# Comparative Study on Behavior of Anti Collapse Steel Beam Column Connection Under Dynamic Loading To Static Loading: A Review

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***Abstract-*** *The design of structures is the process of creating a structure that can withstand the load it will encounter without failing. The aim of design of structure is to design a any structure that is safe, economical and strong enough to support its intended load. A good design will increase the strength and rigidity of structure. It reduces the cost of Structure. The primary purpose of design is to withstand various loads for the period it is intended to serve its purpose and lifespan.*

*A steel structure is a framework composed of component / member i.e. Beam, Column assembled to support load and provide stability. Structural member is made of concrete or steel. Steel Beam Column connection is crucial in building construction, playing a virtual role in structural integrity ensuring stability, safety and durability. Steel Beam Column connection serves as critical link between Horizontal Beam and Vertical Column. Failure of element or member of structure may lead to failure of entire structure or collapse of entire building. Therefore, the analysis of component, Joint of Structure and design of Structure is more important.*

*Structural engineering emphasizes the importance of maintaining and servicing structures to prevent progressive collapse due to unintentional activity. Techniques include studying connections that prevent collapse, but also analyzing design. A different approach is needed to analyze beam-column connections against progressive collapse under column removal scenarios, which is discussed in this paper.*

***Keywords***- Progressive Collapse, Catenary Action, Static and Dynamic Loading condition, Flexural Action, Non Linear Static, General Behavior, Resistance Mechanism.

## I. INTRODUCTION

In the entire lifespan of building or structure, it is continuously subjected to various loading. Failure of any component of structure results in failure or collapse of entire building. The Beam Column Connections are the important part of any building and the Beam Column Connection is the typically weakest point is steel construction. The failure of component of structure can lead to progressive collapse. Progressive Collapse is s situation in which local failure of structural member lead to failure or damage of adjoining member ultimately leading to the collapse of entire structure.

In order to prevent increased collapse as a result, structure must be designed. Steel Building typically have considerable resistance to gradual collapse. To overcome the progressive collapse un-transferred load is to be distributed evenly to the adjacent load carrying member in proper manner. For the purpose, the Steel Beam Column Connection must be design in such a manner that after the failure of column it will not collapse suddenly and transfer the coming load effectively on adjacent column.

Now a day, to avoid the progressive collapse, ant-progressive structures are designed. There are many types of joints invented which are anti-progressive collapse and perform satisfactory in static loading.

Sometime structure will subjected to dynamic loading. Therefore, research on progressive collapse resistance of Steel Beam Column connection under dynamic loading subjected to column removal scenario is essential.

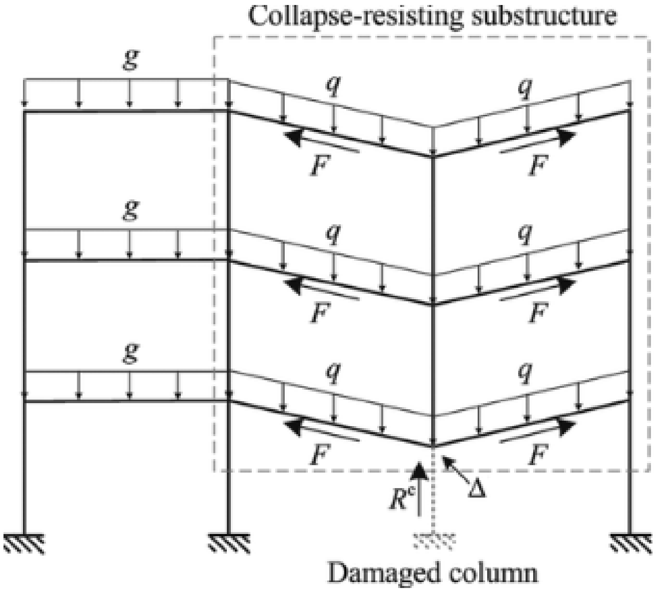

Fig.1: Progressive Collapse Condition

## II. LITERATURE REVIEW

**Xi Qin, Wei Wang, Yiyi Chen, Yihai Bao (2016)**

This paper presents research on two types of beam-to-tubular column connections for progressive collapse prevention. Two specimens, each comprising a central column stub and half of the beam span on both sides, were constructed to represent these two types of connections. One specimen (ST-WB), had a conventional welded flange-bolted web connection, and the other (ST-WBR), which was modified by a special reinforcing technique based on the connection detail of ST-WB, had a reinforced welded flange bolted web connection.

