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A Research Paper on Design and Analysis of a Multistorey Building (G+4) Using Staad.Pro with Different Grade of Concrete

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Abstract: ***The study incorporates structural designing and analysis of a multi-storey (residential) building is having five storeys with ground floor complete car parking and different residential spaces on other floors, including lift having access to all floors (including terrace) by using STAAD.Pro V8i. This study also includes a comparison of different grade of concretes, Comparison to be done on similar type of structure and applying similar type of loadings. Design of the structure will be done using the STAAD.Pro V8i software for both grade of concrete. Analysis part will also be done using the software which in result provide us the graphs for deflection, stress and strain curve, stress areas, etc. in each section individually and wholly. By doing the comparison we can understand the structural behaviour of the similar type of structures under similar type of loading for different types of grades of concrete. Also the analysis will provide us the details as which grade of concrete will be better for structural designing and will also be economical for the project dealings.***

Keywords: Structural Design and Analysis, STAAD.Pro, Grade of Concrete, Layout Plan, Dead Load, Live Load, Stress-Strain Curve, Deflection, Fix Support

I. INTRODUCTION

Structural engineering is the science and art of designing and making, with economy and elegance, buildings, bridges, frameworks and other similar structures so that they can safely resist the forces to which they may be subjected.

Accordingly, the study includes the structural design and analysis of a multi-storey building using STAAD.Pro V8i software, using different grade of concrete to determine which structure is economic with equal strength. Layout plan for the structure to be designed and analysis is finalised.

The layout includes 6 units of flats to be constructed on a single floor (as 1-3bhk, 3-2bhk and 2-1bhk), having extra spaces for lift, stair case and lobby for every flats.

A. Grades of Concrete

We use cement, sand, aggregate, and water which are mixed with a certain ratio, and concrete is cast and put in a cube of 150 mm size and put in a water bath for 28 days and afterwards, it is tested in a compression testing machine. The compressive stress result is known as the "grade of concrete". It is expressed in N/mm².

The "M" refers to Mix and Number after M (M10, M20) Indicates the compressive strength of concrete after 28 days of curing and testing. M indicates the proportion of materials like Cement: Sand: Aggregate (1:2:4) or Cement: Fine Aggregate: Coarse Aggregate.

If we mention M10 concrete, it means that the concrete has 10 N/mm2, characteristic compressive strength at 28 days. In the designation of concrete mix M to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm^2.

B. Objectives

1) Design A Multi-storey (G+4) Building Using Staad.Pro
2) Analysis Of The Structure Designed
3) Comparing Similar Type of Structure under Similar Type of Loading Conditions Using Different Type of Concrete.

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II. LITERATURE REVIEW

[K. Prabin Kumar, R. Sanjaynath, (2018)] this study is related to the design of a multi-storey building using staad.pro software. In this report the building is designed using limit state method and carried out using staad.pro software. The whole procedure is done according to software wise listings and the parameters are defined and designed according to is codes and norms. The building is planned as per is 456 2000. The checks performed are according to the procedure defined by the Indian standards. In the project with the help of software different figures are taken into account from the software graphs and designs. Complete details are shown here related to stress and strain chats, etc.

[Harshita M N, Vinod Kumar Das, Rajiv Kumar Chaudhary, Sourabh Singh, Shivam Shivhare, (2017)] This study is related to design and analysis of commercial building was done in ETABs 2016. This project includes reinforced concrete frame structure (g+4) with parking facilities and the structure members are designed using limit state method as per is 456 2000. The building is planned as per is 456 2000. The checks performed are according to the procedure defined by the Indian standards. Complete details are shown here related to stress and strain chats, etc.

