IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

PROGRESSIVE COLLAPSE OF G+7 STEEL STRUCTURE SUBJECTED TO FIRE LOADS

1MR. PRAJWAL SHIVAJI BERAD, 2Dr. U.R. KAWADE

1STUDENT, 2HOD,CIVIL DEPARTMENT OF DR. VITHALRAO VIKHE PATIL COLLEGE OF ENGINEERING

1DR. VITHALRAO VIKHE PATIL COLLEGE OF ENGINEERING,SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE ,

2DR. VITHALRAO VIKHE PATIL COLLEGE OF ENGINEERING,SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

ABSTRACT

Possible risks and abnormal loads that causes progressive collapse are as follows aircraft collision, design or construction error, firing, gas explosion etc. Such Conditions are not consider in designing structure like Residential,commertial Buildings, since possibility of occurring these kinds of risks is very low. Progressive Collapse in a building occurs when any major structural load carrying member (like columns) leads to collapse of adjoining members, which in-turn leads to the additional collapse. In this paper, the G+ 7 moment resisting steel frame building is analyzed for progressive collapse considering two methods namely linear static method by using ETABS 2018 software. In this attempt, the columns at different levels are subjected to varying temperatures ranging from 250℃-750℃ with the interval of 250℃ with the material properties and yield strength as per IS 800-2007. Different load combinations are considered as per IS-875 part I & II. According to General Service Administration (GSA) -2016 guidelines the fire load is applied additionally at different storey to the selected columns in the Building. The structure is cheacked and analyses and the DCR values obtained are checked as per GSA- 2016 permissible limits.

Keywords : Fire load,Progressive collapse,Demand Capacity Ratio,Steel Structure.

1. INTRODUCTION

In General, Progressive collapse of steel building is due to failure of main supportive member like column and it tends to failure of adjacent member. Steel is a most popular material of construction and now a day's total steel building are also popular like residential building or commercial offices. Steel is efficient than concrete as per availability of material and less time consuming during speed of construction. Steel has high thermal conductivity and loss of strength and stiffness as rise of temperature. So, this study an attempt to understand to change in behavior of steel structure lead to progressive collapse of structure When the fire occurs in a room/compartment, extent of damage to structural elements mainly depends on two factors: Amount of Explosive/Flamable load available in a room and temperature rise in a room. Hence, in the study maximum temperature rise in a compartment/room/building due to fire load is determined and reduction in member capacity of beams, columns due to expected fire exposure is estimated.

2. LITERATURE REVIEW

[1] Anand Baldota R and Bhavana B, *et al*, (2018)have carried continuous collapse leads to structural failure and this occurs due to the demolition of key components that are constructed due to loads from the fire, impact loading on explosive loading etc. exploratory test of continuous collapse of steel frames by performing two new tests to maximize available data importance the performance of structural of multi-level of frame of steel under continuous collapse

[2] C.R.Chidambaram, Jainam Shah, *et al*, (2016)have been regard,the current studyinvestigates the continuous collapse of the moment against the residential building of the steel house (G + 4) which is subject to loading of levels at various levels using ETABS sotware5. Demand Capacity Ratio (DCR) values of neighbouring items were calculated, where columns at various levels failed due to ire risks. Based on the DCR price limit provided in the GSA 7 guidelines, structural strength in continuous falls is predicted

3. OBJECTIVE

1) Analysis of G + 7 steel building on ETAB 2018 by applying of fire load.
2) Analysis of effect of Thermal forces in member of building.
3) Compare changes in (Demand capacity Ratio) DCR value to before and after applying of fire load on frame structure.
4) Check sustainability of structural member after applying of Thermal load.

4. METHODOLOGY

Modelling of building –

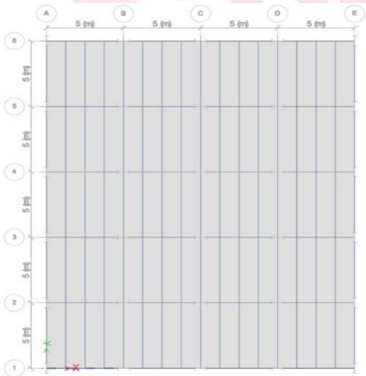


Fig. 4.1 Plan at Ground level

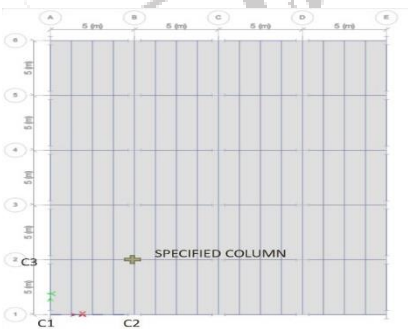


Fig. 4.2 Location,C1,2,3 Column.

