

Simulation of Buildings Using Staad pro

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Abstract: - In recent year the increase of population, commerce and trade and the cost of land in cities have resulted in a considerable increase in the number of tall buildings. At present, there are many factors effecting the selection and design of the high-rise building structural system. In order to compete in the ever growing competent market it is very important for a Structural Engineer to save time. Simulation modelling is used to help designers and engineers understand whether, under what conditions, and in which ways a part could fail and what loads it can withstand.

Key Words—High-rise building, Staad Pro, Building simulation, Simulation Modeling.

I. INTRODUCTION

Human life is affected due to nature's forces like floods, hurricanes, tornadoes, earthquakes etc. The structural design for a building must ensure that the building is able to stand safely, to function without excessive deflections or movements which may cause fatigue of structural elements, cracking or failure of fixtures, fittings or partitions, or discomfort for occupants. It must account for gain insight during planning, design and construction stage and predict the structural behaviour to optimize design in early design stage and engineering processes The Project is about designing different 3 residential buildings of G+5, i.e. Concrete steel and composite structure using staadpro software. The main objective of the project is about to compare the each building based on their loads acting deflections, materials used through the staadpro software. We are designing the buildings in Hyderabad, i.e., Zone II.

II. LITERATURE SURVEY

Chapman.J.C. and Balakrishnan S. (1964): His investigations started with well-known work on composite beams by the authors who concerned about the shear connectors in the overhanging region of the simply supported composite beams.

Johnson R.P (1975): He started by the extensive research by Dr. Chapman and Professor Johnson R, P led to publish a book with a review of behavior of composite structure of steel and concrete. He drafted design methods for composite structures for both building and bridges.

Reinhold M.Schuster (1976), The various commercially available steel decks and classified them based on their means of developing shear resistance and on the pattern of mechanical shear transfer devices into three categories of the decks .

Singh.R.K. and Mallick. S.K. (1977), They presented a formula to find the ultimate torsional strength of the composite beams. The formula presented was: $T_u = T_{cu} + T_r + T_j$ where T_{cu} , T_r and T_j were the torsional strength contribution by concrete, reinforcement and joist respectively.

III. METHODOLOGY

The composite sections using Steel encased with Concrete are economic, cost and time effective solution in major civil structures such as bridges and high rise buildings. In due consideration of the above fact, this project has been envisaged which consists of analysis and design of a high rise building using Steel-Concrete composites. The project also involves analysis and design of an equivalent R.C.C structure so that a cost comparison can be made between a Steel-Concrete composite structure and an equivalent R.C.C. structure. There are three types of buildings i.e , Rcc structure, Steel structure and composite structure. Analyzing each type of building and assigning different types of loads according to the zone in Hyderabad. in zoneII. the safe bearing capacity is taken as 300kg/m³. We analyze each load such as live load, dead load and wind load For live load we assign self-weight and uniform loads or the member loads. For dead load we assign floor load and pressure load is of 3kn/m³. Assgning each load or modulus of elasticity according to the material used in the structure. We have to assign each load according by the design of beam and column.

A. PLANNING

The plan is drawn for the residential building for an existing site and plan consists of 4 flats two elevators and 1 stair case hence it is a residential building of 3 bedrooms it has 3 bath rooms, one store room and 2 balconies?.

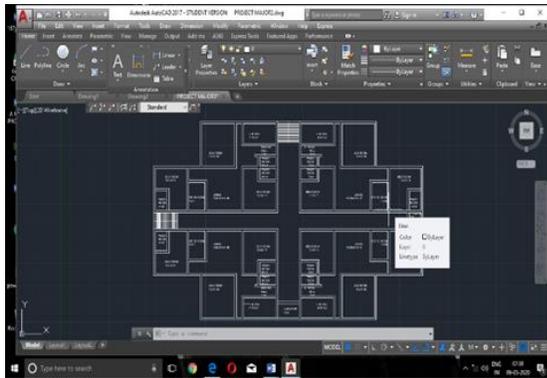


Fig. 1. Designing of RCC structure using staad pro

IV. DESIGN AND ANALYSIS OF RCC STRUCTURE

A. Modelling in Staad.PROV8I

Open STAAD.PRO, click on add beam and then click on ok. Then select units by clicking on meters and kilo newton's and then click OK. Click on geometry and add nodes by using node cursor. Add nodes by giving the assumed distances and the click on ok. By using beam cursor join the nodes for forming beams. Click on general and select support. Create a fixed support and click on assign to selected nodes then supports a reassigned. Click on translational repeat and give spacing of 3.5m and select number of storeys and click on OK

