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Literature Review on Progressive Collapse of Structures

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Abstract: *Progressive collapse is the collapse of all or a big part of a structure caused by damage or failure of a relatively small part of it. The wonder is of particular concern since progressive collapse is often (though not always) disproportionate, i.e., the collapse is out of proportion to the event that activates as per expansion in industry, the public are elaborate towards, new ideas to plan the structures with the irregularities in plan as well as in elevation. On other side structural engineer's aim is to provide the structure safe against all the forces. The structural engineer's role becomes challenging when such buildings which are irregular in plan as well as in elevation. All these structures are analyse and design as per Indian standard (IS800:2007, IS1893:2016) with all combination of loading. After that these structure are again analysis for progressive collapse. These types of analysis are considered i.e. linear static and non-linear static with load six case and critical location suggested by GSA guidelines. From this study following observation are made, as height of structure affect the collapse behaviour, as height increases progressive collapse decreases which is seen from D.C.R. values, joint displacement, and bending moment. Linear static analysis results are more conservative than nonlinear static analysis.*

Keywords: *Progressive collapse*

I. INTRODUCTION

Progressive collapse of structures is initiated by the loss of one or more load-carrying members. As a result, the structure will seek alternate load paths to transfer the load to structural elements, which may or may not have been designed to resist the additional loads. Failure of overloaded structural elements will cause further redistribution of loads, a process that may continue until stable equilibrium is reached. Equilibrium may be reached when a substantial part of the structure has already collapsed. The resulting overall damage may be disproportionate to the damage in the local region near the lost member. Loss of primary members and the ensuing progressive collapse are dynamic nonlinear processes.

Progressive collapse implies disproportional global structural system failure originated by local structural damage. Itis a rare event, as it necessitates an initiation of local element removal criteria either due to the inevitable forces of nature or due to manmade hazards. The gravity load of the structure is now transferred to neighboring columns; these columns should resist the additional abnormal gravity loads & redistribute loads to avoid failure of the major part of the structure. Present day structure design practices and lesser integral ductility and continuity, gets more prone to progressive collapse. However, there should be certain provisions needed for additional consideration to ascertain the safety of structure after any local failure.

1.1 Definition

"it is a situation where local failure of a primary structural component leads to the collapse of adjoining members which, in turn, leads to additional collapse. Hence, the total collapse is disproportionate to the original cause. "[GSA 2003]"a chain reaction failure of building members to an extent disproportionate to the original localized damage." [UFC 4-010-01 2003]

"a progressive collapse is a chain reaction of failure of building members to an extent disproportionate to the original localized damage. Such damage may result in upper floors of a building collapsing onto lower floors." [DOD 2002]

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"progressive collapse is defined as the spread of an initial local failure from element to element resulting, eventually, in the collapse of an entire structure or a disproportionate large part of it." [asce 7-05 2005].

Progressive collapse – this term is indirectly defined in the en 1990, where the code treats the basic requirements a structure should satisfy: "a structure shall be designed and executed in such a way that it will not be damaged by events such as explosions, impact or the consequences of human errors, to an extent disproportionate to the original cause." En 1990

"a progressive collapse is characterized by the loss of load-carrying capacity of a relatively small portion of a structure due to an abnormal load which, in turn, triggers a cascade of failure affecting a major portion of the structure." [gross and mcguire]

