Study of Interior Beam Column Joint under Seismic Effect

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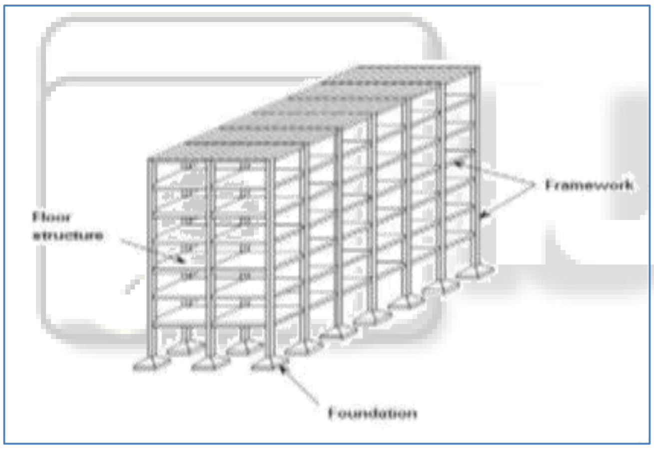
Abstract— Performance of Beam-column joint is matter of concern in the modern ductile design of building. Especially under the earthquake loading this is more susceptible to damage. Brittle nature failure is responsible for devastating damages. Since 1970’s this area is focused by researchers. But still due to versatile nature of the joints core behavior, the problem still needs attention. The earthquake forces in beam-column joint during earthquake may cause cracks and failure, when not designed and detailed properly. In present work, the study of interior beam column joint is studied for seismic effect. The response spectrum method is used for analysis of building. The high rise building (100 m) is analyzed in ETAB’s. Parameters is studied along with ductility, stiffness, energy dissipation, vulnerability index are studied.

Keywords: Interior Beam-Column Joint, Ductility, Stiffness, Energy Dissipation, Vulnerability Index, Hysteresis Curve, ETAB Software

I. INTRODUCTION



Earthquakes are one of the most feared natural phenomena that are relatively unexpected and whose impact is sudden due to the almost instantaneous destruction that a major earthquake can produce. Severity of ground shaking at a given location during an earthquake can be minor, moderate and strong which relatively speaking occurs frequently, occasionally or rarely. Design and construction of a building to resist the rare earthquake shaking that may come only once in 500 years or even once in 2000 years at a chosen project site even though life of the building itself may be only 50 to 100 years is too expensive. Hence, the main intention is to make building earthquake-resistant such that it resists the effect of ground shaking by getting damaged severely but not collapsing during strong earthquakes. Thus the safety of people and contents is assured in earthquake-resistant buildings. This is a major objective of seismic design codes throughout the world.

The performance of structures in earthquakes indicates that most structures, system and components if properly designed and detailed have a significant capacity to absorb energy when they deform beyond their elastic limits. Experience with the behaviour of reinforced concrete beam-column joints in actual earthquakes is limited. To fully realize the benefits of ductile behaviour of reinforced concrete framed structures, instabilities due to large deflections and brittle failure of structural elements must be prevented under the most severe expected earthquake ground motions

Beam column joints can be critical regions in reinforced concrete frames designed for in elastic response to severe seismic attack. As a consequence of seismic moments in columns of opposite signs immediately above and below the joint, the joint region is subjected to horizontal and vertical shear forces whose magnitude is typically many times higher than in the adjacent beams and columns. If not designed for these actions joint shear failure can result.

Aly M. SAID and Moncef L. NEHDI (August 6, 2004 paper no. 1686), “Behaviour of beam-column joints cast using self-consolidating concrete under reversed cyclic loading.” Multi-storey reinforced concrete structural frames are among the most congested structural elements. Placing and consolidating concrete in such structural frames imposes substantial technical challenges. This offers a unique area of application for self-consolidating concrete because of its inherent ability to flow under its own weight and fill congested sections, complicated formwork and hard to reach areas. However, research is needed to demonstrate the ability of SCC structural frames to adequately resist vertical and lateral loads.(1)

Robert Jankowski, “Non-linear viscoelastic modelling of earthquake-induced structural pounding” 3 March 2005. Past severe earthquakes indicate that structural pounding may cause considerable damage or even lead to collapse of colliding structures if the separation distance between them is not sucient.(2)

Sudhir K. Jain And S. R. Uma (March 2006 vol. 23 no. 5), “Seismic design of beam column joint in RC moment resisting frame.” The behaviour of reinforced concrete moment resisting frame structures in recent earthquakes all over the world has highlighted the consequences of poor performance of beam column joints. Large amount of research carried out to understand the complex mechanisms and safe behaviour of beam column joints has gone into code recommendations.(3)