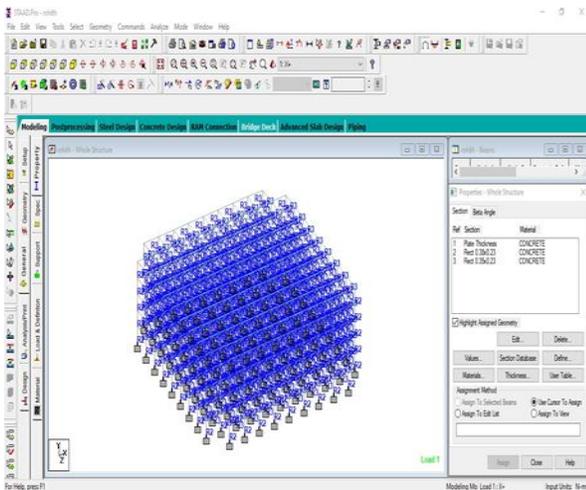


Fig.2. 3D- View of Structure

Assigning the supports: The building is provided with fixed supports in staad pro.

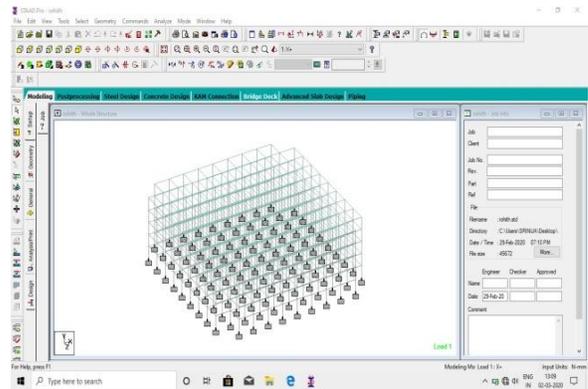
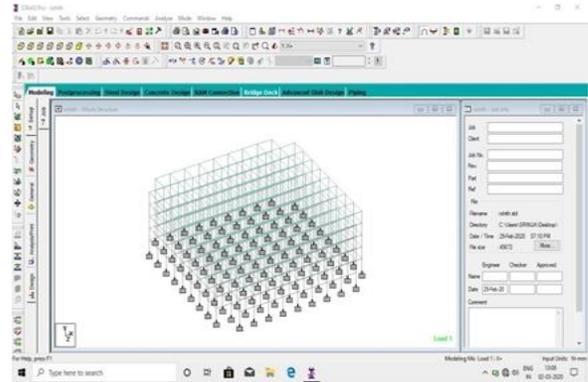


Fig.3. Assigning supports

B. Application of Loads

Application of Seismic Load: Go to load case details and add wind load in positive X direction and in negative X-direction.

 LOAD CASE 1(L1) – Seismic load in positive X-direction

 LOAD CASE 2(L2) – Seismic load in negative X-direction in second load case add wind load in positive Z direction and negative Z-direction.

 LOAD CASE 3(L3) – Seismic load in positive Z-direction

 LOAD CASE 4(L4) – Seismic load in negative Z-direction

Application of Dead Load And Live Load: In third and fourth load cases give dead load and live load according to the IS Codes.

 LOAD CASE 5(L5) Dead load

 LOAD CASE 6(L6) – Live load

 DEADLOAD

Self-Weight = -1

Member Loads = -13.8kn/m² (outer walls)

-6.3(inner walls)

-3(parapet walls)

Live Load:

Floor load = -6kn/m^2 Click on assign to view and assign.

Application of load combinations:

Here for the structure load combination (Dead load +Live load +Sesmic load) with factor of safety 1.5 is applied

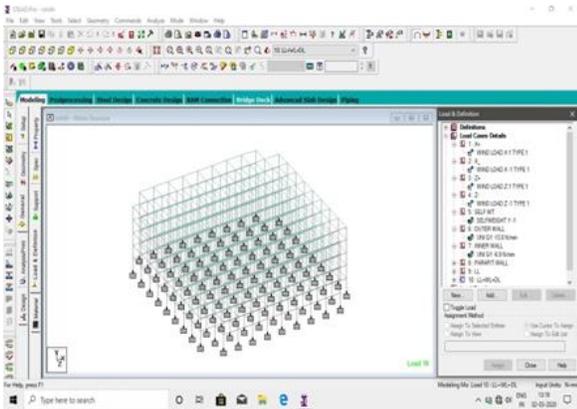


Fig.4. Application of loads

Analysis of RCC Structure: Go to analysis/print and select all and click on OK. Click on analysis and select run analysis. The analysis is done according to Is456 code and the bending moments and shear force diagram