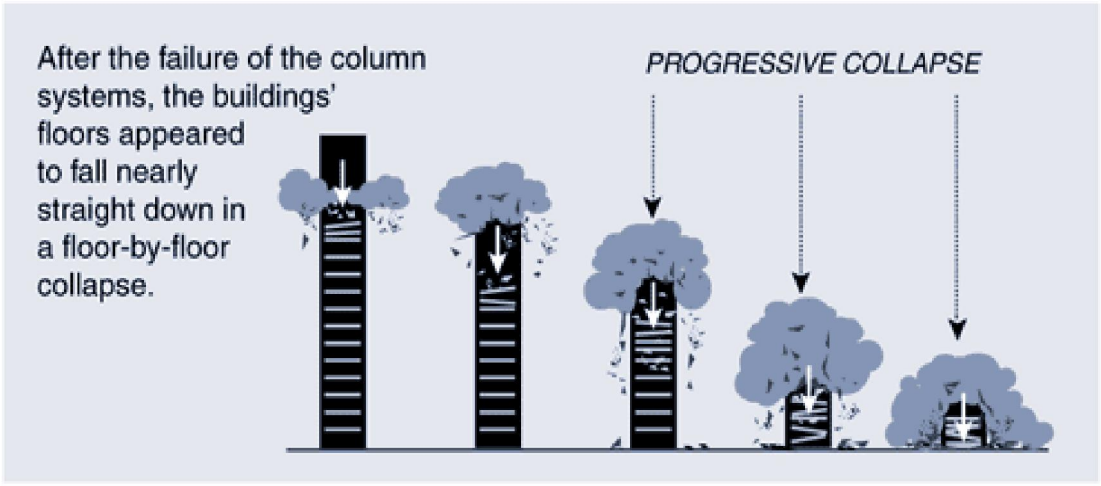

Figure 1: World trade centre tower 1 and 2 on 11th sep 2001

Robustness – the ability of a structure to withstand events like fire, explosions, impact or the consequences of human error, without being damaged to an extent disproportionate to the original cause (en 1991-1-7).

Robustness – the ability of a structure or structural components to resist damage without premature and/or brittle failure due to events like explosions, impacts, fire or consequences of human error, due to its vigorous strength and toughness (GSA guidelines).

1.2 Background of progressive collapse

Progressive collapse is not a new problem for structural engineers, who have always been in some way concerned with the possibility that the loss of load-carrying capacity of a relatively small portion of a structure could lead to a disproportionate level of damage. Following are some example given in table

Table-1 the past cases of progressive collapse

Year	Description
1968	Roman point apartment newham, east London due to gas explosion
1973	26 story skyline towers building in Fairfax county, Virginia because of premature removal of shoring from beneath newly poured floors.
1985	22 story Wedbush building due to over loading on floors so lead to progressive collapse.
1995	The murrah federal office building in Oklahoma city was destroyed by a bomb
2001	World trade Centre tower 1 and 2 collapse due to jetliner crashed with a high speed in a building
2005	28 story Windsor tower in Madrid, Spain suffered the collapse on 11th floor of the building

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2013	8 story rana plaza commercial office complex in saver, Bangladesh due to improper use of building.
2017	Plasco building, Tehran due to fire attack

1.3 Causes of progressive collapse

Progressive collapse may be due to abnormal loading which causes local damage if structure does not have continuity, ductility.

Initial local damage takes place due to gas explosion, terrorist attack, aircraft fires, seismic impact failure of footing.

Accidents and damage to building caused by design, manufacture or installation errors, inadequate quality of materials, and improper use of buildings can also be reasons of collapse.

Miscommunication between worker and engineers document leads to collapse of structure. In which

Some contractors may be pressed for time to where they may improperly address key connections or finishing techniques to adequately install the structure.

Improper inspection or overlooking structural issues also leads to factors that initiate a progressive collapse. In some cases, proper inspection may find a faulty member or connection yet may not properly document it or resolve the issue due to poor miscommunication.

Another root cause of progressive collapse takes place in the design phase of a structure. If structures go for years without receiving proper maintenance, rust or other material failures can occur which weaken the structure and make it more susceptible to a progressive collapse.

1.4 Aim

Modelling and analysis of vertical irregularity of steel structure due to progressive collapse

1.5 Objective

- Study of progressive collapse analysis.
- Discuss guidelines for column removals in structure.
- To study the effect of vertical irregularity of steel structure due to progressive collapse
- To find the critical location of removal of column as per GSA guidelines

1.6 Problem statement

There are very few studies of progressive collapse of irregular steel structure. In this study analytical approach concentrated on simulation structural response of three dimensional vertical irregular steel structure models were considerded. many guides allows linear static procedures designing against progressive collapse.