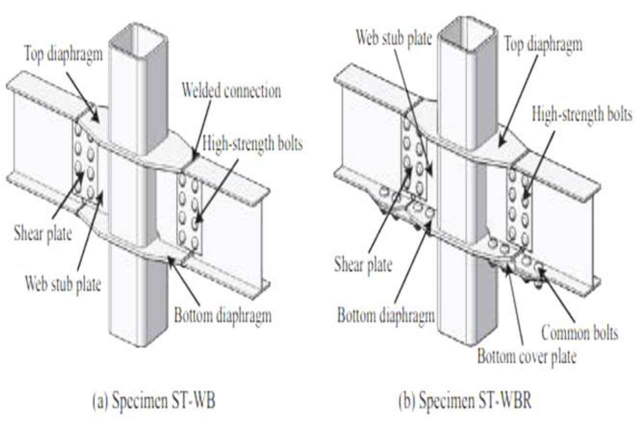

Fig. 2: Specially Reinforced Beam Column Connection

The specimens were subjected to a monotonically increasing vertical displacement of the central column to observe their behaviors under a central-column-removal scenario. Computational simulations of the tests were carried out using detailed finite element models. The analysis gave insights into the behavior and modes of failure, among other things, their ability to withstand the tensile forces that the beams experienced. The reinforced welded flange-bolted web connection can enable the bottom flange to continue to transfer force effectively after the weld failure, which is advantageous for the ongoing development of axial tensile forces in the beams, as shown by the experimental and computational results. This paper demonstrated that the reinforced welded flange-bolted web connection performs better than the conventional welded flange-bolted web connection in terms of strength and deformability, and the unique reinforcing technique can be used to increase structural robustness for preventing progressive collapse.

**Wenda Wang, Huawei Li, Jingxuan Wang (2017)**

In this research, the multi-scale model was used to investigate the progressive collapse performance of steel beam to concrete-filled steel tubular (CFST) column connections. The relationship between resistance capacity and resistance demand of these joints were obtained by analyzing the nonlinear static analysis results and the nonlinear dynamic analysis results. These analysis results showed that the frame structure with these joints which enabled to form the resistance mechanism and new alternate path of unbalanced loads can prevent the occurrence of progressive collapse after the failure of column connected to joints. And the adjacent framework can improve the ability of anti progressive collapse of these joints.

Figure 3 shows the resistance of the beam mechanism phase, which increases tension zones when steel beam sections cross it. Point B represents the point where the beam's cross profile becomes tensed. The C-point on a steel beam is the initial point of fracture and displays the resistance of the catenary mechanism phase. The catenary system may prevent joint collapse, and the frame structure could provide additional support if fully exploited. Failure is the label given to the CD phase because during this phase the steel beams begin to crack and the joints gradually lose their ability to prevent collapse.

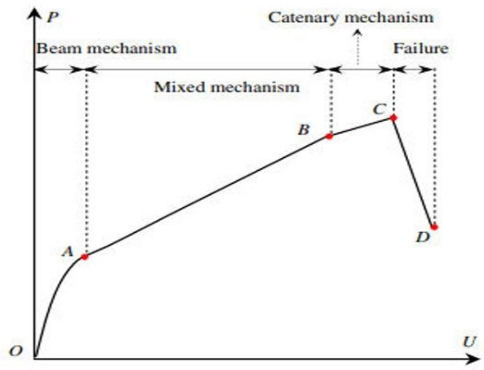


Fig. 3: Anti Progressive Collapse Mechanism

The study utilized a multi-scale model to examine the gradual collapse of steel beam and CFST column connections, employing both nonlinear static and nonlinear dynamic methods, providing various inferences.

**Qinghua Han; Xinxia Li; Mingjie Liu, and Billie F. Spencer Jr., F.ASCE (2019)**

A two-story steel frame was used for a full-scale experimental research on the progressive collapse behavior of beam-column joints using cast steel stiffeners, divided into four vertical pieces, each with a unique joint configuration consisting of (1) joints with CSS and (2) welded joints without stiffeners. On the frame, seven loads of varying magnitudes were applied. A mechanism at the base of one of the columns in each section, known as an adjustable column, may be removed and replaced in order to imitate the column's failure and repair. During column removal, strain displacements and variations were observed. Three other finite-element model types were also created to simulate the test frame. The study found that CSS joints reduced frame strain change and deformation compared to welded joints without stiffeners, as well as the dynamic strain magnification factor of strain change. Concrete slabs significantly impacted load redistribution, leading to the sudden failure of the adjustable column.

