

# Civil Engineering Software

Subject Code: 66466

Presented By:-

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# Structural Analysis And Design

# “What” Is Analysis?

Calculation of the response of  
structures to  
actions

# INTRODUCTION TO STAAD.Pro

- STAAD.Pro is a structural analysis design program software.
- It includes a state of the art user interface, visualization tools and international design codes.
- It is used for 3D model generation, analysis and multi-material design.
- The commercial version of STAAD.Pro supports several steel , concrete and timber design codes.
- It is one of the software applications created to help structural engineers to automate their tasks and to remove the tedious and long procedures of the manual methods.

# HISTORY OF STAAD.Pro

- STAAD.Pro was originally developed by Research Engineers International in Yorba Linda, CA.
- In late 2005, Research Engineer International was bought by Bentley Systems.

# STRUCTURE

- A STRUCTURE can be defined as an assemblage of elements. STAAD is capable of analyzing and designing structures consisting of both frame, and Finite elements. Almost any type of structure can be analyzed by STAAD.

Frame elements – Beam elements – 2 nodes

Finite elements –      1.) Plate – 3 or 4 nodes  
                                  2.) Solid – 4 to 8 nodes

- In case of STAAD

<i>Node becomes Joint</i>	<i>it has a number and xyz coordinates</i>
<i>Beam becomes Member</i>	<i>it has a number and nodes at its ends</i>
<i>Plate becomes Element</i>	<i>it has a number and node at its corners</i>

# TYPES OF STRUCTURE

- A **TRUSS** structure consists of truss members which can have only axial member forces and no bending in the members
- A **PLANE** is bound by a global X-Y coordinate system with loads in the structure plane
- A **SPACE** structure, which is a three dimensional framed structure with loads applied in any plane, is the most general.
- A **FLOOR** structure is a two or three dimensional structure having no horizontal (global X or Z) movement of the structure [FX, FZ & MY are restrained at every joint]. The floor framing (in global X-Z plane) of a building is an ideal example of a **FLOOR** structure. Columns can also be modelled with the floor in a **FLOOR** structure as long as the structure has no horizontal loading. If there is any horizontal load, it must be analyzed as a **SPACE** structure.









## Project Tasks

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-  [truss0](#)
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## License Configuration

- |   |  |  |
|---|--|--|
| <input type="checkbox"/> Advanced Analysis Engine           | <input type="checkbox"/> Indian Design Codes               | <input type="checkbox"/> Middle Eastern Design Codes |
| <input type="checkbox"/> US Design Codes (Standard)         | <input type="checkbox"/> Asian Design Codes                | <input type="checkbox"/> Global Design Codes         |
| <input type="checkbox"/> US Specialized Design Codes        | <input type="checkbox"/> Japanese Design Codes             | <input type="checkbox"/> Nuclear Design Codes        |
| <input type="checkbox"/> British Design Codes (Standard)    | <input type="checkbox"/> Eurocodes                         | <input type="checkbox"/> STAAD.beava (Bridge Codes)  |
| <input type="checkbox"/> British Specialized Design Codes   | <input type="checkbox"/> Euro-zone - Central Design Codes  | <input type="checkbox"/> DESCON English              |
| <input type="checkbox"/> Latin American Design Codes        | <input type="checkbox"/> Euro-zone - Northern Design Codes | <input type="checkbox"/> DESCON Metric               |
| <input type="checkbox"/> Candian/Australian/SA Design Codes | <input type="checkbox"/> Euro-zone - Eastern Design Codes  |  |