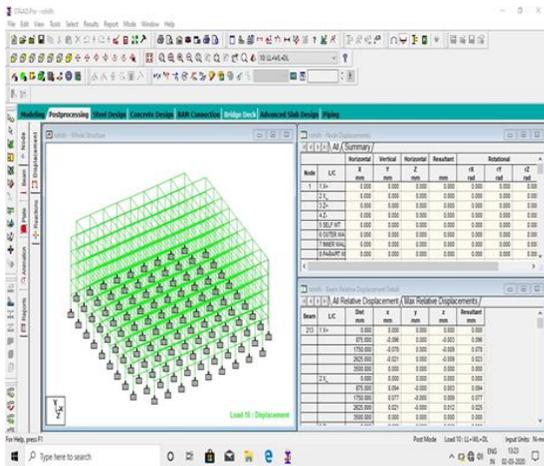


Fig.5(a). Shear force diagram of the structure

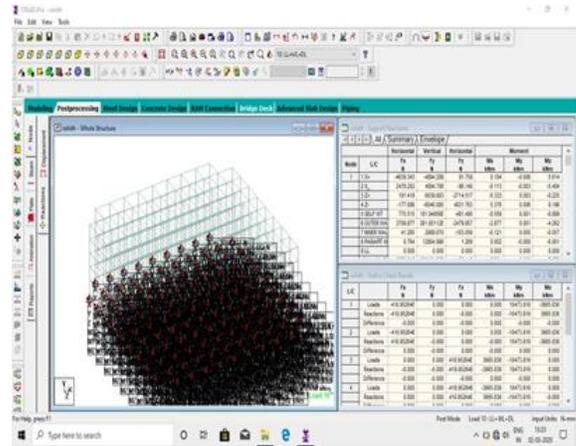


Fig.5(b). Shear force diagram of the structure

C. Advance Concrete Design for Beam and Column

After the completion of design. Click on mode in the main menu. Select design & click on concrete. Enter the job details click on envelope in the page converts. Select all the beams and click on new envelope in the command panel. Specify the envelope and click on ok. Select the load combinations & click on ok Click on members in page converter select all the beams click on members in the main menu click on auto from members. Go to groups of page in the converter select all the beams. Click on new brief in the command panel. Specify the design name, type, code and click on ok. Now specify the parameters & click on ok. Select all the beams and click on new design group specify the name, select the brief and click on ok. Now click on concrete member in the page converter and select the design group in main menu click on design. Click on schedule in the page converter to save the drawings in auto cad format.

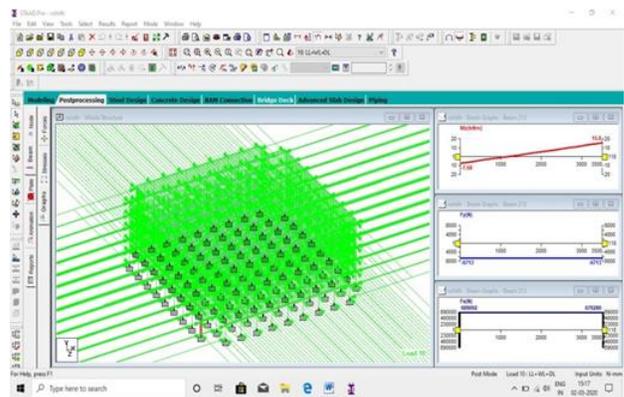


Fig.6. Concrete design of a beam

Detailing of beam:

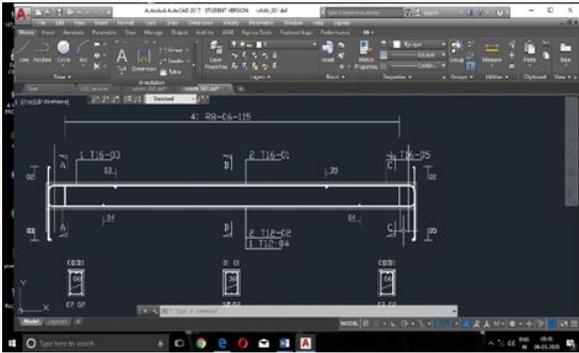


Fig.7.Detailing of beam

The beam detailing is done in staad pro and designed in auto cad

Detailing of column:

A column may be defined as an element used primary to support axial compressive loads and with a height of a least three times its lateral dimension. The strength of column depends upon the strength of materials, shape and size of cross section, length and degree of proportional and dedicational restrains at its ends.

