DESIGNING A HIGH RAISED RESIDENTIAL STRUCTURE WITH STIPULATED FIRE RESISTANCE

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ABSTRACT

Effects of Fire on Structure. In India, there have been many fire incidences that could have been avoided if properly planned for fire safety. There are no proper guidelines for fire safety in India for GROUP-A category structures which also include hostels and hotels. To avoid Fire incidents, it is required to follow fire safety and need to incorporate it right from the design of structures.

In the present study, a G+15 structure is being designed with suitable requirements to resist fire loading which is being given in terms of live load and dead load with suitable factors and by providing fire stress. A Reinforced Concrete structure is being considered as a test model and is being tested with general loading and with fire stress using AUTODESK ROBOT STRUCTURAL ANALYSIS PROFESSIONAL 2021. Then results are being compared IS – 875 part 1 for live load, IS – 875 part 2 for dead load, IS – 875 part 5 for load combinations, IS – 3809 for fire curves, and euro code 2: part 1-2 for parameters.

I.INTRODUCTION

The main purpose of this thesis statement is **to provide a clear, specific argument that will serve as a guide to the** Design of Fire-Retardant High-Rise RCC Structure.

As there is a lot of Work done for Fire safety of high-rise buildings –As High rise should have Smoke Detectors, Sprinklers, First Aid Fire Fighting system, PA system, Adequate water supply, Fire pumps, Fire escape routes, Fireman Lift, Service shaft enclosures, compact mentation, approved electrical system, refuse area (reference - National Building Code**)**

There are a few below listed fire incidents in India and abroad **motivated to work on this particular topic** "**Designing a High Raised Residential structure with stipulated Fire resistance.**

Main Purpose of Design of Fire-Retardant High-Rise RCC Structure, with the increasing number of fire accidents in the country, developers must give ample heed to the construction designs and abide by the various mandatory fire safety norms documented in the National Building Code (NBC). There are Statutory rules and regulations laid down in the NBC to prevent fire casualties in high-rise buildings in India.

With a steep rise in the construction activity in India, especially the high-rise structures, the incidences of fire outbreaks have also increased considerably. The major fire mishap in a multi-story hotel in Karol Bagh, early this year, followed by the massive fire accidents in Mumbai, Kolkata, Chennai, and Surat are some cases in point which throw light on the fire safety concerns in high-rise buildings across the country.

Reference fire incidents in India and abroad: **-**

- Jun 07, 2015 incident at Mumbai--At-least-seven-people-died-and-several-people-were-injured-after-a-fire-broke-out-at-a-21-storey-building-in-Powai-in-Mumbai
- The two deadliest high-rise fires in U.S. history were caused by terrorism. The fires and building collapse after the planes flew into the twin towers of New York City's World Trade Centre on September 11, 2001, killed 2,666 people, not including the 157 passengers and crew on the two planes. On April 19, 1995, a truck bomb outside a nine-story federal building in Oklahoma City killed 169 people.
- In 2009-2013, U.S. fire departments responded to an estimated average of 14,500 reported structure fires in high-rise buildings per year.
- Five property types account for three quarters (73%) of high-rise fires: apartments or other – multi-family housing; hotels; dormitories or dormitory type properties; facilities that care for the sick; and office buildings.
- High-rise fires are more likely to have fire detection, sprinklers, and to be built of fire-resistive construction and are less likely to spread beyond the room or floor of origin than fires in shorter buildings.
- Most high-rise building fires begin on floors no higher than the 6th story.

According to a report on Accidental Deaths and Suicides in India, in 2015, fire incidents in commercial buildings surged by 300 percent between 2014 (179 cases) and 2015 (716 cases). Government buildings also witnessed a rise of 218 percent during the same period; however, residential buildings were found to be more prone to fire outbreaks. Around 7,500 cases of fire outbreaks in the residential buildings were reported in 2015, indicating a 100 percent increase from 2014 (3,736 cases). Factually, 42 percent of the total deaths recorded in the year were due to an accidental fire that occurred in the residential buildings due to a violation of building norms laid down by the National Building Code 2016 (NBC).

