in load at failure with variations in concrete grade at beam-column junction"

E.) To study the effect of using high grade concrete mix at junction plus one-third of the length of the beam into the column

F.) To produce a beam-column junction which is free from concrete crushing at junction

G.) To produce an economical beam-column junction free from concrete crushing at junction

H.) To rejuvenate awareness about beam-column junction failures and associated pre-construction strengthening measures

I.) To add more to the durability and serviceability of the structures

J.) To divert the attention of the research organizations about our project and pay a way for further future work on this project which may add further good modifications to our work

K.) To safeguard our structures and occupants of the structures and as a whole to add compatibility to our engineering ethics and engineering duties

METHODOLOGY:

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With the purpose to examine the beam column joint behavior samples are prepared in T shaped beam. The magnitude of beam were set as per IS specifications. The length of beam is 50 cm including thickness of column. The length of column is 50 cm. The height and width of T beam is kept 10 cm each. The following figures illustrate the dimensions of T beam

PROCEDURE:

The concrete mix is prepared through several samples with varied composite at beam column joint. These different specimens have been experimented after the 7days & 28days. Each specimen is provided with four bolts & nuts for the fixing purpose. To obtain the fixity condition a proper management has been done during the testing period which is illustrated below: M15, M20, M25 and etc joints were used for special concrete grades. In UTM testing procedure of specimens were conducted after the 7days & 28days.

The following are the information of tests applied on samples:

S.NO	SAMPLE	DETAILS OF SAMPLE
1	SAMPLE 1	M15 USED UNIFORMLY
2	SAMPLE 2	M15 AND M25@L/3 IN THE DIRECTION OF BEAM
3	SAMPLE 3	M15 AND M20@JOINT
4	SAMPLE 4	M15 AND M25@JOINT
5	SAMPLE 5	M15 AND M20@L/3 IN THE DIRECTION OF BEAM

ANALYSIS:

RESULTS OF DIFFERENT SAMPLES

The outcomes of the testing conducted after 7days & 28days on UTM. The outcomes of each and

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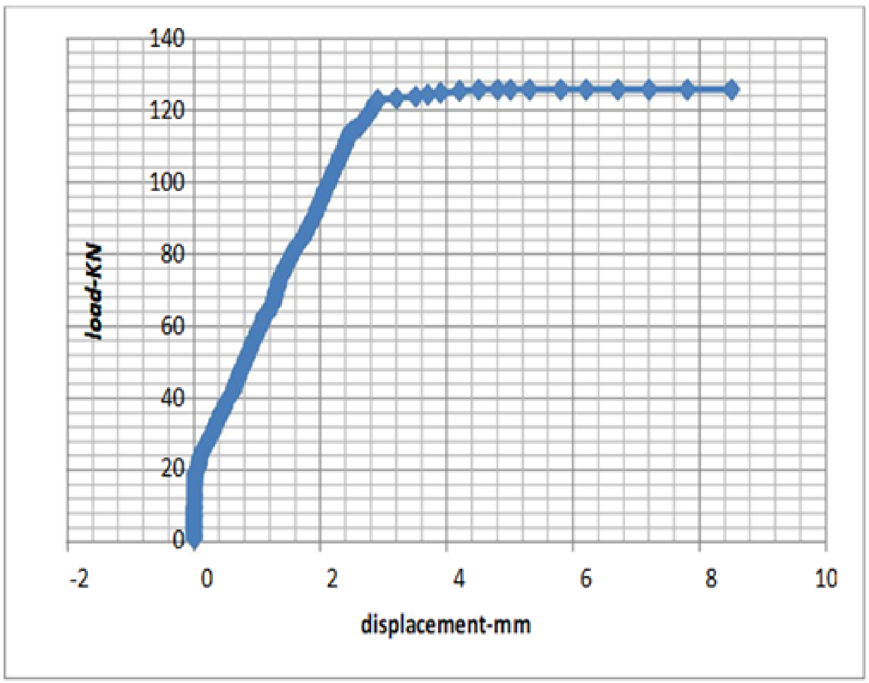
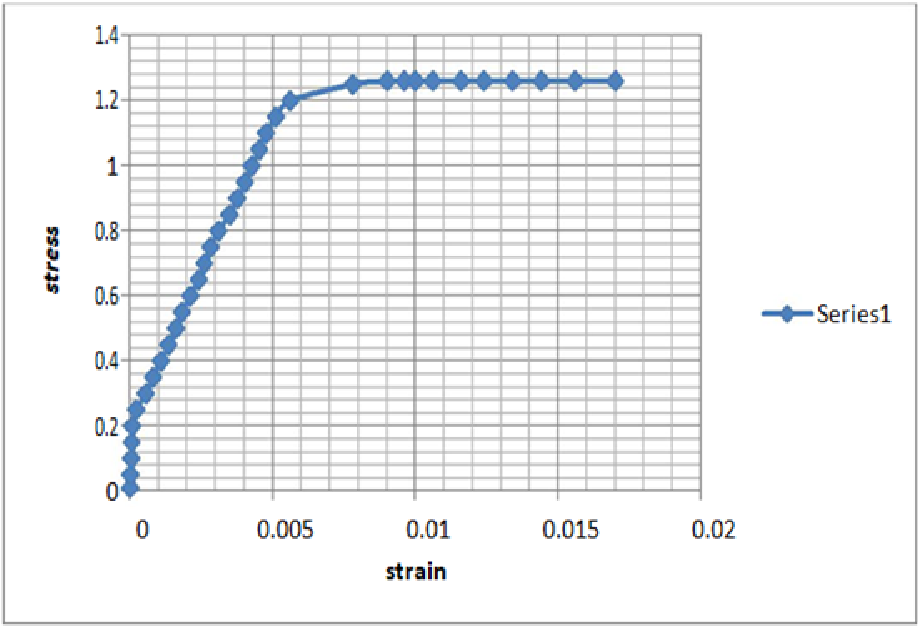
every experiment have been summarized below:

1) Sample 1

In the sample 1: M15 sample were used uniformly on the beam column joint as it is assumed that no change has been occurred in the concrete mix at beam column joint. The specimen was experimented following 7days & 28days using UTM with suitable arrangement for fixity. The "load-displacement and stress-strain" curves for the sample 1 are given below:



Load-displacement curve (sample 1)



Stress strain curve (sample 1)

From above all graph:

KN represents the load

KN/m2 represents the stress & displacement

The specimen 1 was experimented after completion of 28days and rest the specimens such as 2, 3, 4, and 5 were experimented after completion of 7 days.

Results of samples

SAMPLE	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
PEAK LOAD	126 KN	80 KN	85 KN	101 KN	116 KN

4.3 CONCLUSION

- In the beam column joints the use of higher concrete grade saves the junction from failure and hence in the present day construction this technique will surely add to the structural efficiency and at the same time this technique is relatively economic and this may surely add to its implication

- "This modified beam column-junction is economically as well as practically feasible and at site; this technique can be applied with ease without much complexities".
- This modified beam-column junction is surely a new concept of research related to beam-column junctions and with the course of time this modified beam-column junction will be surely further modified to add to its structural efficiency
- "A modification we would like to draw the attention of the research fellows towards use of steel fibers in addition to higher concrete grade at beam-column junction."
- Though no study has been done on the seismic efficiency of this modified beam – column junction but surely it may take care of the seismic efficiency of the beam-column junction.

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