In this study of different heights of structure such as 5x7, 7x 9,9x11 stories considered. And analyzed for all combination of loading. And maintain demand capacity of structure between 0.5 to 0.9 which is consider as an economical. Then apply GSA-2013 guide lines and then structure analyzed for progressive collpase.and compare before and after result of DCR, displacement of removal location of column and from which finding the critical location of column

II. LITERATURE REVIEW

This chapter presents an overview of literature studied in relevance to the objective of the present study

There are lot of research carried out on many aspects of progressive collapse of steel buildings. To identify the clear objective of present research work & its scope, summary and review of the critical observations of some researches as under are presented.

Progressive collapse is a situation in which a local failure in a structure leads to load redistribution, resulting in an overall damage to an extent disproportionate to the initial triggering event while the disproportionate collapse is associated with local failure of a structural component leading to the total failure of the entire structure or a significant portion of the structure

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Name: "progressive collapse basic," [1]
Author: r. Shankar nair (march 2004)
Publication: modern steel construction
Studied previous case study of major collapse of structure such as Ronan point tower in new ham, murrah federal office building, world trade Centre I and II in which observation on progressive collapse and disproportionate collapse. In which prevention of progressive collapse generally is an important in structural engineering today. But virtually all collapses could be regarded as "progressive in one way or another, and building's susceptibility to progressive collapse should be of particular concern only if the collapse is also disproportionate. The engineering imperative should be not the prevention of progressive collapse but the prevention of disproportionate collapse.

Name: collapse behavior of steel special moment resisting frame connections [2]
Author: kapil khandelwal and sherif ei-tawil (2007)
Publication: journal of performance of constructed facilities
Researcher studied on collapse behavior of steel frame. The aim is to increase the collapse resistance the frame because during collapse there is effect on connection performance of the tensile forces develop in the structure during collapse. The main objective of this paper is that computational structural simulation to investigate number of key design variable that effect on the formation of centenary action in steel moment resisting frame.

Name: mechanism of collapse of tall steel moment-frame buildings under earthquake excitation [3]
Author: swami nathan krishnan and matthew muto (2012)
Publication: journal of structural engineering
Studied the mechanism of collapse of tall steel moment-frame buildings is explored through three-dimensional nonlinear analyses of two18-story steel moment-frame buildings under earthquake excitation. Both fracture-susceptible and perfect-connection conditions are investigated. Classical energy-balance analysis shows that only long-period excitation imparts energy to tall buildings large enough to cause collapse. Under such long-period motion, the shear-beam analogy alludes to the existence of a characteristic mechanism of collapse or a few preferred mechanisms of collapse for these buildings.

Name: progressive collapse of structure[4]
Author: r.m. bennett
Publication: elsevier science publishers, structural safety
In this studied the investigation of progressive collapse done by using different nonlinear models. Finite element method used for nonlinear material of steel frame model and nonlinear geometry considered. These steel structure models have different geometries and damping ratio. This paper shows that how building will collapse subjected to local damage or loss of structural carrying element this study shows as per following points.
By increasing damping ratios in dynamic analysis the maximum lateral deflection decreased for all frames.
The progressive collapse potential decreased as the number of story increased since more structural members participate in resisting progressive collapse.
The nonlinear dynamic analysis method provided a realistic representation of the progressive collapse behaviour.
The increase only in the girder size for the purpose of preventing progressive collapse may result in weak story when the building is subject to seismic load.

Name: assessment the behavior of seismic designed steel moment frames subjected to progressives collapse (2005) [5]
Author: azlan bin adnan, iman faridmehr, babak faramanbordar, reza hodjati and mohammad gharehzadeh shirazi, a.b.a. rahman
Publication: research journal of applied sciences, engineering and technology
The design of buildings is based on the fact that they need to withstand all the loads exerted on the structure, failure occurs as a result of inadequate design and modelling techniques, particularly for abnormal and extreme loading