This violation due to cost is making life safety in danger in residential high-rise structures and needs to be implemented seriously. Apart from fire norms implementations, High rise Structures need to with Stand Fire incidents. Here is the thesis work to Take care of the effects of Fire on Structure. That is considering this right from the structural design.

Conceptualization of design of Fire-Retardant High-Rise RCC Structure.

To design a high raised structure (hostels) and calculate fire resistance of the structure and try to improve the fire resistance of a structure by controlling factors affecting for a better outcome and safe future of the resident living in a structure or using it.

A G+15 structure is being designed with suitable requirements to resist fire loading which is being given in terms of live load and dead load with suitable factors.

India has seen many fire incidences in past years which could have been avoided if adequate planning and rescue works could have been done in time. Property damage could have been minimal if the structure could resist fire for a long duration. In India, we lack proper guidance to provide fire safety measures in the case of a residential structure.

As we lack any fire safety measures which are to be taken during and after construction for a residential structure, all we have are guidelines that are to be followed to improve the fire resistivity of a structure by installing proper HVAC (heat, ventilation, and air conditioning) system. Which could help to stop the spread of fire if any is caused.

II.LITERATURE REVIEW

1. **Fire Resistance of Reinforced Concrete Frames Subjected to Service Load: Part 1. Experimental Study -** Mohammad Mahdi Raouffard and Minehiro Nishiyama, Journal of Advanced Concrete Technology Vol. 13, 554-563, December 2015

In these two RC frames, RCF1 and RCF2 with statically indeterminate at a scale of 1\3 are under service load were exposed to the ISO- 834 (fire curves). the target frame was a two-story frame in which the lower column and middle beam were under fire attack. RCF1 was heated for 175 min until failure (shear and flexural cracks) and RCF2 was hatred for 60 min until the temperature of the tensile reinforcement of its beam reached 550`c. The beam ends and joints relatively attained lower internal temp and unheated upper columns. The axial and moment restraints significantly increased the load-bearing capacity of the fire-attacked beams without the occurrence of any failure at the side column and joints.

2. **Increase of fire resistance of reinforced concrete structure with polypropylene microfiber –** Marina Gravit and Elena Golub, MATEC web of conference 245, 03005 (2018) EECE – 2018. Peter the great St. Peter burg university, polytechicheskaya 29, St. Peter burg 195251 Russian federation.

The increase in the construction of high-rise, technically. Complex buildings and structures are a prerequisite for the widespread use of structures of heavy concrete. A special type of concrete was considered in the fire action – explosive spalling, 4 slabs of 1100X1100X50mm were tested. 2 samples A1and A2 were of heavy concrete and M1 and M2 where with the addition of polypropylene microfiber during the test all slabs were loaded with UDL of 400kg and it was found that A1 at 90 min gave I59 means crack was visible at 59 min from the start of the test. A2 at 90 min I 58, M1 at 120 min I75, and M2 at 90 min I76.

III.METHODOLAGY.

A G+15 structure is being designed with the data mentioned above, the grade of concrete is taken as M30.IS 456 is being used for designing the structure, IS 875 part 5 for load combinations, IS 3809 for fire curves and tables. IS – 875 part 1 for live load, IS – 875 part 2 for the dead load.

The steps are as follows; After running the software, we need to set the input dimensions (meter's/feet's). Then design codes are set as per project. Now the grid is assigned so that columns can be placed with ease at the right positions. For placing the column, they need to be designed (length, breadth, and grades are defined). After columns are placed now beams are designed (length, breadth, and grades) and placed. After beams, slabs are designed (one way/ two way, thickness, and grades). After slabs, walls are constructed with appropriate materials and thickness. Now loads are defined as live load, dead load, and temperature stress (live load and dead load). One's loads are defined values and factors are entered manually or factors can be directly taken from code. Now loads are imposed at required locations. Loading combinations can be inputted or the software can generate its load combinations with help of assigned code. Then analysis type is defined. After analysis types, calculations are run for any errors and warnings. One's calculations are done they can be obtained in terms of required parameters. Which can be interpreted in the required format.