[Rashmi Agashe, Marshal Baghele, Vaishnavi Deshmukh, Sharad Khomane, Gaurav Patle, Kushal Yadav, (April 2020)] From the work carried out in staad.pro we can conclude that: Comparison between manual calculation and stadd.pro software analysis and design, conclude that the analysis is same but design is some different. Using STAAD.Pro, analysis and design of multi-storey building has completed much quickly and easier than the manual calculation. Building plan was develop and draft in auto- cad with required dimension. During designing g+ 4 storeys residential building structure is capable to sustain all loads acting on building. The design of slab, beam, column, rectangular footing and staircase is done with is 456-2000 as limit state method.

III. METHODOLOGY

We are going to design similar type of a G+4 multi-storey structure having similar type of loading conditions with exactly similar conditions and parameters for both the types of grade of concrete. The common conditions, loading conditions and values and structural details are given below:

A. Structure Designed for the Analysis

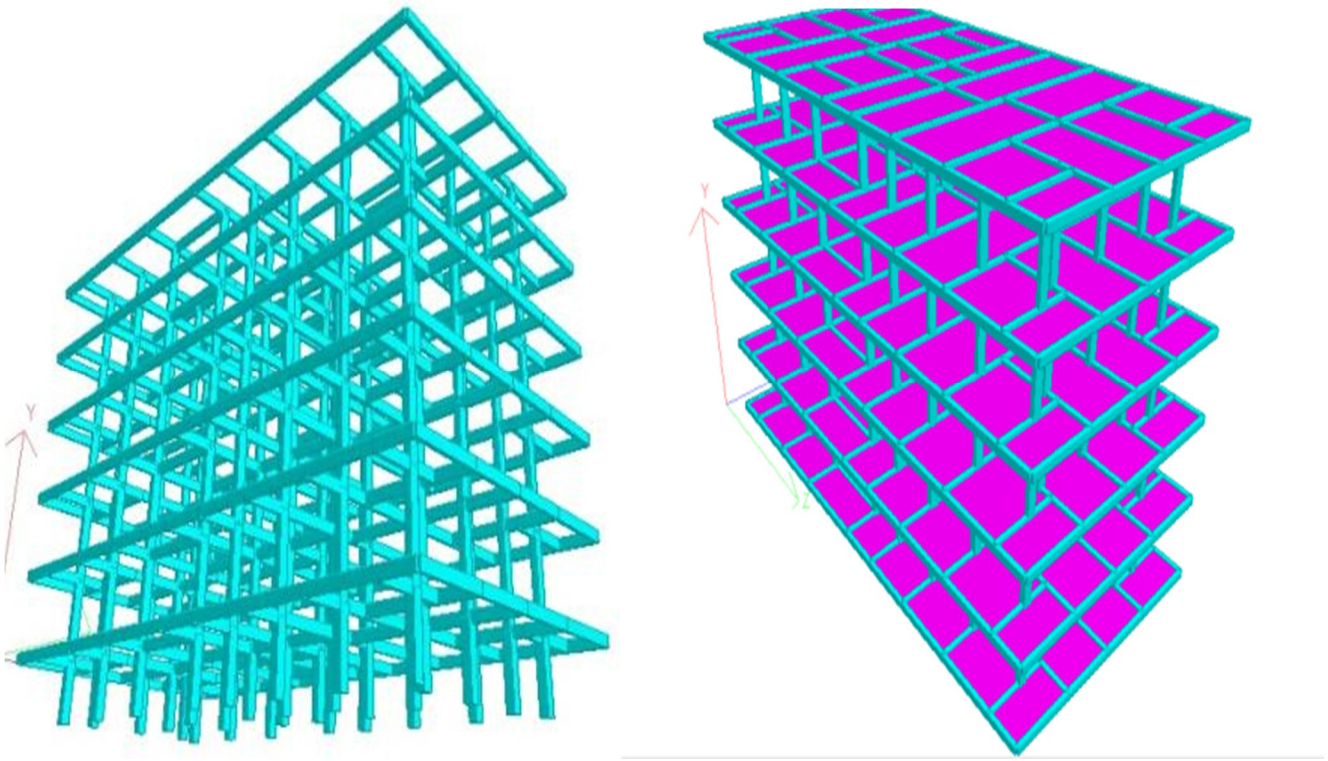


FIGURE A: Structure

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B. Loading Cases and Values

LOAD CASES	LOAD
DEAD LOAD	
Self-weight	-1
Member Load (Roof)	-1.5
Member Load	-3
Floor Load (Roof)	-0.8
Floor Load	-1
LIVE LOAD	
Floor Load (Roof)	-1.5
Floor Load	-3