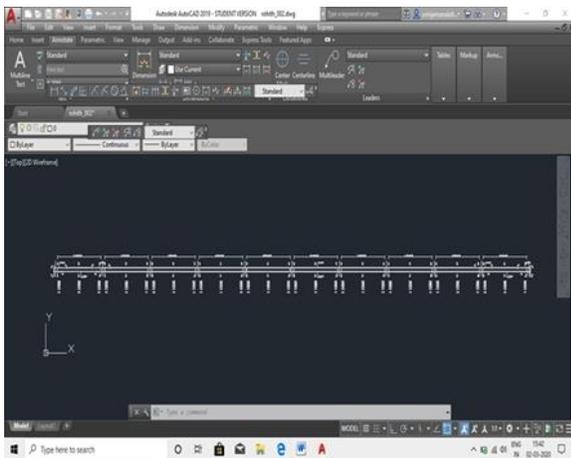


Fig.8. Detailing of column

Design of slab:

There are three types of slabs that are needed to be designed they are:

1. s1 interior slab
2. s2 Two short edges discontinues
3. s3 one long edge discontinues

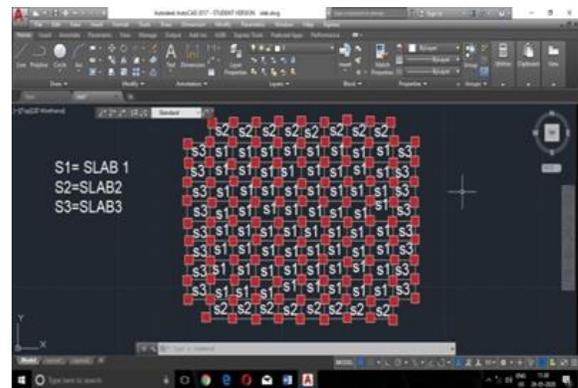


Fig.9.Design of slab

SLAB 1

- DEPTH=175mm
- TOTAL LOAD = 9.25 kn
- MX+ = 9.01KN/M
- MX- = 11.792KN/M
- MY+ = 2KN/M
- MY- = 2.66KN/M
- AST X+ = 276MM²
- AST X- = 300 MM²
- AST Y+ = 215MM²
- AST Y- = 254MM²
- AST MIN = 300 MM²

SLAB 2

- DEPTH=225mm
- TOTAL LOAD = 9.25 kn
- $M_{X+} = 9.01 \text{KN/M}$
- $M_{X-} = 2.91 \text{kn/m}$
- $M_{Y+} = 4.91 \text{kn/m}$
- $M_{Y-} = 0$
- $AST_{X+} = 175 \text{MM}^2$
- $AST_{X-} = 248 \text{MM}^2$
- $AST_{Y+} = 200 \text{MM}^2$
- $AST_{Y-} = 254 \text{MM}^2$
- $AST_{MIN} = 270 \text{MM}^2$

SLAB 3

- DEPTH= 225mm
- TOTAL LOAD = 9.25 kn
- $M_{X+} = 9.01 \text{KN/M}$
- $M_{X-} = 11.792 \text{KN/M}$
- $M_{Y+} = 2 \text{KN/M}$
- $M_{Y-} = 2.66 \text{KN/M}$
- $AST_{X+} = 150 \text{MM}^2$
- $AST_{X-} = 201 \text{MM}^2$
- $AST_{Y+} = 238 \text{MM}^2$
- $AST_{Y-} = 248 \text{MM}^2$
- $AST_{MIN} = 270 \text{MM}^2$
- SPACING: MIN OF

- $\pi/4 * 10 * 10 / 270 * 1000 = 290 \text{MM}$
- $3d = 3 * 150 = 450$
- Therefore provide 10T@290c/c in both ways

Table:1.