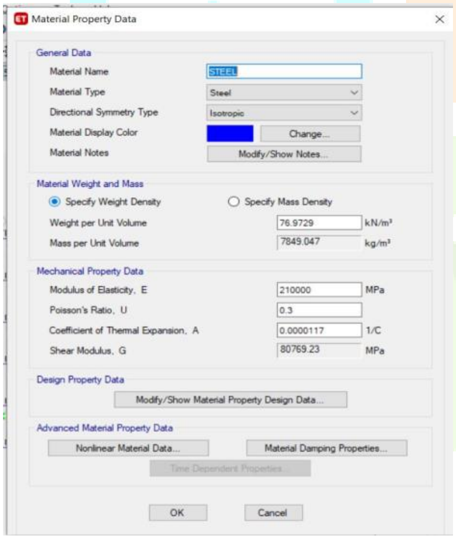
Building Parameters –

Table No. 4.1 Building Parameters

Parameters	Values
No. of Storey	G+7
Length of Building	25 m
Breadth of Building	20 m
Height of Building	24 m
Height of Each Storey	3.00 m
Height of Foundation Below GL	3.00 m
No. of Bays Along X-Direction	5 m
No. of Bays Along Z-Direction	5 m
Size of Primary Beams	ISLB 600
Size of Secondary Beams	ISWB 550
Size of Columns	550 x 550 mm
Slab Thickness	150 mm
Material’s	M20 & Fe500

4.2.1 Material Properties

1. Steel Properties



Above fig shows the Unit Weight, Modulus of Elasticity, Poisson’s Ratio, Coefficient of Thermal Expansion, Shear Modulus of steel .

Fig4.2.1 Properties of Steel

2. Concrete Properties

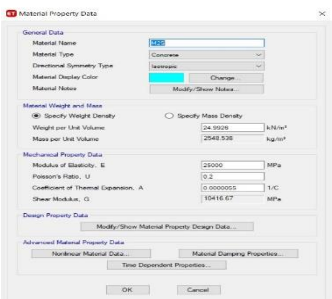


Fig4.2.2, Shows The Properties of Concrete Which is used in modelling of a deck slab

Fig.4.2.2 Concrete Properties

3. Column Properties

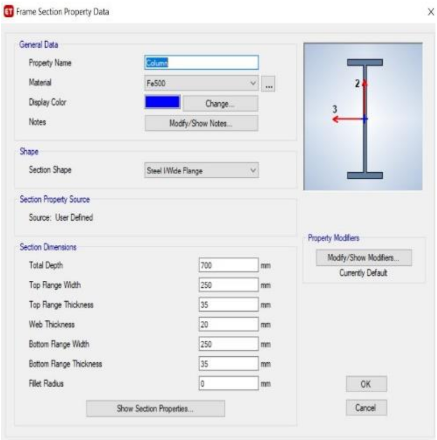


Fig.4.2.3 Material Properties added for Steel Column/Beam

4. Primary Beams.

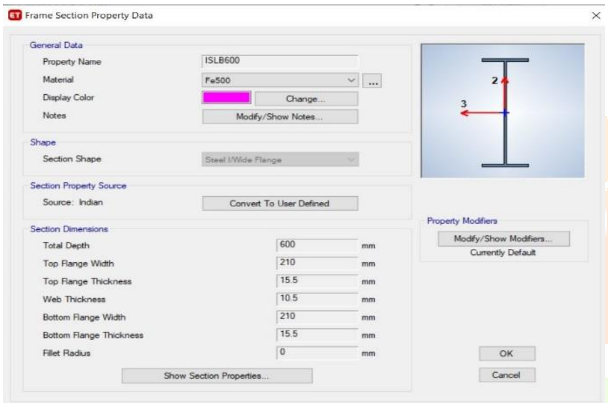


Fig.4.2.4 Material Properties added for Primary Beam ISLB 600.

