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A REVIEW ON PROGRESSIVE COLLAPSE ANALYSIS OF STEEL STRUCTURE

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Abstract: This paper focuses only on the literature review about various concepts of Progressive Collapse Analysis. In this chapter we are going study in depth about progressive collapse analysis. In this chapter we will discuss various types of Progressive Collapse, various analysis methods of Progressive Collapse etc. Progressive collapse of structures is characterized by a disproportion in size between a triggering event and the resulting collapse. Although the disproportion between cause and effect is a defining and common feature, there are various differing mechanisms that produce such an outcome. Review various guidelines & techniques used for to analysis of progressive collapse analysis and to develop a report in the form of literature review. Identify an appropriate technique and suitable guideline from the reviewed literature for progressive collapse analysis of industrial shed. On basis of above characteristics progressive collapse of structure is differentiated which is as follows. Progressive collapse is the result of a localized failure of one or two structural elements that lead to a steady progression of load transfer that exceeds the capacity of other surrounding elements, thus initiating the progression that leads to a total or partial collapse of the structure.

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I INTRODUCTION

Progressive collapse occurs as a consequence of a localized failure of one or two structural components, which results in a continuous progression of load transfer that surpasses the capacity of adjacent parts, starting the progression that results in the structure collapsing completely or partially. When one or more vertical load-bearing elements (usually columns) are removed, the building structure gradually collapses. Once a column is removed due to a car collision, a fire, an earthquake, or any other man-made or natural danger, the structure's weight (gravity load) is transferred to adjacent columns. As a result of the redistribution of forces, the stresses inside surviving structural components such as columns and beams are altered, and if the stresses surpass the element's yield stresses, the element collapses. This failure may propagate from one element to the next, until the whole structure collapses. The term "failure" refers to the gradual collapse of multi-story structures. Steel frames are often utilized as the primary structural supporting system in multi-story structures due to their efficiency. However, detailed behavior of steel frames during progressive collapse has been uncommon to date, and there is a dearth of knowledge about the design of steel frames to withstand progressive collapse, which prompted the present study. Full-scale studies to determine the gradual collapse of steel frames are very expensive and time consuming.

Although progressive collapse is a relatively uncommon occurrence in industrialized nations, its impact on structures is very hazardous and expensive. Without careful consideration of sufficient continuity, ductility, and redundancy, gradual collapse is unavoidable. Until date, just a few studies have been conducted on steel buildings. With advancements in steel materials, technology, and techniques, especially in industrialized nations, research on the progressive collapse resistance of steel framed structures is progressively expanding.

Progressive collapse is a phenomena in which a localized failure of a main structural element results in the breakdown of a section or the whole structural system, with no proportionality between the initial and ultimate damage.

On November 1, 1966, while under construction, the seven-story University Of Aberdeen Zoology Department building in Aberdeen, Scotland, collapsed completely. The collapse was blamed on faulty girder welds caused by metal fatigue. Metal fatigue was produced on the structure by oscillating lateral forces (primarily wind). Five individuals were murdered and three were wounded in the attack. The structure was steel-framed, and it was the first known instance of a steel-framed structure collapsing completely.

The 26-story Skyline Towers Building in Fairfax County, Virginia, fell on March 2, 1973, as a consequence of premature removal of wooden shoring from an upper-story level during construction. There were 14 fatalities and 34 injuries. The skyscraper was constructed of steel-reinforced concrete.

On December 19, 1985, the Wed bush Skyscraper, a 22-story commercial office building located at 1000 Wilshire Boulevard in Los Angeles, suffered a partial collapse. Construction workers were unloading freshly arrived steel girders from a flatbed truck onto the newly constructed 5th floor deck by crane when a girder detached from the crane and plummeted into the existing stockpile below, which was already filled to double the floor's maximum intended load capacity. This precipitated the gradual collapse of the overloaded level, which resulted in the floor section and girders colliding with the 4th, 3rd, 2nd, and 1st floors

before colliding into the parking garage. Three individuals were killed. The structure was steel-framed.

On May 10, 1993, the four-story Kader Toy Factory in Nacho Pathos, Thailand, collapsed after a fire that started on the ground level and quickly spread across the complex. At the time, the plant was operating at full capacity, and all fire exits were closed. There were 188 fatalities and nearly 500 injuries. The structure was steel-framed.

After the terrorist assault on the Alfred P. Murray building in Oklahoma City in 1995 and the collapse of the World Trade Center in 2001, both of which occurred in the United States, study in this area has intensified. This kind of event occurs in a variety of nations, including the United States, Germany, Japan, and Thailand.

To prevent structural failures that result in damage and the death of humans and animals. To avert this gradual breakdown, an analysis must be conducted. Which will be discussed in more depth later in this paper.