| S.NO | SLAB | STEEL | |
|------|------|--------------------|--------------------|
| | | ASTX | ASTY |
| 1 | S1 | 270MM ² | 270MM ² |
| 2 | S2 | 270MM ² | 270MM ² |
| 3 | S3 | 270MM ² | 270MM ² |

Design of Stair Case:

Assume

Riser=6"

thread=12"

height of the floor=3.5m=10'

Step:1- Stair in base

Number of risers= mid landing/riser

$5' / 0.5' = 10$ (numbers)

Number of thread = number of risers-1= 10-1=9(numbers)

Horizontal distance= number of thread x thread

$$= 9 \times 1'$$

=9'

step2: Stair on floor

Number of risers = mid landing height/riser

=10(numbers)

Number of threads=9(numbers)

Step3: Total area:

Total number of risers= 10+10 =20

Total number of threads=18

Total Area =15' x6.5'=97.5 sq feet

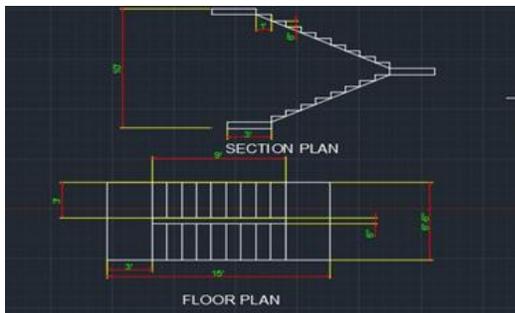


Fig.10. Design of stair case

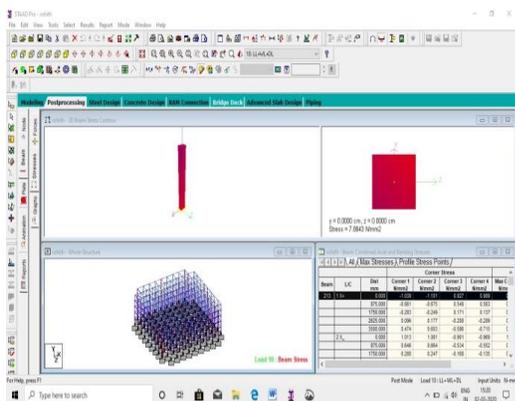


Fig.11. Design of column in staad pro

D. Steel structure Design

Geometric parameters:

Beam dimensions: 0.35 x 0.30M

column dimensions: 0.38 x 0 .23 m

Design and Analysis:

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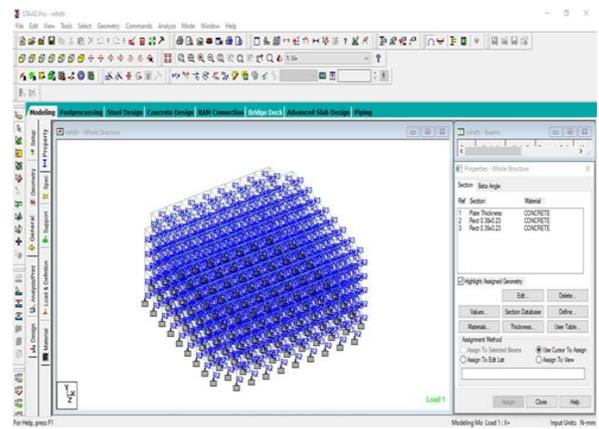


Fig.12. 3D View for Steel Structure

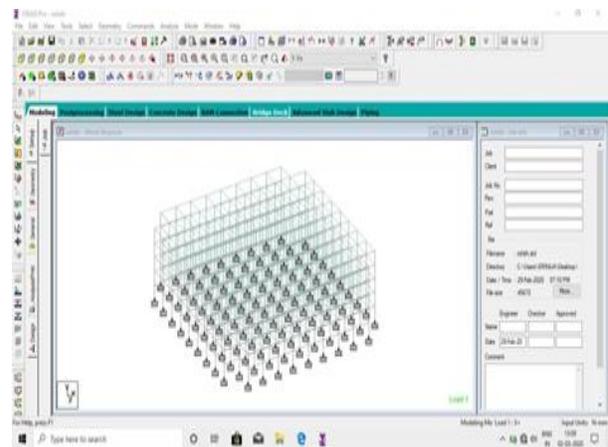


Fig.13. Assigning The Supports

Assigning of Properties to The Structure: Go to general and select property. Then click on define and select rectangle and give the dimensions of required size. Click on the required property and select assign to selected beams and assign

Application of Loads Application of Seismic Load: Go to load case details and add wind load in positive X direction and in negative X-direction. LOAD CASE 1(L1) – Seismic load in positive X-direction. LOAD CASE 2(L2) – Seismic load in negative X-direction. In second load case add wind load in positive Z-direction and negative Z-direction.