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conditions. Once one or more load bearing member is eliminated from the structure, progressive collapse, mainly in columns, will commence. By the time a column is eliminated from the structure as a result of a sudden motor vehicle strike or earthquake or fire or any other internal or external factor that could take one column out of the system, the weight of the building (gravity load) will be distributed among other columns within the structure. Failure commences in the part of the structure that has lost a column unless other columns are designed appropriately against gravity loads and are capable of redistribution of additional loads imposed on them. Failure of vertical load bearing elements will continue until the stabilization of extra loading. Hence, this could lead to serious damage and collapse of the building which will lead to higher damage to the building than the primary damage. This research is based on the regulations conforming to the specifications of UFC guidelines and the structures have been modelled using sap2000 (2012). In order to study the effects of the progressive collapse on the seismic design of special steel moment frames, smrf, two 5-story and 15-storystructures are modelled in sap2000 (2012). In order to have a better understanding of progressive collapse and obtain reliable results, linear static (ls), nonlinear static (nls) and nonlinear dynamic analyses (nld) procedure for single and 2 adjacent columns removal have been implemented in this study. Having a good perception of the possibility of progressive collapse involves incorporation of demand capacity ratio, plastic hinges formation and vertical displacements of removed column's location plus axial force in columns adjacent to the removed column. Other factors such as number of stories and the amount of local damage resulted from the removal of 2 adjacent columns could also lead to a better understanding of the structural behavior.

According to this research, discrepancies occurred in the assessment of progressive collapse potential for many cases according to the acceptance criteria mentioned in the guidelines including DCR for the ls and ductility ratio and connection hinge rotation for the nd and nl; it was observed that more conservative results was obtained using ls method compared to that of nd method. Also, it was observed that the progressive collapse potential was higher compared to other occasions when a corner column is removed. This potential will be the highest once two adjacent columns are removed suddenly. The variation of progressive collapse analysis results is a function of variables such as applied load, location of removed column and number of stories in the structure. Removal of column in upper floors (compared to the first floor) will lead to the spread of collapse to other parts of the structure. Also, removal of 2 adjacent columns of the mid height, considering vertical displacements and plastic hinges, will lead to the most critical case resulting in progressive collapse. Providing the progressive collapse resistance involves increasing the size of the structural members which will eventually increase its weight. Demonstrates the required weight for the structure once column 2 in the first story of the 5 and 15-story structures is removed using linear static (ls) and nonlinear dynamic (nd) analysis.

Name: progressive collapse of structures: annotated bibliography and comparison of codes and standards[7]
Author: osama a. Mohamed
Publication: journal of performance of constructed facilities

The moto of this literature paper on progressive collapse of building from structural engineering prospective. The literature includes research on important issue related to progressive collapse as follows.

Limitation and difference between analysis of methods, difference between linear and non-linear static model, static versus dynamic analysis method.

Load combination for structural analysis.

Design philosophy.

Name: collapse resistance of locally damaged steel columns[6]
Author: n.m. youssef b, s. El-tawil, (2013)
Publication:

Studied the strength and stability of steel columns that have suffered localized damage are investigated through analytical and computational means. An analytical model based on the rayleigh–ritz technique is employed in conjunction with detailed finite element models that were validated using available experimental results. A parametric study is performed using the finite element models to assess the effect of location of damage, extent of damage, role of initial imperfection, as well as asymmetric damage on the stability of a steel column. Design guidelines utilizing

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commercial software typically found in a design office are presented to a practical technique for approximating the results obtained using the analytical and computational models. Analytical and simulation results show that localized flange loss in a steel column could lead to a severe reduction in its axial resistance.

Name: progressive collapse of multi-storey building due to sudden column loss[8]
Author: b.a. izzuddin, a.g. vlassis, a.y. elghazouli, d.a. nethercutt
Publication: simplified assessment framework
This author proposes a novel simplified framework for progressive collapse assessment of multi-storey buildings, considering sudden column loss as a design scenario. The proposed framework offers a practical means for assessing structural robustness at various levels of structural idealization, and importantly it takes the debate on the factors influencing robustness away from the generalities towards the quantifiable. A major feature of the new approach is its ability to accommodate simplified as well as detailed models of the nonlinear structural response, with the additional benefit of allowing incremental assessment over successive levels of structural idealization. Three main stages are utilized in the proposed assessment framework, including the determination of the nonlinear static response, dynamic assessment using a novel simplified approach, and ductility assessment. The conceptual clarity of the proposed framework sheds considerable light on the adequacy of commonly advocated measures and indicators of structural robustness, culminating in the proposal of a single rational measure of robustness that is applicable to building structures subject to sudden column loss. The companion paper details the application of the new approach to progressive collapse assessment of real steel-framed composite multi-storey buildings, making in the process important conclusions on the inherent robustness of such structures and the adequacy of current design provisions.