5. Secondary Beam

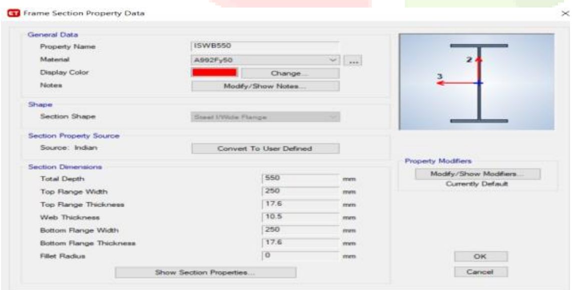


Fig.4.2.5 Material Properties added for Secondary Beam ISWB 550.

4.3 ANALYSIS PART

A. Software Analysis

Analysis of the structure model on ETAB 2018 by under load of dead load, live love, Wind and fire load.

Main task to analysed the steel structure is to analysis under the fire load. Application of fireload is in rising manner for250^{0C}to 1000^{0c}. Apply all load combinations and check the Demand Capacity Ratio (DCR) value of column. As per DCR value can be check column is safe or not..If a member's DCR exceeded the conditions of admission, the member was considered a failure. After the failure of selected one column we see the effect of fire load on adjacent 4 column. The measurement of the demand volume calculated from the static vertical process helps determine the strength of the continuous collapse of the structure.

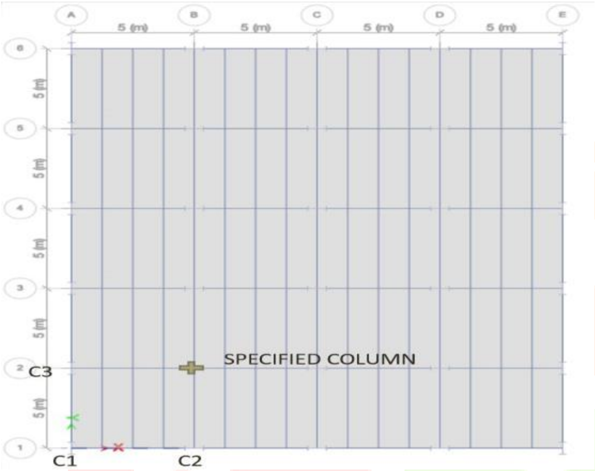


Fig.4.3.1 Location Of Selected,C1,2,3 Column.

B. Part of loading analysis.

Gravity masses were calculated as per IS 875 I and additionally use of 875I, III, load after design mixtures and service load mixtures got as per IS 875

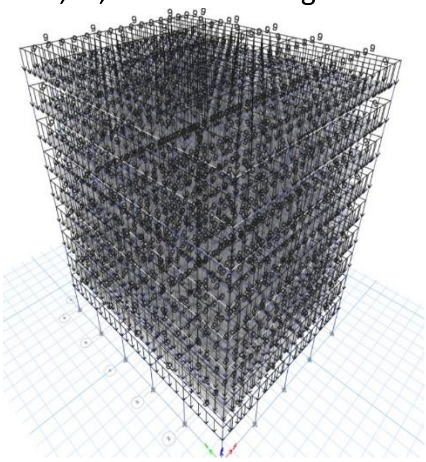


Fig.4.3.2 Assigning wall loads in ETABS.

Above fig shows wall loads as per wall dimensions and height of floor in ETABS software and G+7 story structure. And assigned with parapet load and parking loads as per mentioned in methodology

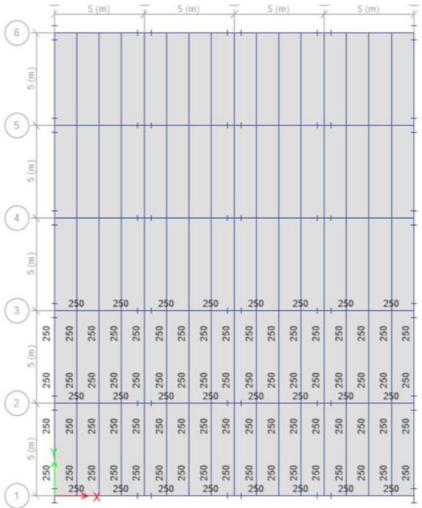


Fig.4.3.3 Assigning Temperature loads250^{0}con Specified Column in ETABS.