TABLE – 1 SPECIFICATIONS OF BUILDING

Specifications of building	
Type of building	Residential
Number of bays in x-direction	5
Number of bays in y-direction	5
Length of each bay	6 M
Height of each storey	3.5 M
Beam cross section	75X30 CM
Column cross section	60X60 CM
Thickness of slab	20 CM
Thickness of wall	10 CM
Grade of concrete	M30
Grade of steel	E 410
Thickness of parapet wall	6 CM

IV.RESULTS

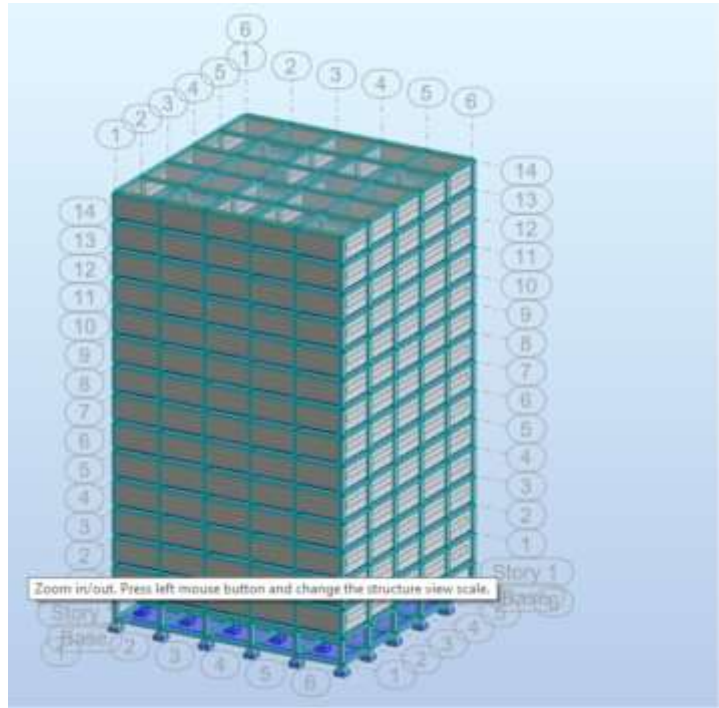

FIG – 1 BUILDING WITH SLABS AND WALLS.

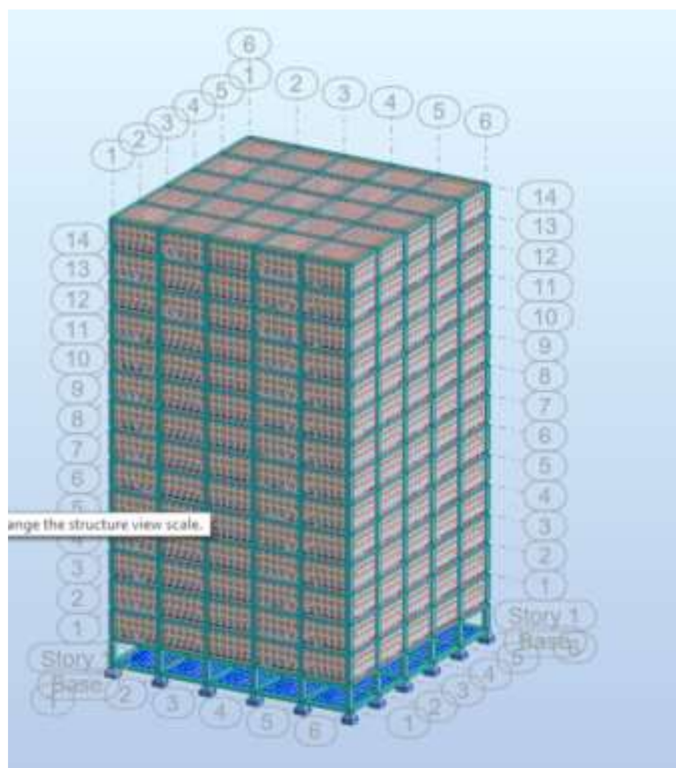

FIG – 2 BUILDING MESHED.