C. Parameters

PARAMETERS	VALUE
F_C	20000/25000

IV. DESIGN AND ANALYSIS

A. Design Of Beam

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	750.0 mm	1500.0 mm	2250.0 mm	3000.0 mm
TOP REINF.	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)
BOTTOM REINF.	2-10í 1 layer(s)	2-10í 1 layer(s)	2-10í 1 layer(s)	2-10í 1 layer(s)	2-10í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 100 mm c/c	2 legged 8í @ 100 mm c/c	2 legged 8í @ 100 mm c/c	2 legged 8í @ 100 mm c/c	2 legged 8í @ 100 mm c/c

B. Design Of Column

```
LENGTH:  3500.0 mm   CROSS SECTION:  310.0 mm X  410.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    3 END JOINT:   144  SHORT COLUMN


REQD. STEEL AREA   :     1635.94 Sq.mm.
REQD. CONCRETE AREA:   125464.07 Sq.mm.
MAIN REINFORCEMENT : Provide  16 - 12 dia. (1.42%,   1809.56 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 190 mm c/c

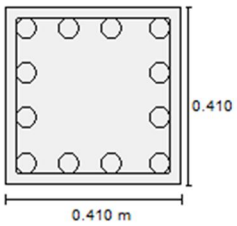
SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
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Note: The structure is safe.

V. COMPARISON

Here are some of the graphs and results from the above design and analysis:

FOR M20 CONCRETE



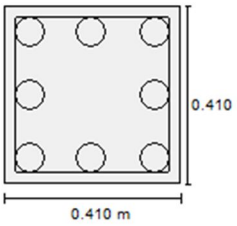
Design Load

Load	3
Location	End 2
Pu(Kns)	1078.97
Mz(Kns-Mt)	0.03
My(Kns-Mt)	35.24

Design Parameter

Fy(Mpa)	415
Fc(Mpa)	20
As Reqd(mm²)	968
As (%)	0.80
Bar Size	12
Bar No	12

FOR M25 CONCRETE



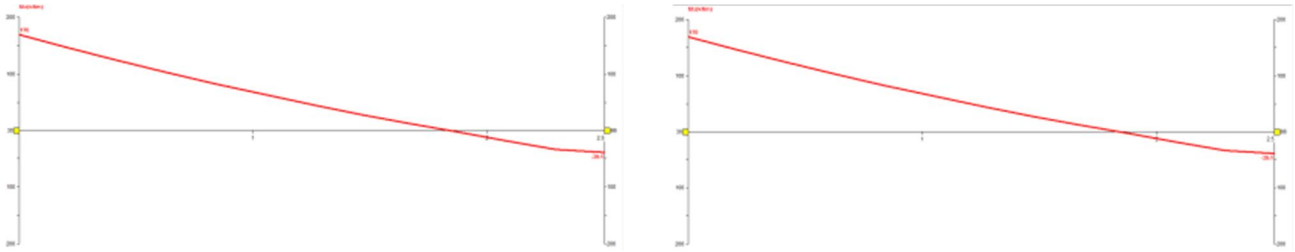
Design Load

Load	3
Location	End 2
Pu(Kns)	1078.97
Mz(Kns-Mt)	0.03
My(Kns-Mt)	35.24

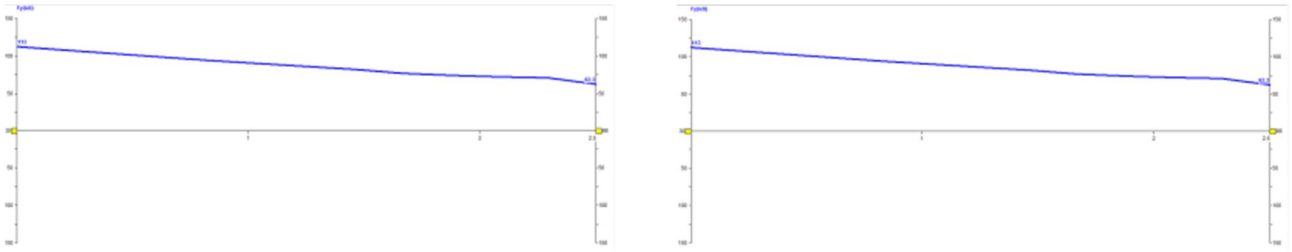
Design Parameter

Fy(Mpa)	415
Fc(Mpa)	25
As Reqd(mm²)	774
As (%)	0.53
Bar Size	12
Bar No	8

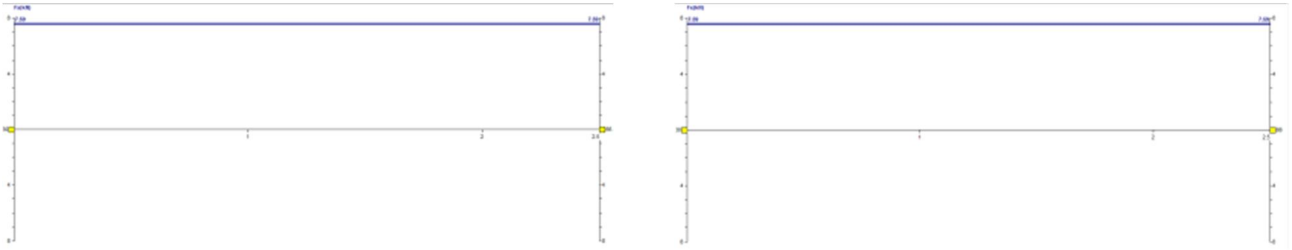
Concrete Design



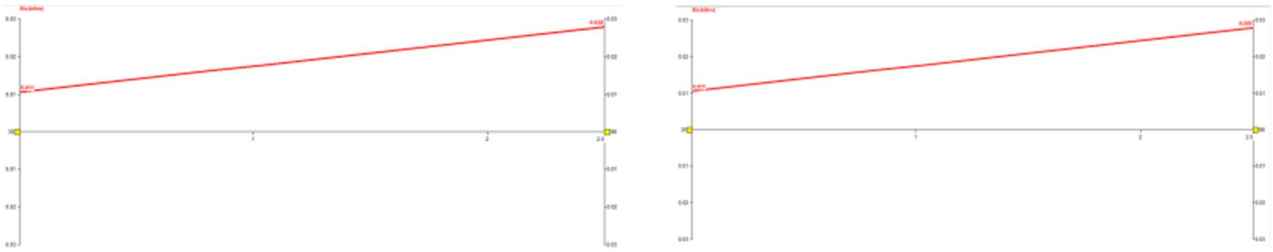
Graph for M_z (BEAM)



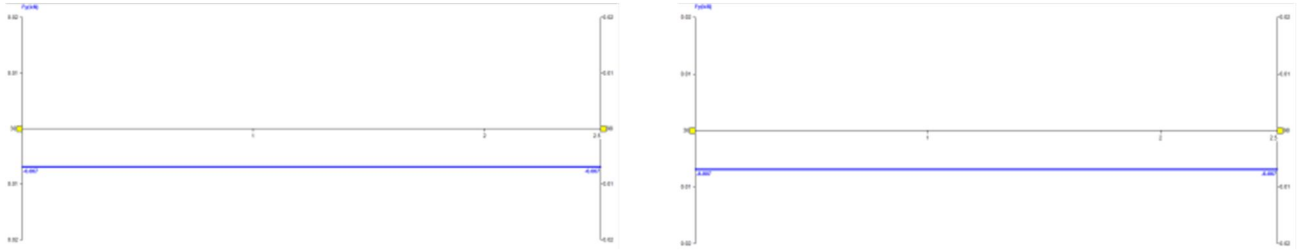
Graph for F_y (BEAM)



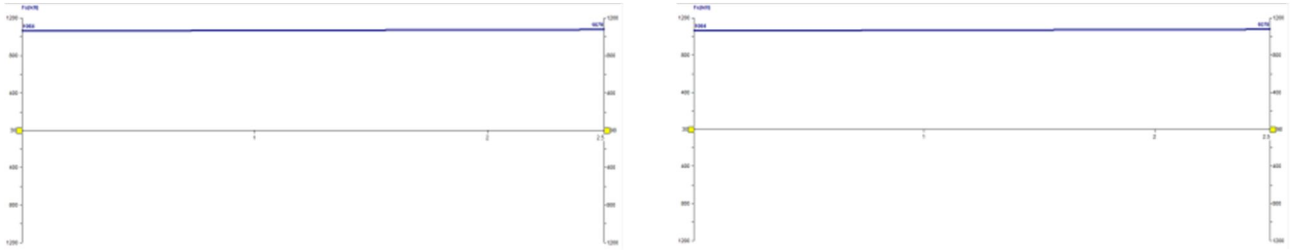
Graph for F_x (BEAM)



