A Technical Eveluation on Reduced Beam Section

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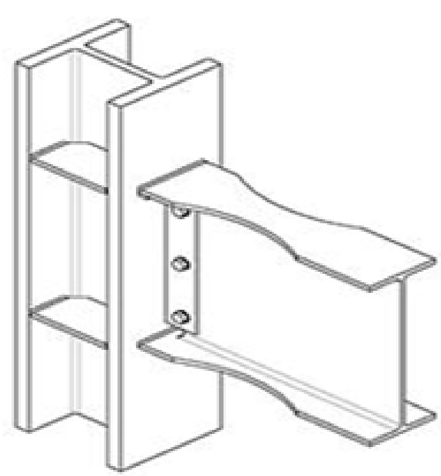
Abstract- *In developing India, the demand of steel increasing in heigh rise building.Mostly the buildings is designed for earthquake resistant, not the earthquake proof. As the concrete is brittle material and steel is ductile material, so the use of steel is more in high rise buildings. Thus the buildings are designed as per the considerations of mainly lateral forces viz. earthquake force. In steel design, the sections are designed along with connection design. Connections are mainly designed for resisting moments during the failure of beam and saving the damage in column. This paper is regarding the moment resisting connections and reduced beam sections. In this paper, the past work and the experimental work done by various people according to their views is studied. To conclude in the end, the reduced beam sections prove to be the better option as the moment resisting connection.*

I. INTRODUCTION

After Northridge earthquake, most researches were directed toward making bending connections in steel structures more ductile. One of the different kinds of these connections is RBS (reduced beam section connection). In this kind of connection, reducing flange section near the end of the beam and within a definite length makes the plastic hinge move to the reduced part and expanding plastic hinge in the length of cut area causes a significant ductility in the hinge. In fact, reduced flange section acts like a fuse and prevents the initial cracks in the connection (FEMA 355D 2000).



Reduced Beam Section

The most common kinds of RBS connections are: (i) RBS with straight reduced section (ii) RBS with tapered cut reduced section (iii) RBS with radius reduced section (FEMA 350 2000). Other researchers investigated optimal flange shape under monotonic loads. The optimal shape strongly depends on the upper bound of the equivalent plastic strain, which is to be specified in practice based on the performance required for each frame , and other new type of Reduced Beam Section (RBS) connection, ``Accordion Web RBS (AW-RBS)" were . The AW-RBS decreases the web contribution in moment strength and a reduced section is developed in the beam, so it can’t be used regularly and in wide range in construction of buildings. Most researches approve using different kinds of RBS connections .Most of the experiments which are carried out include the sizes of the beams and the kinds of the steels used in practice. The primary studies on this kind of connection indicate that this connection has got some appropriate unique characteristics such as high ductility, appropriate resistance, less cost in comparison to other bending connections, much less operation time for building and installing structure, much more assurance to the welding and it’s welding at work place. In this kind of connection by cutting some parts of the flange, the plastic hinge moves by the side of the column into the area within the beam, and as a result there won’t be beam-column connection problems at the work place anymore. The reduced area absorbs much more energy by its plastic function and makes a controlled hinge with a wonderful ductility (FEMA 355D 2000).

In multi-story bending steel frames, it is favourable if a regular frame is designed so that the plastic hinge can be made in the beams and the columns remain elastic (the weak beam - strong column rule). Using reduced beam section in the width of flange in the vicinity of beam-column joint is a good design for improving ductility effect in frames which are exposed to intense earthquake loading. The reduced beam section reduces the force directed to the parts of the beam-column joint by directing and regulating stress properly, besides it reduces the volume of welding metal and increases the stiffness of the connection (FEMA 355D 2000&Sac 2000). One of the most remarkable

Characteristics of RBS connections with radius cut are the strain hardening. For a 50 percent reduction in section, the reduction in stiffness is about 6 to 7 percent and for a 40 percent reduction in flange section this amount falls to 4 to 5 percent (Grubbs K.V 1997). But the reduction of stiffness also causes a rise in the lateral drift of the story. Regarding the fact that drifting is considered as one of the important criteria in designing steel structures, so it seems research worthy to investigate the effect of RBS connection on drift. In this study, the effect of this connection on the drift of the structure is investigated. Nonlinear time history analysis is used for investigating the effect of RBS connection on the amount of the inside drifting angle of the story.

1] F. Dinu, D. Dubina Politehnica University of Timisoara, Romania Romanian Academy, Timisoara Branch.(2012) [1]

Experimental tests on two types of short beams of RBS connections confirmed the design procedure. The specimens exhibited excellent ductility and rotation capacity up to 60 mrad before failure. The numerical model can predict with a good accuracy the response of the structure if the slippage at the splice connections is appropriately accounted for. Based on the results, a redesign of the splice connection, which is more consistent with the predominant shear stress at the mid-length of the beams, is proposed.. The detail should prevent the bolt slippage which can cause both an increase of the lateral deflection and, under extreme deformations, brittle failure of the bolts. - For very short beams, the interaction between the shear and normal stresses caused an inclination of the buckled shape in the web. The plastic rotation capacity has two major components, i.e. rotation of the beam (reduced beam section) and distortion of the web panel in the reduced region. Due to the large stiffness of the columns, the contribution of the column web panel can be neglected. - Numerical analysis for cyclic loading is in progress. The numerical simulation of the slip behavior will be also considered. The final calibrated model will be applied to verify the design procedure for the types of connections proposed in the project. - For design purposes, a fiber hinge model of the plastic zone (reduced beam section) will be also developed. The model will be employed in the nonlinear static and dynamic analysis and design of the steel frame building.