II LITERATURE REVIEW

Tawakoni, H.R., Akashi, A. Rashid, and Abdollahzadeh, G.R. They examined the 3-D Nonlinear Static Progressive Collapse Analysis Of Multi-Story Steel Braced Buildings in three dimensions.

They explored different techniques of progressive collapse analysis in this article. Which are referred to as the Direct and Indirect Design Methods. The structural reaction is modelled in this article using macro models. Macro models are very straightforward to construct and run, and as such, they have been effectively utilized in the past by a large number of researchers to study system response to seismic stress. Structural models can account for braces' buckling and post-buckling behavior. The structures have been built to withstand both gravity and lateral loads in line with Iranian law and have passed all seismic criteria pertaining to strength and drift limitations. In this article, buildings are built according to the Iranian building code, and the results of push-over analysis in target displacement are compared to the UFC and GSA nonlinear analysis approval criteria. This study created a two- and three-dimensional model of a widely used kind of lateral load resisting system, namely a specific steel moment frame with X braces. The investigated buildings have five to fifteen stores and four to six bays. When a column and neighboring bracing in the first floor failed to perform their load-carrying function correctly for whatever reason, the structures built to seismic specifications were strong enough to withstand progressive collapse and no plastic rotation exceeded the specified acceptance criteria. Increased storey and bay count results in a greater ability to withstand progressive collapse under lateral stress and a higher degree of robustness index. Due to the fact that extra components were included to ward against gradual collapse. In the same way, the unfavorable consequences of irregularity were going to be minimal. Nonetheless, it seems as if there is no need to be concerned about progressive collapse under seismic loading in a single column and adjacent brace loss scenario for steel special dual systems comprising a special moment resistant frame and an X brace.

Sheriff El-Tail, Rapil Khandelwal, and Fahim Sadek They have conducted a study on Progressive Collapse Analysis Of Seismically Designed Steel Braced Structures. This study established macro-models for two widely used kinds of braced frames, namely SCBF (Secondary Concentrically Braced Frames) and EBF (Eccentrically Braced Frames). We addressed models for different frame components, such as braces, shear links, and shear-tab connections, and provided validation exercises to instill confidence in the suggested models. The generated models were then used in conjunction with APM to compare the progressive collapse resistance of two-dimensional ten-story SCBF and EBF buildings built in accordance with current seismic design standards and practices. While both systems benefitted from seismic systems being located on the exterior of the structures, the simulation findings indicate that the EBF built for high seismic risk is less susceptible to gravity-induced progressive collapse than the SCBF designed for moderate seismic risk. The greater performance of EBF over SCBF is mostly due to a better system architecture, more than ductile detailed activation. Additionally, the simulation findings demonstrate that, despite their ductility, shear-tab connections employed in gravity bays lack the strength necessary to withstand progressive collapse in the absence of a gravity column. This result is obtained without considering the positive impact of slab action, which may be significant, particularly at high deformation levels. Even if the combined resistance of the slab and beams is sufficient to avoid the collapse of a gravity bay, significant deformations and associated structural and nonstructural damage are very certain to occur in the impacted bay. Therefore, it is suggested that perimeter gravity columns be avoided in seismically built braced frame structures if gravity-induced progressive collapse is a danger from an external source.

Fereidoon Irani, Arash Naji they have conducted research on the Simplified Procedure for Progressive Collapse Analysis of Steel Structures. In the United States of America, the Department of Defense (DOD) and General Service Administration (GSA) established design standards to minimize the structure's gradual collapse. GSA and DOD authorize the use of three techniques, namely Linear Static, Nonlinear Dynamic, and Nonlinear Static. It is shown in this article that when a steel moment resistant frame progressive collapses, nonlinear static analysis produces a lower structural response than nonlinear dynamic analysis. However, the linear method makes more cautious decisions about the structures potential. The article proposes a simpler technique for progressive collapse analysis of steel moment resistant frames based on the load-deflection response of a fixed

end beam. This formula is derived by equating the exterior work performed by the imposed load to the interior work performed by the column removed bay's beams. According to the findings of nonlinear dynamic analysis and the instances computed using the suggested approach, it can be concluded that the proposed method is very accurate.

Bijou Mathew, Renshaw C they have conducted research on the Progressive Collapse Analysis of Steel Frame Structures. The paper building selected for the project is an eight-story steel frame structure with six longitudinal bays and three transverse bays. According to research, the likelihood of progressive collapse reduced as the number of stories rose, implying that more structural components actively participated in preventing progressive collapse. They resorted to the Demand Capacity Ratio in order to determine if the building would eventually collapse. Column spacing is uniform in the longitudinal direction. They investigated the impact on the construction of removing the corner and center columns. They discovered that by eliminating the corner column, a large force is applied to the neighboring column, resulting in gradual collapse. This condition has little effect on the other columns, but in certain columns, the axial force is reduced. The axial force is transferred to the two neighboring columns when the center column is removed. Eliminating the corner column is more important than eliminating the center column. According to DCR standards, structures with DCR values higher than two are considered seriously damaged.