Dr. Suraj. N. Khante, Aniket V. Nemade Volume 2, Number 9; April –June, 2015 pp 49-53, “Performance of Beam-Column Joint using Nonconventional Reinforcement Technique under Cyclic load Performance of Beam-column joint is matter of concern in the modern ductile design of building.” Especially under the earthquake loading this is more susceptible to damage.(4)

Mohit Jain1, Dr. Sudhir S. ,Bhadauria *ETL* (volume -5, Issue-10, 2016), “Present study presents comparative analysis of flat slab system and wide beam system in reinforced concrete buildings.” The comparison is performed with reference to conventional moment resisting frame.(5)

S.R. Uma and A. Meher Prasad jun-2016, “Seismic behaviour of beam column joints in reinforced concrete moment resisting frames". The beam column joint is the crucial zone in a reinforced concrete moment resisting frame. It is subjected to large forces during severe ground shaking and its behaviour has a significant influence on the response of the structure.(6)

Mohit Jain, Dr. Sudhir S. Bhadauria, Danish Kha 2016," Seismic analysis of flat slab and wide beam system." Present study presents comparative analysis of flat slab system and wide beam system in reinforced concrete buildings. The comparison is performed with reference to conventional moment resisting frame.(7)

Mohsen Malekinejad , Reza Rahgozar , Ali Malekinejad , Peyman Rahgozar 10 August 2016, "In this paper, a continuous–discrete approach based on the concept of lumped mass and equivalent continuous approach is proposed for free vibration analysis of combined system of framed tube, shear core and outrigger-belt truss in high-rise buildings."(8)

Arsalan Alavi1, Reza Rahgozar1, Peyman Torkzadeh1, Mohamad Ali Hajabasi 25 September 2017, "In modern tall and slender structures, dynamic responses are usually the dominant design requirements instead of strength criteria." Resonance is often a threatening phenomenon for such structures. To avoid this problem, the fundamental eigenfrequency, an eigenfrequency of higher order, should be maximized. An optimization problem with this objective is constructed in this paper and is applied to a high-rise building.(9)

II. Beam Column Joint

The portion of the column where beam join is called beam-column joint. Beam column joints are classified in to three types based on the number of beam sending into the column. Types of beam column joints are i) Interior Beam-Column joints, ii) Exterior Beam-Column joints, iii) Corner Beam-Column joints. Typical beam column joints in structure are shown in Figure 2.

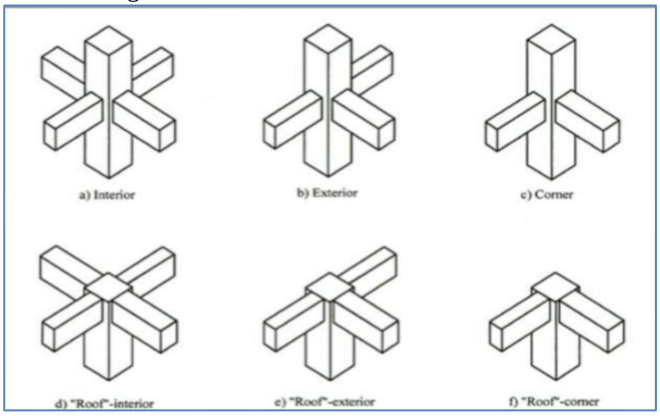


Fig. 2: Types of joints

III. Analytical Modeling

The interior beam-column joint is considered to study joint behavior subjected to cyclic loading. The interior beam-column joint is analyzed using ETAB software.

A. *Material Properties*

The material properties are used in model grade of cement & steel used are M30 & Fe415 Mpa respectively.

IV. Properties of Structure

A. *Ductility:*

The term ductility in seismic design is used to mean the ability of a structure to undergo large amplitude cyclic deformations in the inelastic range without a substantial reduction in strength.

B. *Stiffness:*

Stiffness is a measure of a material's resistance to deformation. It is characterized by the value of Young's modulus for the materials. Young's modulus is the slope of a stress-strain curve. The more ductile a material is, the more deformation it can accommodate before cracking.

C. *Dissipation of Energy:*

A physical process (as the cooling of a body in the open air) by which energy becomes not only unavailable but irrecoverable in any Form compare conservation of energy, degradation of energy. The area enclosed by the hysteresis loop in Load-displacement curve at a given cycle represents the energy dissipated by the specimen during that cycle.

D. *Hysteresis Curve:*

It is curve generated under cyclic loading & it is successive addition of stress-strain curve. It also gives energy dissipation under these curve.

E. *Vulnerability Index:*

Seismic vulnerability is the amount of damage induced by a given degree of hazard expended as a function of value of facility. SVF method is the empirical method and it is also called as seismic vulnerability function.

V. Expected Outcome

1) To find weaker joints in the structure comparing strain energy dissipation is each joint
2) Improves performance of interior beam column joint to resist against seismic effect.

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