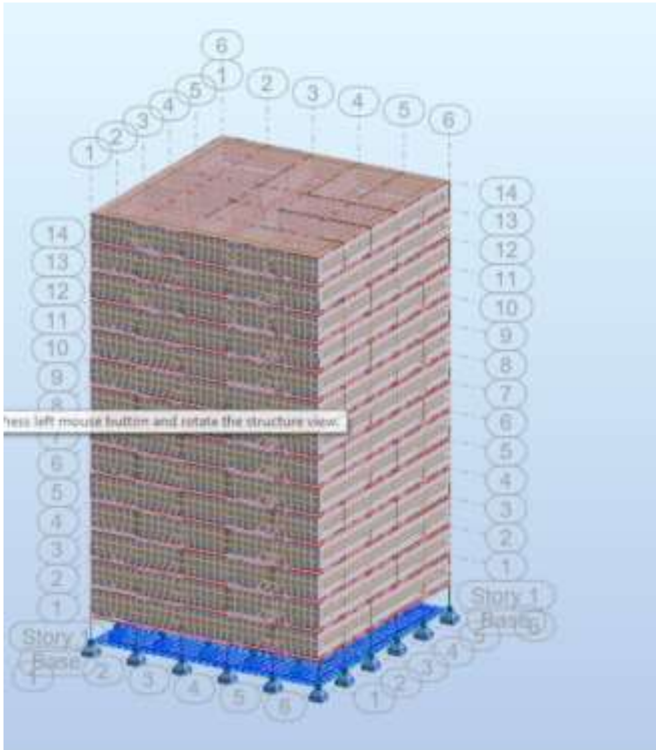

FIG – 3 BUILDINGS MESHED AND LOADED**.**

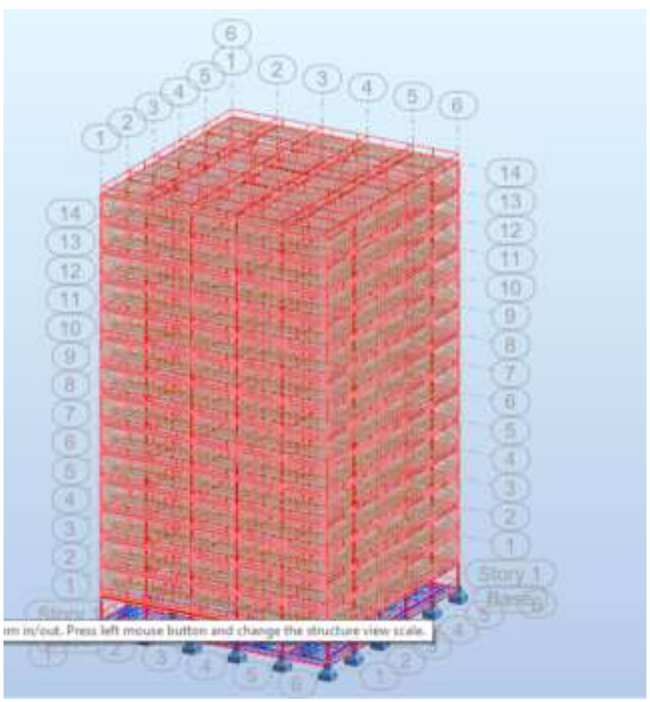

FIG – 4 COMPLETELY MESHED AND LOADED BUILDING**.**

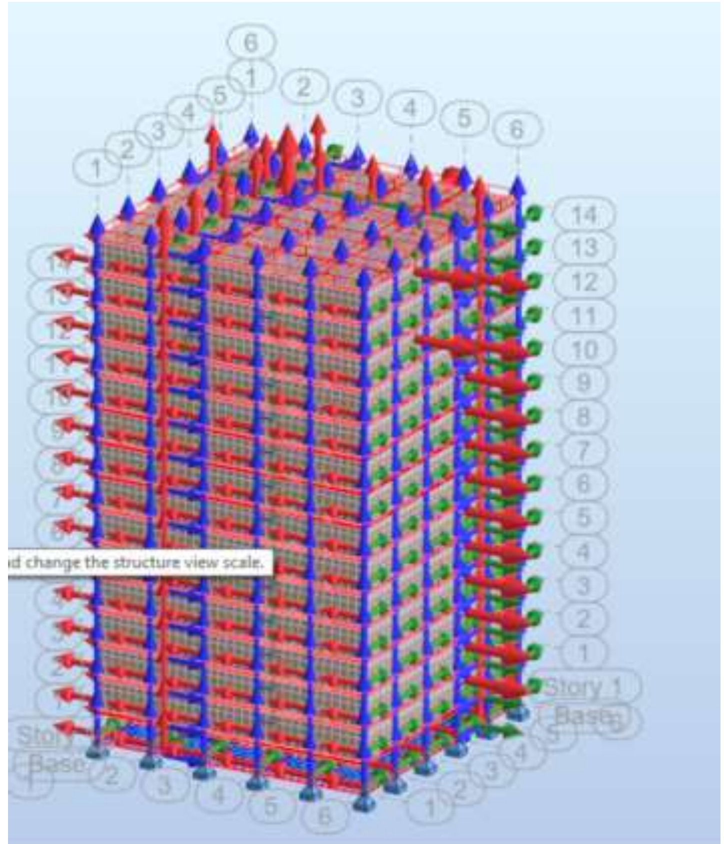