**Canwen Chen, Huiyun Qiao, Jinpeng Wang, Yu Chen (2020)**

In this study, Nine laboratory experiments were conducted to evaluate the performance of earthquake-resistant structures with reduced beam section (RBS) connections in the event of a destroyed central column. To evaluate the performance of RBS and various bean web connection techniques, study tested four types of joints i.e. welded unreinforced flange - bolted web connection without RBS (WUF-B-NRBS), welded unreinforced flange - bolted web connection with RBS (WUF-B-RBS), and welded unreinforced flange - welded web connection without RBS (WUF-W-NRBS).

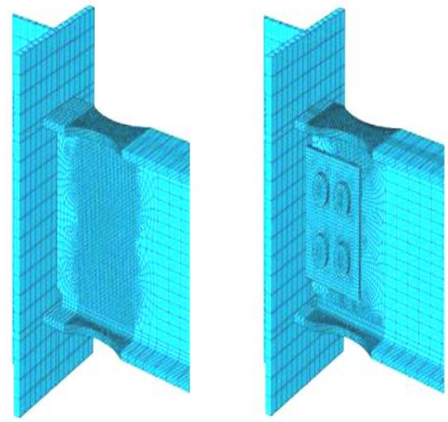

Fig. 4: Welded Flange – Welded Web and Welded Flange-Bolted Web

General Behaviors and resistance mechanism- The shear and axial forces generated by flexural mechanism and catenary mechanism, after removing the middle column, resist the load applied on the middle beam-to-column joints. The internal force can be calculated using the reduced computational model by analyzing the strain in the projected elasticity section.

The study examined steel moment frames' general behavior, resistance mechanism, and mode of failure after removing the center column, focusing on nine specimens with four connection joints, examining the influence of RBS, beam web connection techniques, and weakening parameters.

**Long Zheng, Wen-Da Wang, Wei Xian (2022)**

The resilience of constructions to progressive collapse depends critically on the connection between the column and the beam. The concrete-filled steel tubular (CFST) column-to-composite beam connection with the ring plate demonstrated a high resistance and a clear force transmission path in earlier progressive collapse tests. The ring plate and composite beam, however, were put together on site. Therefore, more research into the link between the CFST column and the composite beam is required. An experimental and numerical analysis of the anti-progressive collapse performance of the constructed connection with CFST column and composite beam was done in this paper. To examine the failure manner, vertical resistance-deformation mechanism, and strain-deformation relationship, three different types of fabricated connections and two different types of shear connectors were compared. Calculations and analyses were done to determine the steel beam's axial force, bending moment, and contribution ratio to vertical resistance. Additionally, the specimens' nonlinear progressive collapse resistance values were compared to DoD and FEMA350 standards. Lastly, a discussion of the dynamic increasing factors (DIFs) by the test, finite element (FE) model, and energy balanced (EB) approach was held.

**Zhan Guo, Zhiquan Xing, Heng Zhang, Hanwu Zhang, Long Chen, Yu Chen (2022)**

This paper presents experimental and numerical studies on the collapse resistance of beam-column substructures with all-welded connections in a middle-column removal scenario induced by fire scenarios. During push-down tests, extensive structural responses and failure phenomena were observed, showing deterioration in collapse resistance of specimens exposed to fire compared to those without fire exposure. The potentials of catenary systems and bending mechanisms to prevent progressive collapse generally degraded over time as the fire temperature increased. In terms of the structural behaviors against progressive collapse, two common strengthening techniques applied to post-fire substructures after fire incidents were thoroughly compared. The post-fire all-welded connections were thought to benefit most from reinforcing with welded ribbed plates from a practical standpoint.

## III. STUDY

Numerous aspects must be taken into account when designing an anti-collapse beam column connection. Research indicates that the beam column connection with the diaphragm works best, but loading is still necessary. However, the link needs to provide sufficient resistance because increasing collapse is a dynamic, nonlinear phenomenon. This resistance might result from flexural action as well as catenary movement. Catenary motion is the most efficient way to transfer load in order to stop progressive collapse. It is not sufficient to just maximize resistance against vertical loads when analyzing the beam-column connection against dynamic loading under progressive collapse.

Hysteresis behavior, energy dissipation, maximum load attained, stress development and anti-progressive collapse mechanism, flexural action, catenary action, vertical reactions developed at support, and dynamic increasing factor must all be considered when examining the relationship through a variety of non-linear static, pseudo-static, and dynamic loading studies.

## IV. CONCLUSION

1. The Authors used various types of Steel Beam Column Connections or models to analysis the Progressive Collapse of connection and to examine the general behavior, resistance mechanism and mode of failure of steel beam column connection considering the sudden column removal scenario.
2. The vertical load carrying capacity increases drastically due to reinforcing technique. It gives various failures before total failure.
3. From the above research, it is concluded that the behavior of Steel Beam Column Connection under Static and Dynamic Loading in progressive collapse can be investigated.

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