Graph for M_z (COLUMN)



Graph for F_y (COLUMN)



Graph for F_x (COLUMN)

VI. RESULT AND DISCUSSION

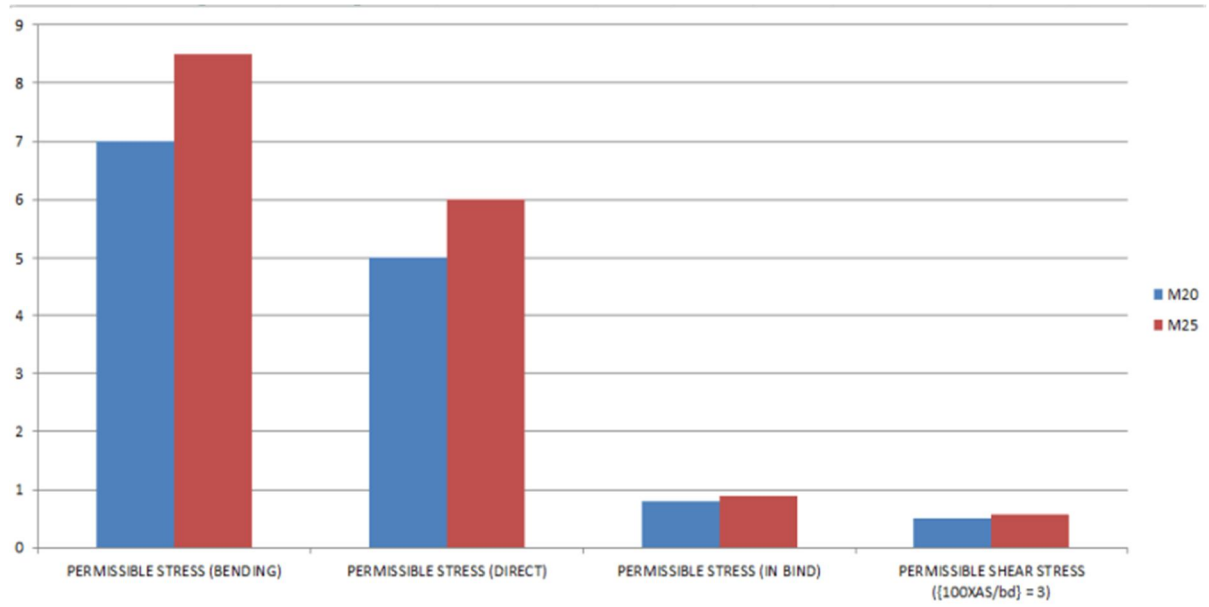
We got the certain results from the above design, analysis and the comparison for the grade of concrete. They are:

1) Both the structures are safe and can be constructed.

2) The below table describes the warnings given:

No of beams under warning	Warning given
24 Members – 30, 35, 83, 88, 315, 320, 368, 373, 408, 413, 461, 466, 501, 506, 554, 559, 594, 599, 647, 652, 687, 692, 740, 745	Length to Depth ratio is less than 2.5. Deep beam is not designed and assuming it to be a part of a continuous beam and away from the critical section.

3) The permissible stresses indicates that M25 concrete is a better grade then M20 as shown:



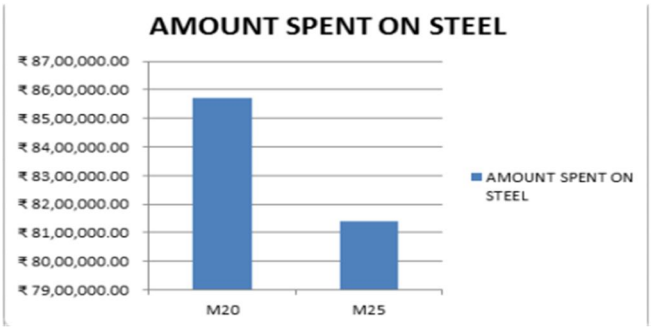