FIG – 5 COMPLETELY MESHED, LOADED BUILDING WITH LOCAL SYSTEM.

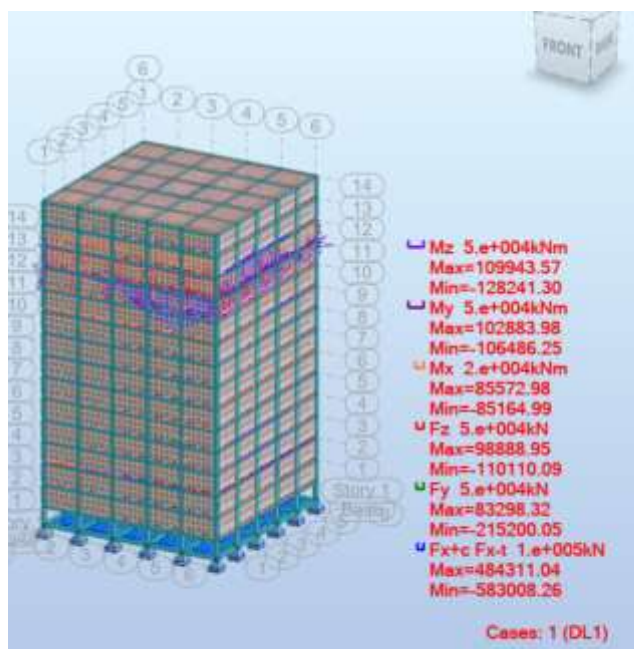

FIG – 6 DEAD LOAD STRESS AND MOMENTS.

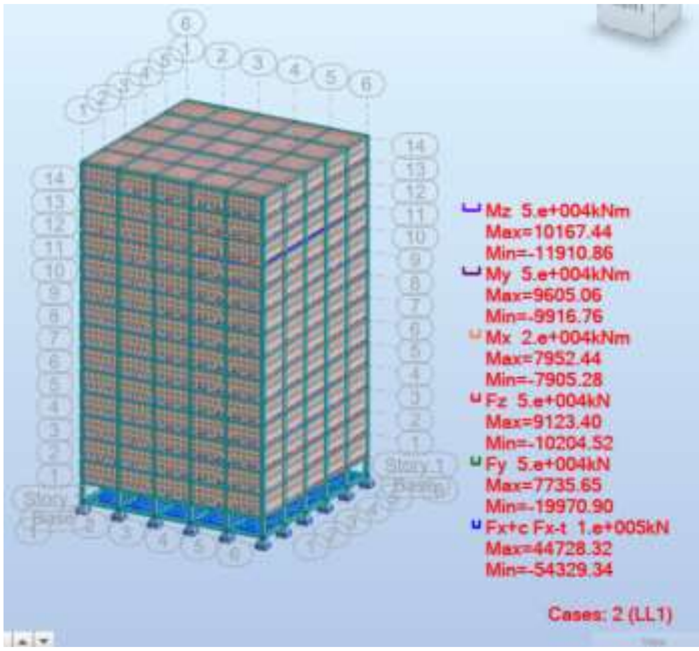

FIG – 7 LIVE LOAD STRESS AND MOMENTS.