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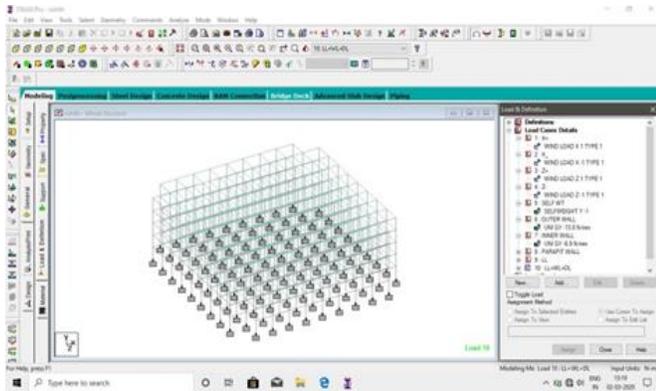


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Application of Load Combinations: For the steel structure load combinations (dead load + live load + seismic load) with factor of safety 1.5 is applied

Go to analysis/print and select all and click on OK. Click on analysis and select run analysis.

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V. SIMULATION OF RCC AND STEEL

Here the designed and analyzed values of RCC and Steel structures are compared

RCC Structure:

An RCC framed structure is essentially an assembly of slabs, beams, columns, and foundation inter-related to every different as a unit. The load transfer, in this kind of structure, takes location from the slabs to the beams, from the beams to the columns after which to the lower columns and sooner or later to the muse which in flip transfers it to the soil. However, for a load bearing structure, the loads are directly transferred to the soil via the walls which might be designed to specifically carry the hundreds. Since brick is vulnerable in compressive strength in evaluation to 1:2:4 cement concrete, the width of load bearing walls for homes having to say greater than 4 Storey's will become abnormally thick and for

such cases, framed structures are designed. The ground region of an R.C.C framed shape constructing is 10 to 12 percentage greater than that of a load bearing walled building. Hence, there may be a real economic system in case of

Advantage of RCC structure on the basis of analysis:

Materials used in RCC construction are easily available. It is durable and long lasting. It is fire resisting and not attacked by termites. It is economical in ultimate cost. The reinforced concrete member can be cast to any shape because of the fluidity of concrete. Its monolithic character gives much rigidity to the structure. The cost of maintenance is nil.

Disadvantages of RCC structure:

Scrap value of reinforced members is almost Constant checking is required. Skilled labor is engaged in the work. The advantages of RCC outweigh its disadvantages.

Advantages of Structural Steel Structures:

Steel is tensile. It has a high strength to weight ratio which means it has high strength per unit mass. So no matter how large the overall structure is, the steel sections will be small and lightweight, unlike other building materials. Steel can be easily fabricated and produced massively. Steel sections can be produced off-site at shop floors and then assembled onsite. This saves time and increases the efficiency of the overall construction process. Structural steel is very flexible. You can mold it into any shape, without changing its properties. You can convert it into sheets or turn it into wires as per the design. Structural steel is relatively cheap compared to other building materials. It is very durable. Structural steel structures can withstand external pressures such as earthquakes, thunderstorms, and cyclones. A well-built steel structure can last up to 30 years if maintained well.

Disadvantages of Structural Steel Structures:

Steel is an alloy of iron. This makes it susceptible to corrosion. This problem can be solved to some extent using anti-corrosion applications. It has high maintenance costs as it has to be painted to make it corrosion-resistant. There are extensive fireproofing costs involved as steel is not fireproof. In high temperatures, steel loses its properties.

VI. CONCLUSION

The aim of our project was planning, analysis and design of a multi-storeyed, earthquake resistant residential building. We

were able to complete the project in a successful and efficient manner by considering all the relevant features given as nine chapters. Planning of this building has been done based on the space requirements suggested by the prevailing rules stipulated in Kerala Building Rules, 1999. The design is completely based on relevant Indian Standard Codes. The analysis has been done with the help of STAAD Pro and the drawings have been made with the help of AutoCAD. We have completed this project to the best of our knowledge and ability.

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