# GETTING STARTED

## STAAD WINDOW

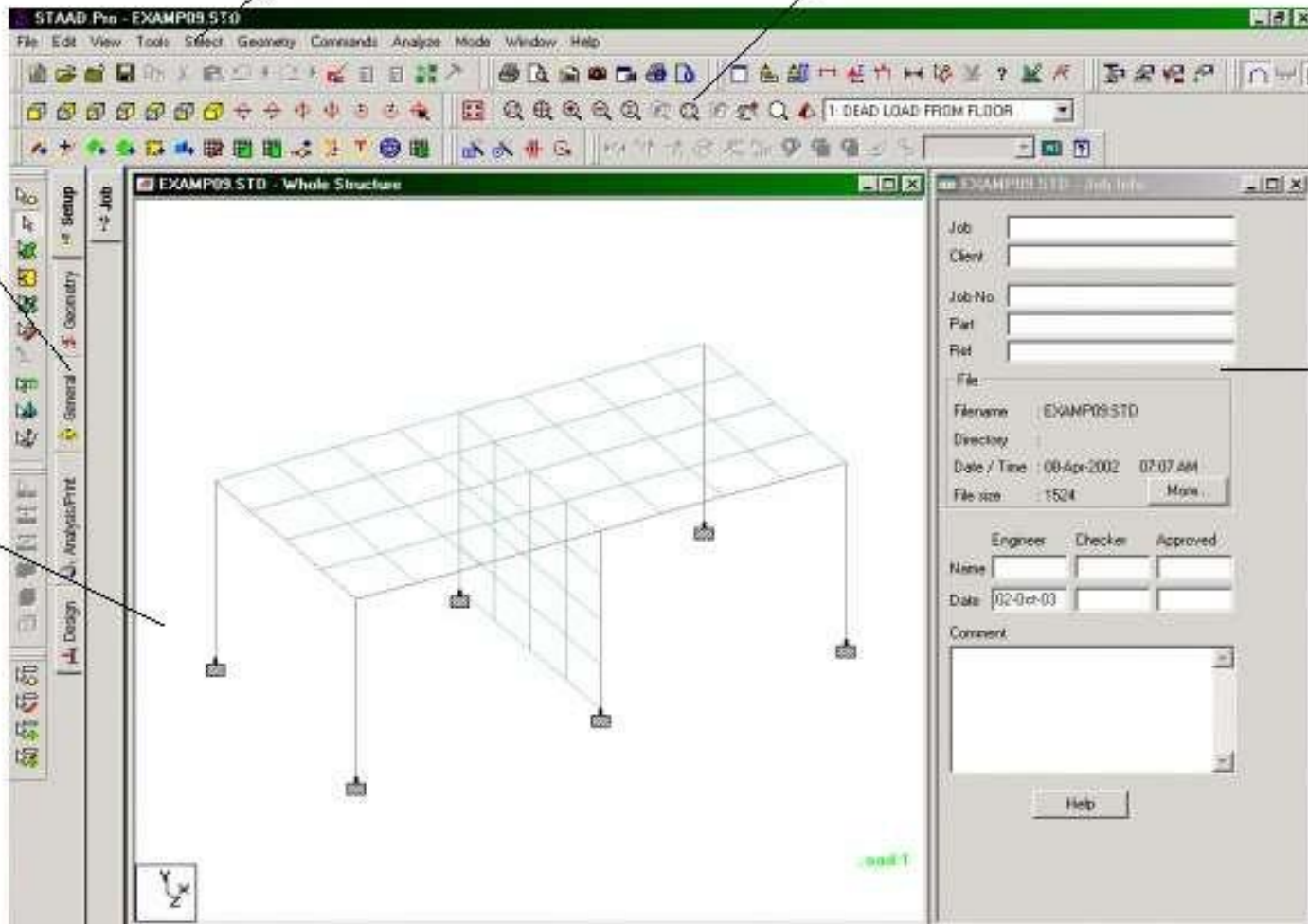
Menu Bar

Tool Bar

Page Control

Main Window

Data Area



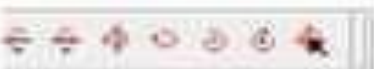
# TOOLS USED



All these options are used to see the view of structure from various sides.



Rotation can be done by rotating the option.



To zoom the structure and return to previous, these are required.



If you want to return the whole structure, use this.



To see the 3D render view, use.



# VARIOUS TYPES OF CURSORS

(4) Various Selection: Selections are found for various part such as node, beam, surface, plate, solid.