Name: experimental study on the progressive collapse resistance of a two-story steel moment frame (2012) [9]
Author: junling chen1, xin huang, renle ma, and minjuan he
Publication: journal of performance constructed facilities
In this study, the progressive collapse resistance of a two-story steel moment frame was investigated after the sudden removal of perimeter column in the first floor through an experimental study. Two finite-element models with and without concrete slabs were developed and compared with the experimental results. The results indicate that the numerical model with slabs agrees well with that of the experiment and the concrete slabs play a significant role during the process of load redistribution. After the removal of the column, the partial loads previously carried by the removed column were transferred to its adjacent columns by the slabs. In addition, the concrete slabs and steel beams formed composite beams through shear connectors to resist the loads after the removal of the column. As a result, the stresses in the beams and the vertical displacements above the removed column were reduced significantly.

Name: effect of the building height on progressive collapse[12]
Author: majid mohammad, bahram kordbagh
Publication: international institute of earthquake engineering and seismology
In this paper effects of building height on progressive collapse analyzed. For this researcher make a model of different height (4,8,12) stories and these model are designed for most severe zone area and also progressive collapse considered. For this alternate load path method is considered.

Name: progressive collapse of steel frames (2013) [7]
Author: kamel sayed kandil, chabad el fattah ell body, hanady eldehemy
Publication:
These researchers studied the behaviour of steel frames under progressive collapse using the finite element method. Non-linear finite element models have been developed and verified against existing data reported in the literature as well as against tests conducted by the authors. The nonlinear material properties of steel and nonlinear geometry were considered in the finite element models. The validated models were used to perform extensive parametric studies investigating different parameters affecting the behaviour of steel frames under progressive collapse. The investigated parameters are comprised of different geometries, different number of stories and different dynamic conditions.

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Name: progressive collapse performance of irregular buildings (2009) [26]
Author: jinkoo kim and sumin hong,
Publication: journal of structural engineering
In this study, the progressive collapse-resisting capacities of tilted or twisted buildings were evaluated by nonlinear static and dynamic analyses. For analysis models, 30-storey tilted buildings with braced cores and 30-storey twisted buildings with reinforced concrete cores were designed, and their performances were compared with those of the regular buildings. According to the analysis results, the progressive collapse potential of the tilted structures varied significantly, depending on the location of the removed column. It was also observed in the tilted structures that the plastic hinges formed not only in the base from which a column was removed, but also in the nearby bays. Similar results were observed in the analysis of the twisted structures. The progressive collapse potentials of the tilted structure were high when a column was removed from the tilted side. However, the twisted structures considered in this study had progressive collapse potentials not very large compared with those of the corresponding regular structures, mainly because more structural elements were involved in resisting progressive collapse when a structural member was eliminated.

Name: analytical assessment of steel frames progressive collapse vulnerability to corner column loss[14]
Author: s. Gerasimidis (2013)
Publication: journal of constructional research
Author stuided the approaches to the progressive collapse analysis of steel frames have focused so far on computational methods which try to capture the solution of the system responding to localized damage. For the case of progressive collapse, damage is included in the model through the removal of a key element of the structure. The computational difficulty of these approaches, however, makes it very hard for practicing engineers to perform these analyses. For that reason, it is very important for the engineering community to develop simple and reliable analytical tools which could provide useful information on the response of a structure to a column loss. This paper applies a threat-independent analytical method regarding the corner column loss case, which has been presented by the author in previous papers to a wide range of symmetric and non-symmetric steel moment-resisting(sway) frames. The analytical and simple method can indicate the collapse mechanism of a steel frame for the case of a corner column loss through the development of critical ductility curves. The impact of the number of floors, the column removal location.