Above Fig. Shows the Assigning of 250^{0}c Temperature Load on Steel Frame in the ETAB 2018 Software

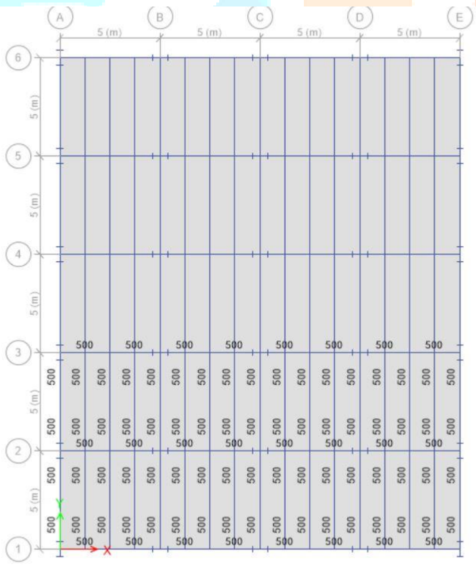


Fig.4.3.4 Assigning Temperature loads 500^{0}c on Specified Column in ETABS.

Above Fig. Shows the Assigning of 500^{0}c Temperature Load on Steel Frame in the ETAB 2018 Software

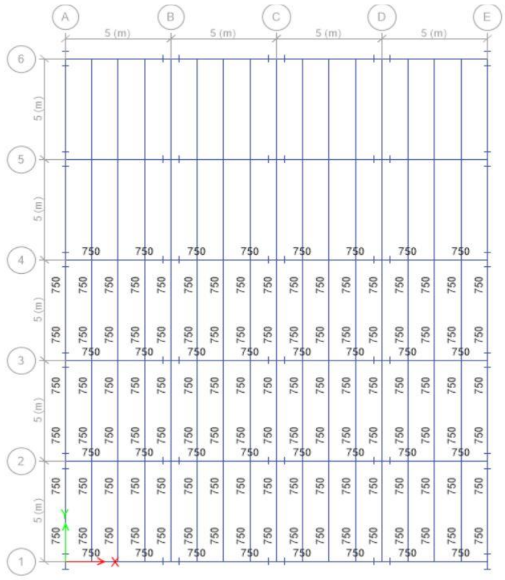


Fig.4.3.5 Assigning Temperature loads 750^{0}c on Specified Column in ETABS.

Above Fig. Shows the Assigning of 750^{0}c Temperature Load on Steel Frame in the ETAB 2018 Software

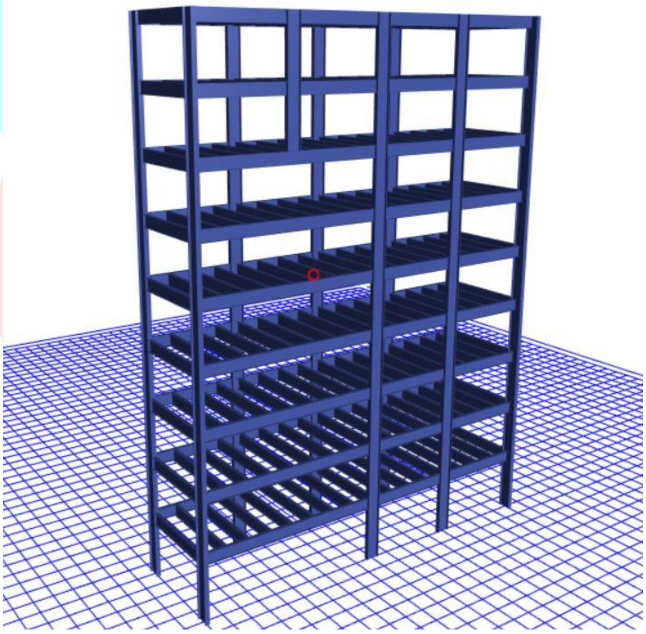


Fig.4.3.6 3d Model of Deleting Failure Column

Above Fig. Shows the Assigning of 750^{0}c Temperature Load on structure with removing the Failure column From Ground To Fifth Floor.