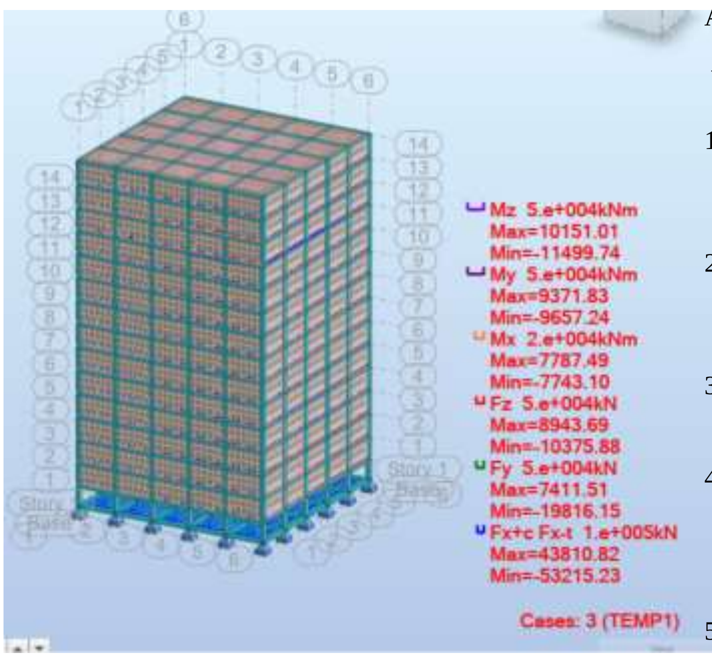

FIG – 8 FIRE LOADING STRESS AND MOMENTS.

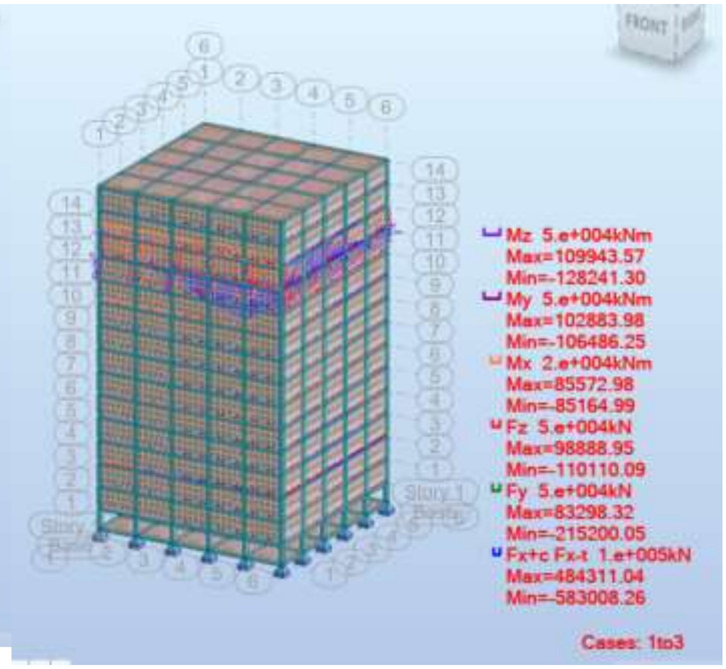

FIG – 9 COMBINATION OF ALL LOADS STRESS AND MOMENT.

V.CONCULATIONS

1. In this project we have designed a building that can resist fire for 4 hr. at full exposure and moderate environmental condition and have achieved desired results.
2. The maximum and minimum values of loading are considered at the critical section and designing and detailing of columns, beams, slabs, and nominal design of footing are calculated.
3. At the critical section we design the beam, column, and slab and the design of any floor is the same as the loading of this building is identical.
4. At the critical section the beam and column are designed for stress maximum 988888.95 kN and minimum -110110.09 kN and bending moment maximum 109943.57 kNM and -128241.30 kNM.
5. As it is new software there is much scope and many possibilities, as it is a complete software that can design, analyze and provide output.
6. It is also possible to design pre-cast, composite, and steel structures.
7. We can also specify the codes, materials, and parameters of its application.

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