4) As we have obtained a calculation of total amount for concrete and steel required for the structure, we found out that M25 concrete will be more economical as compare to M20 concrete as the steel require increases with the decrease in grade of concrete.

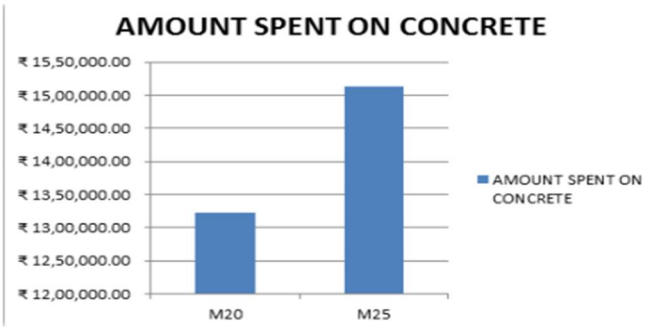
TOTAL VOLUME OF CONCRETE = 180.0 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	59437
10	18681
12	62447
16	13875
20	18254
25	8187
*** TOTAL=	180880

TOTAL VOLUME OF CONCRETE = 180.0 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	59239
10	18473
12	60840
16	17611
20	25388
25	7225
32	1734
*** TOTAL=	190510





5) Also, when we use M25 grade of concrete instead of M20 our structure will be more stable, having better resistance to forces and better life span.

VII. FUTURE SCOPE

Here are some points that maybe helpful:

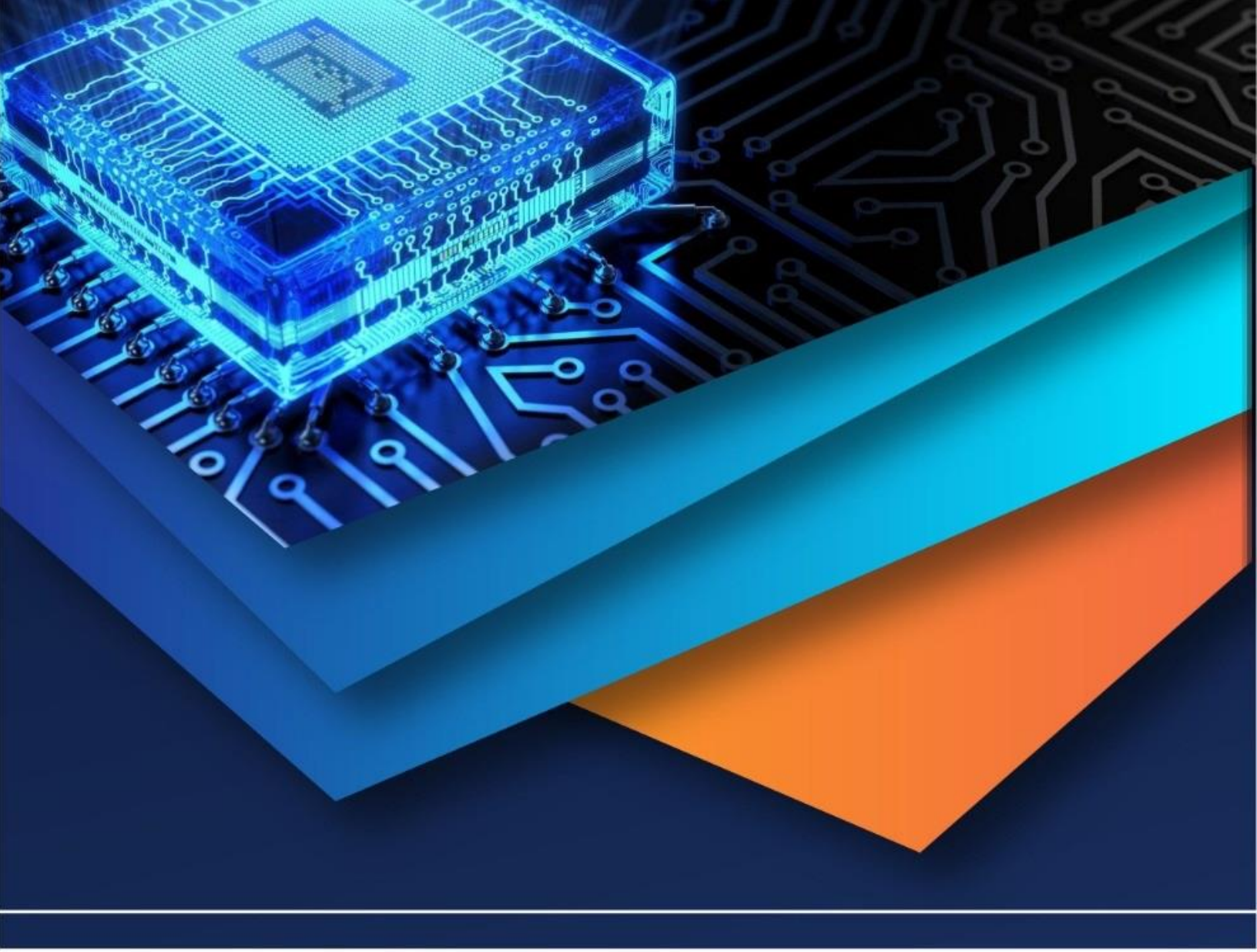
1) Using a low grade of material does not always means that it will be economical.
2) This study will helps to understand that a single material individually can never make a project economical.
3) This study will be helpful to design a multi-storey building using multiple loading at different members differently.
4) This can help the future researchers to better understand the behaviours of grades and members with different loads and designs.

VIII. CONCLUSION

This study concludes that the structure designed by using the above data for nodes, beams, loads, frames, parameters, etc. is safe whether we design it by using M20 grade of concrete or using M25 grade of concrete. The analysis results are that both the structures are safe and can be constructed. While the comparison result shows that using different type of grade of concrete does not affect the volume of concrete but is severely affect the amount of steel used (mainly in the columns/vertical members). Therefore, we must completely analyse the project details and design results to clear out the economical betterment of the project.

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