4.4 Calculation For Calculating DCR Value For Specified Column:-

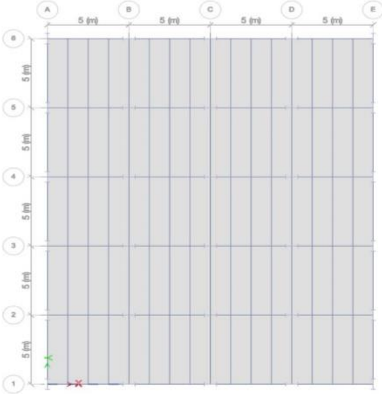


Fig.4.4.1 plan for working

Calculation of various design parameters

1. Zone factor :- for Ahmednagar zone III ……. As per IS 1893:2002 (Clause -6.4.2)

   Z = 0.16
2. Importance factor

   Building is Commertial building

   I = 1.2
3. Response reduction factor

   Building s special RC moment resisting frame

   R=5

Calculation of Demand Capacity Ratio :-

1) DCR value for specified Column At Ground Floor Having A Fire Load 250^{0}c

Demand Capacity Ratio(DCR) = Axial Ratio + Flexural Ratio Major

=1.386 + 0.011

=1.447

2) DCR value for specified Column At Ground Floor Having A Fire Load 500^{0}c

Demand Capacity Ratio (DCR) = Axial Ratio + Flexural Ratio Major

=1.247 + 0.735

=1.982

3) DCR value for specified Column At Ground Floor Having A Fire Load 500^{0}c

Demand Capacity Ratio (DCR) = Axial Ratio + Flexural Ratio Major

=3.252 + 0.20

=1.982

5. RESULTS

5.1 Result

1) Demand Capacity Ratio (DCR) of Column

Sr no.	Location	Before Fire	250^{oc}	500^{oc}	750^{oc}
1	Ground Floor	0.356	1.447	1.982	3.452
2	1^{st} Floor	0.324	1.364	1.783	3.336
3	2^{nd} Floor	0.253	1.262	1.605	3.166
4	3^{rd} Floor	0.215	1.149	1.445	2.956
5	4^{th} Floor	0.177	1.024	1.300	2.705
6	5^{th} Floor	0.137	0.941	1.170	2.552
7	6^{th} Floor	0.121	0.841	1.465	3.348
8	7^{th} Floor	0.109	0.729	1.83	4.288

2) Demand Capacity Ratio (DCR) of Column C 1,2,3 at 0^{oc}

Sr no.	Location	C1	C2	C3
1	Ground Floor	0.452	0.68	0.670
2	1^{st} Floor	0.443	0.540	0.582
3	2^{nd} Floor	0.410	0.496	0.510
4	3^{rd} Floor	0.352	0.464	0.489
5	4^{th} Floor	0.303	0.388	0.440
6	5^{th} Floor	0.253	0.355	0.396
7	6^{th} Floor	0.316	0.426	0.475
8	7^{th} Floor	0.379	0.511	0.570

3) Demand Capacity Ratio (DCR) of Column C 1,2,3 at 750^{oc} After Removing a Failure Column

Sr no.	Location	C1	C2	C3
1	Ground Floor	0.823	1.224	1.139
2	1st Floor	0.708	1.101	1.025
3	2nd Floor	0.637	0.991	0.922
4	3rd Floor	0.574	0.803	0.830
5	4th Floor	0.516	0.727	0.747
6	5th Floor	0.465	0.650	0.672
7	6th Floor	0.581	0.778	0.834
8	7th Floor	0.726	0.975	1.015

4) DCR values of Specified Column

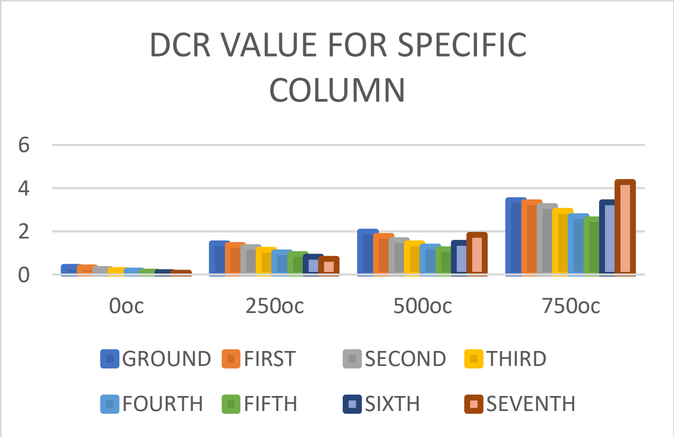
DCR values

Sr no.	Location	Before Fire	750^{oc}
1	1st Floor	0.324	3.336
3	3st Floor	0.215	2.956
5	5st Floor	0.137	2.552
8	7thFloor	0.972	3.125