Name: vertical geometric irregularity assessment of steel frames on robustness and disproportionate collapse[27]
Author: gerasimidis, c.d. bisbos, c.c. baniotopoulos (2012)
Publication: journal of constructional steel research
Disproportionate collapse of building structures can be defined as the partial or total failure of a building as a consequence of an initial local damaging event which develops throughout the structural system of the building. Various building structural systems depending on their level of available ductility and redundancy can perform better or worse to disproportionate collapse events; their resistance to the phenomenon is a function of many parameters including their regularity or not. This paper presents an extensive parametric study on the response of irregular steel frames in case of initial damage, expressed by the total removal of their columns, one in turn. The study regards a set of 15 steel frames designed according to the euro codes and the greek codes. Morphologically, the frames include vertical geometric irregularity leading to useful conclusions regarding the influence of such a property in their resistance to disproportionate collapse. At the end of the paper, the results of the analyses are presented for their limit analysis, their elastic limit and their respective robustness measures. Special attention is given to the influence of vertical geometric irregularity through comparative result

Name: nonlinear static behavior of irregular structure on progressive collapse different failures of columns[25]
Author: bondla mahendra reddy, p. Rajesh
Publication: international journal of engineering research and general science
The researcher studied the comparison between the irregular steel structure frame with and without having cases of progressive collapse using nonlinear static analysis. Pushover analysis using various invariant lateral load patterns and

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modal pushover analysis were performed on steel moment resisting frames. The results revealed that the steel space frameworks with progressive collapse cases showed a large decrement in the maximum base share and maximum displacement capacity compared to their irregular steel space frameworks without progressive collapse cases. The results of the pushover analysis also confirmed that the irregular steel frames work with progressive collapse cases have significantly improved stability in seismic zones over their counterparts without progressive collapse cases.

Name: **progressive collapse of a steel braced frame building**[23]
Author: gokul g, joshua daniel
Publication: international journal of technical innovation in modern engineering & science
These researcher studies in this paper that the progressive collapse is a catastrophic structural failure mechanism, triggering by an abnormal event such as explosion, vehicular collision and constructional errors that makes local damage of a key member in the structure. For evaluating the potential of progressive collapse, the alternate path method in accordance with both GSA and UFC guidelines is used. In this study, the braced steel moment frames of two bracing systems like double diagonal and inverted v type with four bays and six bays of 20 storey height was investigated to know vulnerability of the structures subjected to progressive collapse. The simulation results obtained from the modal analysis are time period, cumulative modal mass participation ratio and from linear static analysis the member forces were obtained these results from the analysis were compared with the intact structure. The result shows that if the number of redundancy increases then the redistribution of forces from the failed member make the structure to collapse progressively.

Name: **seismic evaluation of multi-storey moment-resisting steel frames with stiffness irregularities using standard and advanced pushover methods**[15]
Author: g. Tarța and a. Pintea
Publication: science direct
The nonlinear static procedure, based on pushover analysis, has become an important tool to characterize the seismic demand and the performance of structures. The standard pushover procedure is restricted to single-mode response, a valid supposition for symmetrical or low-rise buildings, where the response is dominated by the fundamental vibration mode. The standard pushover procedures become misleading when the response of the structure is influenced by higher vibration
Modes. This is the case of tall or non-symmetrical buildings. Several pushover procedures, able to take into account the effects of higher vibration modes, have been lately developed to overcome this drawback. This paper presents a comparison between standard, advanced pushover analyses and the exact results obtained by nonlinear time history analysis. The analyses have been conducted on a series of moment-resisting steel frames with stiffness irregularities, with different number of stories, designed according to ec8 and the romanian seismic design code for romania's vrancea seismic area.