Uwe starossek, uwe starossek, uwe starossek, they had studied Progressive Collapse Typology. This article discusses different forms of gradual collapse. Six distinct kinds and four distinct classes are identified, the distinctive characteristics of each group are explained and contrasted, and a proposed nomenclature is proposed. Theoretical treatment of progressive collapse and the creation of countermeasures are facilitated on this basis, since they vary for various kinds of collapse. Progressive collapse may occur as a result of a variety of different processes. Five different kinds of collapse have been identified based on a consideration of these processes. The names pancake-type, zipper-type, domino-type, section-type, and instability-type collapse are proposed for these five types. These groups are very easy to identify based on the characteristics mentioned below. These characteristics, however, may interact in a variety of ways and to different degrees. The resultant collapse types have been grouped together into a sixth category dubbed mixed-type collapse. A further degree of abstraction was reached by combining the pancake- and domino-type categories on the one hand, and the zipper- and section-type categories on the other hand, into a so-called impact class or redistribution class. The article discusses collapse-promoting characteristics and potential countermeasures, as well as their relationship to certain kinds of collapse. Dynamic action, force concentration, brittle material behavior, and, in certain instances, over strength and ductile material behavior are among these characteristics.

Kevin A. Garifuna's and Hail Seen, They have conducted research on Progressive Collapse Analysis of an Existing Structure. This research examines the possibility of a real-world structure collapsing owing to gradual collapse. The purpose of this study is to ascertain whether or not a building is prone to gradual collapse. The recorded strain levels are evaluated and compared to the findings of the building's SAP2000 computer model. The possibility for gradual collapse of the building was evaluated using SAP2000. This study examined the gradual collapse potential of a real-world structure slated for destruction. The field data was examined and compared to data extracted from a SAP2000 computer model. We reviewed the GSA (2003) recommendations and computed demand-capacity-ratio (DCR) figures. The SAP2000 analysis for this experiment was comparable to some of the strain gauge recordings, with an average inaccuracy of 21% from the SAP2000 analysis for Strain Gauge 7. When all four columns were removed, the DCR values indicated that the structure was at significant danger of progressive collapse, while the field strains did not approach failure. It is worth noting that DCR values are derived using linear elastic static analysis, as GSA recommends (2003).

Pollini Kozlova, Polina Kozlova, and Polina Kozlova they have investigated The Progressive Collapse Phenomenon according To Russian Standards. According to this article, removing any load-bearing vertical element increases the spread of slabs and beams and the loads on other components, resulting in the development of a plastic hinge in the center of the span and significant deflection but no damage. It is possible to do this if the beams and slabs are built as membrane structures capable of withstanding a portion of the increased loads. Vertical (with regard for resistance to moment) and tension loads will be supported by the membrane structure. It is concluded in this article that it is a comprehensive study.

OBJECTIVE OF THE WORK:-

The present work aim at following objective

- To review various guidelines & techniques used for to analysis of progressive collapse analysis and to develop a report in the form of literature review.
- To identify an appropriate technique and suitable guideline from the reviewed literature for progressive collapse analysis of industrial shed.
- To analyses the asymmetrical building for identified technique of progressive collapse analysis and to determine different remedial measures for building
- To interpret the results derived from chosen technique and to derive conclusion

SCOPE OF THE WORK:-

- Industrial steel structure is analyses and design by conventional method for dead load, imposed load, and earthquake load in STAAD PRO V8 software.
- The structure is further analyses for removal column considering load combinations as per GSA guidelines.
- Results are compared with first case which is without accidental load to see the collapse path by using same software
- Remedial measures are provided to avoid progressive collapse like Bracing system meanwhile provided Alternative Bracing system,

III. CONCLUSION

This paper focuses only on the literature review about various concepts of Progressive Collapse Analysis. This project will go into the intricacies of progressive collapse analysis. This chapter will cover the different kinds of Progressive Collapse, as well as the various techniques for analyzing Progressive Collapse. Progressive collapse of structures is defined by a size disparity between the triggering event and the collapsed structure. Although the imbalance between cause and effect is a defining and widespread characteristic, it is produced by a variety of distinct processes. On the basis of the above features, the gradual collapse of structure is classified as follows. Macro models are used to simulate structural reaction. Macro models are very straightforward to construct and run, and as such, they have been effectively utilized in the past by a large number of researchers to study system response to seismic stress. Structural models can account for braces' buckling and post-buckling behavior. The structures have been built to withstand both gravity and lateral loads in line with Iranian law and have passed all seismic criteria pertaining to strength and drift limitations. In this article, buildings are built according to the Iranian building code, and the results of push-over analysis in target displacement are compared to the UFC and GSA nonlinear analysis approval criteria.

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