5) DCR values of Column Before/After Removing of failure Column

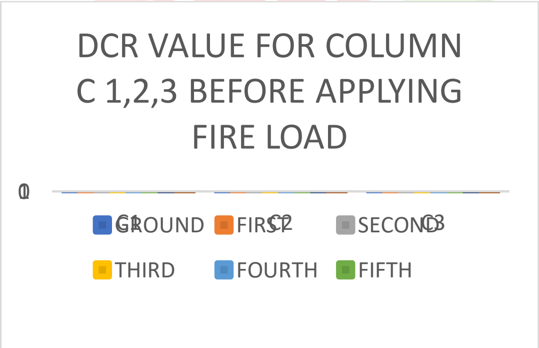
(At 1st Floor Level)

Sr no.	Location	Before	After
1	C1	0.443	0.708
3	C2	0.540	1.101
5	C3	0.582	1.025



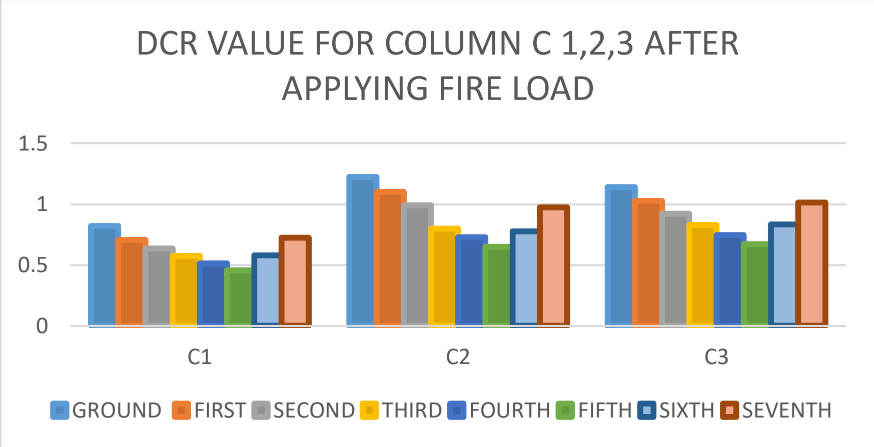
Graph.1 DCR Value for Specific Column at different fire load

The Above Graph Shows the DCR Value of a Selected Column is increased From fifth to Seventh Floor and decreases from ground to fourth floor.



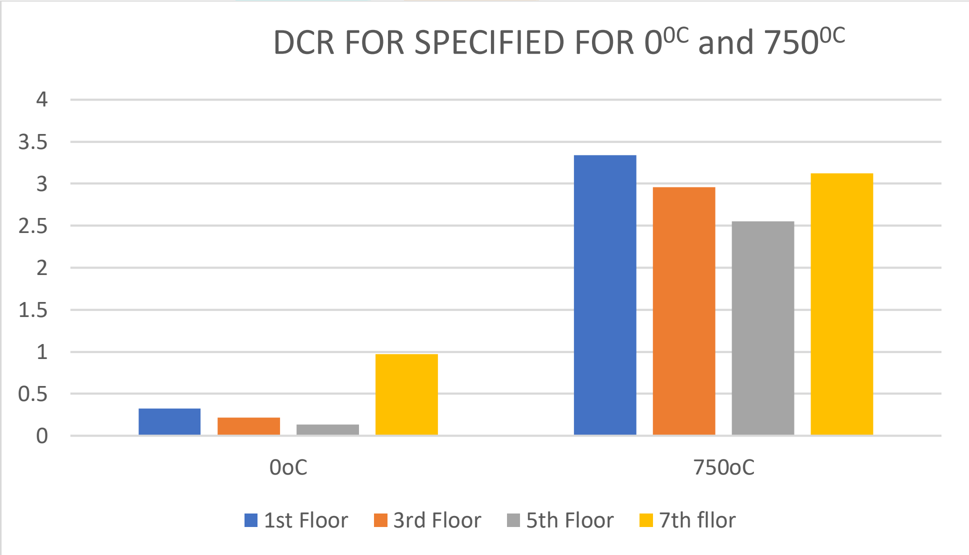
Graph.2 DCR value for Column 1, 2, 3 before applying fire load (i.e. 0^{oc})

The Above Graph Shows the DCR Value of a Column C1, 2, 3, is increased from fifth to Seventh Floor and decreases from ground to fourth floor.