2] Bing Qu, S.; Michel Bruneau; Chih-Han Lin; Keh-Chyuan Tsai (2008)[2]:

A two-phase experimental program was generated on a full-scale two-story steel plate shear wall with reduced beam section connections and composite floors, to experimentally address the irreplaceability of infill panels following an earthquake and the seismic behaviour of the intermediate beam. In Phase I, the specimen was pseudo dynamically tested, subjected to three ground motions of progressively decreasing intensity. The buckled panels were replaced by new panels prior to submitting the specimen to a subsequent pseudo dynamic test and cyclic test to failure in Phase II. It is shown that the repaired specimen can survive and dissipate significant amounts of hysteretic energy in a subsequent earthquake without severe damage to the boundary frame or overall strength degradation. It is also found that the specimen had exceptional redundancy and exhibited stable force-displacement behaviour up to the story drifts of 5.2 and 5.0% at the first and second story, respectively. Experimental results from pseudo dynamic and cyclic tests are compared to seismic performance predictions obtained from a dual strip model using tension only strips and from a monotonic pushover analysis using a three-dimensional finite-element model, respectively, and good agreement is observed.

3]Kamyar Kildashti, Rasoul Mirghaderi, Iradje Mahmoudzadeh Kani (2012)[3]:

In most framed structures anticipated deformations in accordance with current codes fall into acceptable limit states, whereas they go through substantial residual deformations in the aftermath of severe ground motions. These structures seem unsafe to occupants since static imminent instability in the immediate post-earthquake may be occurred. Moreover, rehabilitation costs of extensive residual deformations are not usually reasonable. Apparently, there is a lack of detailed knowledge related to reducing residual drift techniques when code-based seismic design is considered. In this paper, reduced beam section connections as a positive approach are taken action to mitigate the huge amount of residual drifts which are greatly amplified by P-Δ effects. To demonstrate the efficacy of RBS, a sixteen-story moment resisting frame is analyzed based on a suite of 8 single components near field records which have been scaled according to the code provisions. The results are then processed to assess the effects of RBS detailing on drift profile, maximum drift, and residual drift. Besides, a special emphasis is given to estimate overall trend towards drift accumulation in each story in the presence of RBS assembly. A main conclusion is that using this connection predominantly alleviates the adverse effects of P-Δ on amplifying residual drifts.

4]Kulkarni Swati Ajay, Vesmawala Gaurang(2013)[4]

Reduced beam section (RBS) is one of the several connection types, which is economical and popular for use in new steel moment frame structures in seismic zone. To form RBS connection, some portion of the beam flanges at a short distance from column face is purposefully trimmed so that the yielding and plastic hinge occurs within this area of flanges.

Use of RBS connection is found advantageous due to: a) the shear force in the panel zone is reduced; b) the force demand in column continuity plates i.e. stiffeners are reduced; and c) strong-column – weak-beam requirement is satisfied.. The purpose of this study is to understand behaviour of RBS beam-to-column moment connections for various flange cut geometries. This document represents nonlinear finite element analysis of the connection models performed using the computer program, ANSYS/Multiphysics.

Stress concentration is uniform for radius cut RBS.

For the Trapezoidal and straight cut RBS connections stress concentration observed at the re-entrant corner eventually may lead to fracture of the beam flange.

At .005radians beam lateral torsion buckling and column flange twisting was found almost same in all cases.

5] Adithya. M1, Swathi rani K.S2, Shruthi H K3, Dr. Ramesh B.R4(2015)

as per displacement criteria bracings are good to reduce the displacement and the max reduction of 68.43% is observed in Single diagonal braces arranged as diamond shape compared to model without brace. The bending moment and shear force in columns are also reduced in braced models from which it can found that these are less in single diagonal braced model compare to other models. The lateral storey displacements of the building are greatly reduced by the use of single diagonal bracings arranged as diamond shape in 3rd and 4th bay in comparison to concentric (X) bracing and eccentric (V) bracing system.

II. CONCLUTION

- Radius cut will give best performance Other than straight cut or tapered cut.
- For Welded RBS connection, The Panel zone could easily developed a plastic rotation of 0.01rad.Withot distressing the beam flange.
- As the length of the cuts is increased, the reduction in the shear and bending stiffness terms increases at a decreasing rate, and the reduction in axial stiffness increases at practically a constant rate.
- The design selection of the member plasticity location also affects the end moment transfer to the supporting column.
- The increasing e/d decreases the required RBS plastic moment.
- Formation of Plastic hinge will helpful to improve seismic Ductility by minimizing the effects of Stress concentration at the member end.

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