Name: performance based analysis of vertically irregular structure under various seismic zones[24]
Author: mohammed azemuddin, venkata ratnam, mohammed abdul hafeez.
Publication: international journal of research and innovation in civil and construction engineering
In this paper researcher studied that earthquake is natural disaster which causes natural calamities such as loss of properties as well as loss of human beings so more attention has given for earthquake analysis of steel structure. This is the reason there has been a lot of focus on the structures to be earthquake resistant. Buildings get damaged because of many reasons but mostly due to the earthquake ground motions. The study aims to predict the response of a structure in different zones according to the is 1893:2002 (part 1) for a g+15 storied building with and without steel cross bracing. The structure is irregular in geometry vertically. And analysis done by using finite element software sap2000. It has been observed that the structure can resist more loads with the inclusion of steel bracings, base shear capacity of the building is observed to be doubled and the roof displacement of the building has reduced co miserably. The base shear capacity of the building increases with increase in zone factor i.e. from zone ii to zone v. The story drift changes suddenly at the level of setback due to the large concentration of forces at that level.

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Name: review of different structural irregularities in buildings[26]
Author: s. Varadharajan, v.k. sehgal and b. Saini
Publication: journal of structural engineering *journal of structural engineering. Vol. 39, no. 5, december 2012 - january 2013 pp. 393-418. No. 39-51.*
The researcher studied the different irregularity system, also they describe various types of irregularity the criteria and limits are defined for irregularity by different types of codes. They observe that plan and vertical irregularity are comparable the review of previous research works regarding different types of plan irregularities justify end the preference of multi-storey building models over single storey building models and concept of balanced
Cv (centre of strength) – cr (centre of rigidity) location was found to be useful in controlling the seismic response parameters. Regarding the vertical irregularities, it was found that strength irregularity had the maximum impact and mass irregularity had the minimum impact on seismic response. Regarding the analysis method mpa (modal pushover analysis) method even after much improvement was found to be less accurate as compared to dynamic analysis.

Name: linear and nonlinear analysis of progressive collapse for seismic designed steel moment frames. [22]
Author. A. Hadianfard & m. Wassegh
Researcher studied the intermediate steel moment frames structures with different levels of height designed for different seismic zones of iran are studied. For evaluating the potential of progressive collapse, researcher uses the alternate path method in accordance with both GSA and UFC guidelines is used in two different methods; linear static analysis and nonlinear static analysis. The results show that, if the steel structures designed for higher seismicity there is higher capacity for progressive collapse and in the low height steel structures, there is no enough redundancy to dispersing loads of the failed elements so, the potential of progressive collapse increases with decreasing the height of the structure.

Name: progressive collapse analysis of steel structures under fire conditions[21]
Author : ruirui sun , zhaohui huang , ian w burgess
Publication: science direct
In this paper a robust static-dynamic procedure has been developed. The development extends the capability of the vulcan software to model the dynamic and static behavior of steel buildings during both local and global progressive collapse of the structures under fire conditions. The explicit integration method was adopted in the dynamic procedure. This model can be utilized to allow a structural analysis to continue beyond the temporary instabilities which would cause singularities in the full static analyses. The automatic switch between static and dynamic analysis makes the vulcan a powerful tool to investigate the mechanism of the progressive collapse of the structures generated by the local failure of components. The procedure was validated against several practical cases. Some preliminary studies of the collapse mechanism of steel frame due to columns' failure under fire conditions are also presented. It is concluded that for un-braced frame the lower loading ratio and bigger beam section can give higher failure temperature in which the global structural collapse happens. However, the localized collapse of the frame with the higher loading ratio and smaller beam section can more easily be generated. The bracing system is helpful to prevent the frame from progressive collapse. The higher lateral stiffness of the frame can generate the smaller vertical deformation of the failed column at the re-stable position. However, the global failure temperature of the frame is not sensitive to the lateral stiffness of the frame

III. CONCLUSION

Many researcher and guidelines used only linear procedures for designing against progressive collapse. In this study, the importance is in capturing accurate structural response of three-dimensional structures using linear, nonlinear static evaluates.
This study discuss about effect of vertical irregularity in special moment resisting steel frame structures. For that we consider three models having 5x7,7x9,9x11 vertical irregularity. Following observation are made.
Very few studies of progressive collapse on high rise multi-storey steel structures have been reported. Many analytical approaches involve two-dimensional analyses. In these study three-dimensional structures was considered.

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