Graph.3 DCR VALUE FOR COLUMN C 1,2,3 AFTER APPLYING FIRE LOAD**.**

The Above Graph Shows the DCR Value of a Column C1, 2, 3, is increased from fifth to Seventh Floor and decreases from ground to fourth floor



Graph.4 DCR FOR SPECIFIED FOR 0^{0C} and 750^{0C}

The Above Graph Shows the DCR Value of a Selected Column is at Different Floor at 0^{0C} and 750^{0C} .The graph Shows the Failure of Column At 750^{0C}

6. CONCLUSION

1) The values obtain from manual method & STAAD.Pro software is almost same.
2) Difference between manual method & STAAD.Pro software is 7.59 KN.
3) Due to various combinations of load present on the structure, material starts degrading at elevated temperature. As temperature is increased, the respective demand capacity ratio values (DCR) of the column also gets increased.

4) As per the graph 1 value of Demand Capacity Ratio is increases from top to ground floor for to 250^{oc}.
5) From 500^{oc} to 750^{oc} DCR value decreases from 7^{th} to 5^{th} floor and again increases up to ground floor.
6) At 750^{oc} temperature DCR value showing increasing from 6th floor to 7^{th}floor.
7) As per result for columns subjected to temperature from 250°C to 500°C, the obtained DCR values are well with-in limits for most of the columns i.e. less than 2.
8) As Per Result the DCR value is Exceed the limit for 750^{oc}From Ground Floor to & 7^{th} Floor. That means The Selected Column is Fail at 750^{oc}. hence the structure may undergo progressive collapse. This can be resolved by the sections or adding extra bracings and also by providing by larger steel sections.
9) Result Shows That After The Failure Of Selected Column, The DCR Value of C1,C2, C3 are increased with in the limit.
10) The progressive collapse of steel structure under fire conditions vary with the loadings. when small loads levels applied on the structure, the occurs horizontal movement of the steel frame before the collapse of the frame where the collapse is generally confined to the storey above the heated floor. The mode for high loadings of progressive collapse, in the form of downward collapse of the whole structure, may occur as early as about 400°C Since the DCR value of each column at initial stage of fire loads are with in the limit 2 as per GSA 2016 guidelines, the building is safe against the progressive collapse due to fire load

7. REFERENCE.

1) [1]Arioz, O. (2007), "Effects of High Temperature on Concrete Buildings", Fire Safety Journal, 42, 516-522.
2) [2] ASCE (2010), "Minimum Design Loads for Buildings and Other Structures", American Society of Civil Engineers, Reston, VA.
3) [3] Buchanan, A. H. and Abu, A. K. (2017), "Design of Fire Safety Design (Second Edition)", John Wiley & Sons Ltd., pages 35-83.
4) [4] CEN (2002a), "Eurocode 0: Structural Foundation", EN 1990, European Committee for Standardization, Brussels, Belgium.
5) [5]Hadole, C. (2017), “Fire tests affect reinforced concrete structure”, M. Tech. Demolition, VNIT Nagpur, India.
6) [6] Hager, I. (2013), "Behavior of Cement Concrete at High Temperature", Bulletin of the Polish Academy of Civil Engineering Technical Sciences.
7) [7] IS IS 875 (Part 1) (1987), “Code of practice for design loads (without earthquakes) of buildings and structures (second revision)”, BIS, New Delhi, India.
8) [8] IS 875 (Part 2) (1987), "Operational code of cargo construction (excluding earthquakes) of buildings and structures (second revision)", BIS, New Delhi, India.

9) [9] Kamel Sayed Kandil1, EhabAbd El Fattah Ellobody, HanadyEldehemy, A Survey of Advances in Steel Frames, World Journal of Engineering and Technology, 1, (2013), 33-38.

10) [10] Segura, CC, Hamra, L., D'Antimo, M., Demonceau, JF, Feldmann, M. (2017). Determination of Loading Conditions in Buildings Due to Column Damage. Buildings.