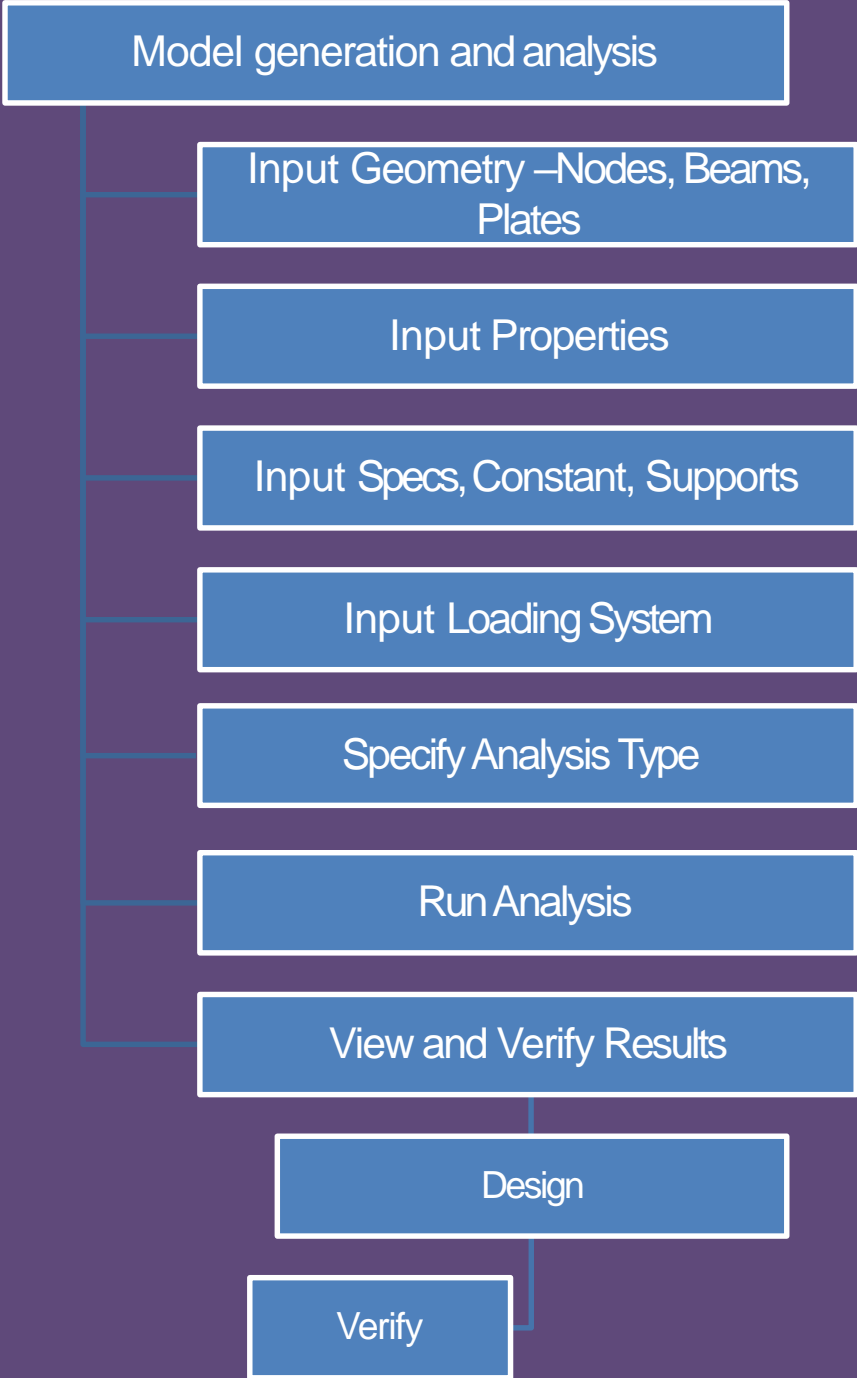
# PAGE CONTROL IN VARIOUS MODES

## Page Control in Modeling Mode



## Page Control in Post-Processing Mode

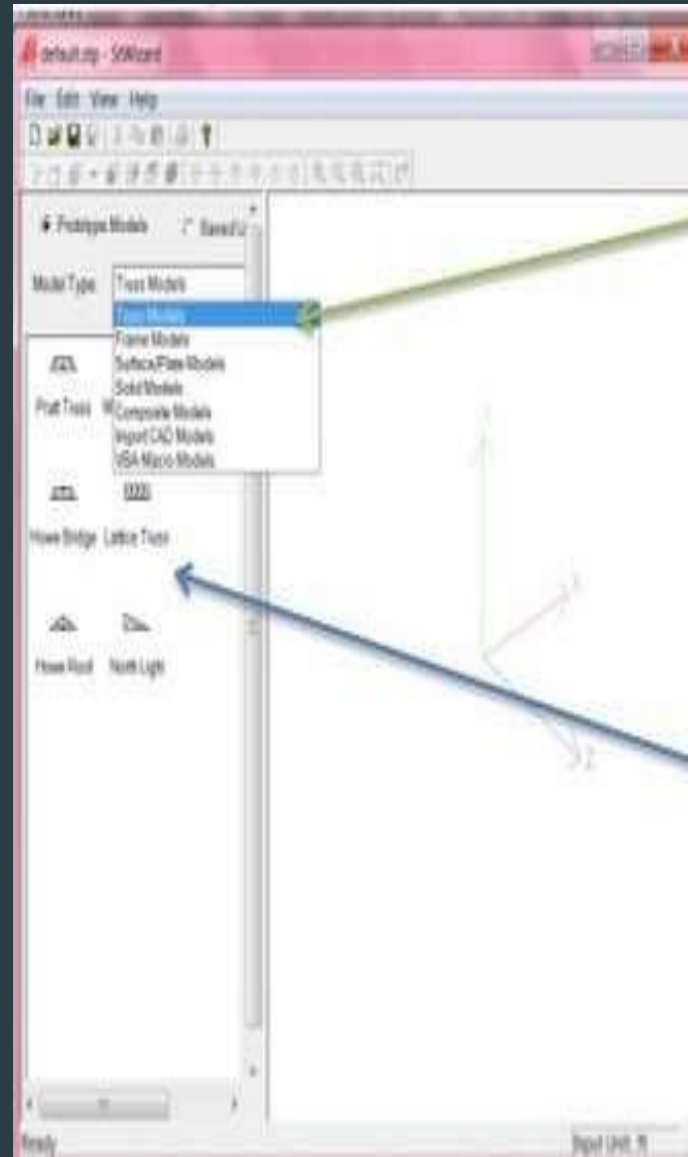
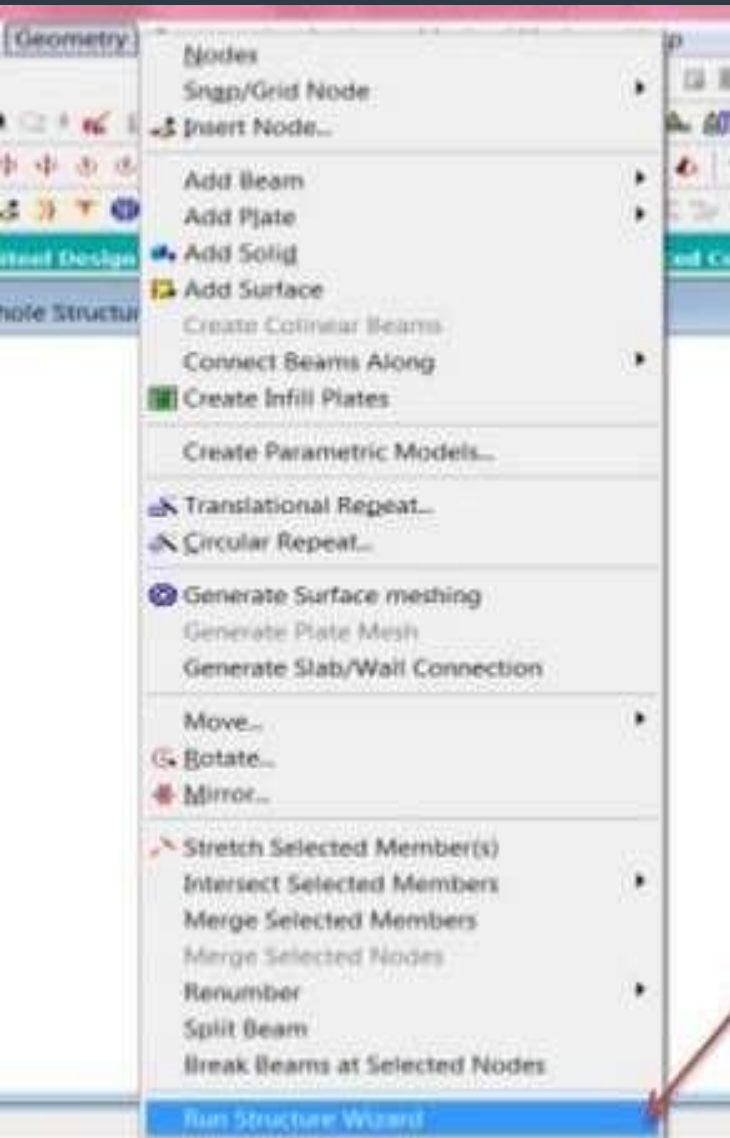




# MODEL GENERATION

- There are basically 3 methods of generating a model
  1. Snap node method
  2. Coordinate method
  3. Copy paste method
- Out of these three methods most commonly used is copy paste method
- By using these three methods a structure of any geometry can be created
- STAAD.Pro also contains a command **wizard** which is its library of structures such as frames , trusses are present which can be merged with the STAAD.Pro model

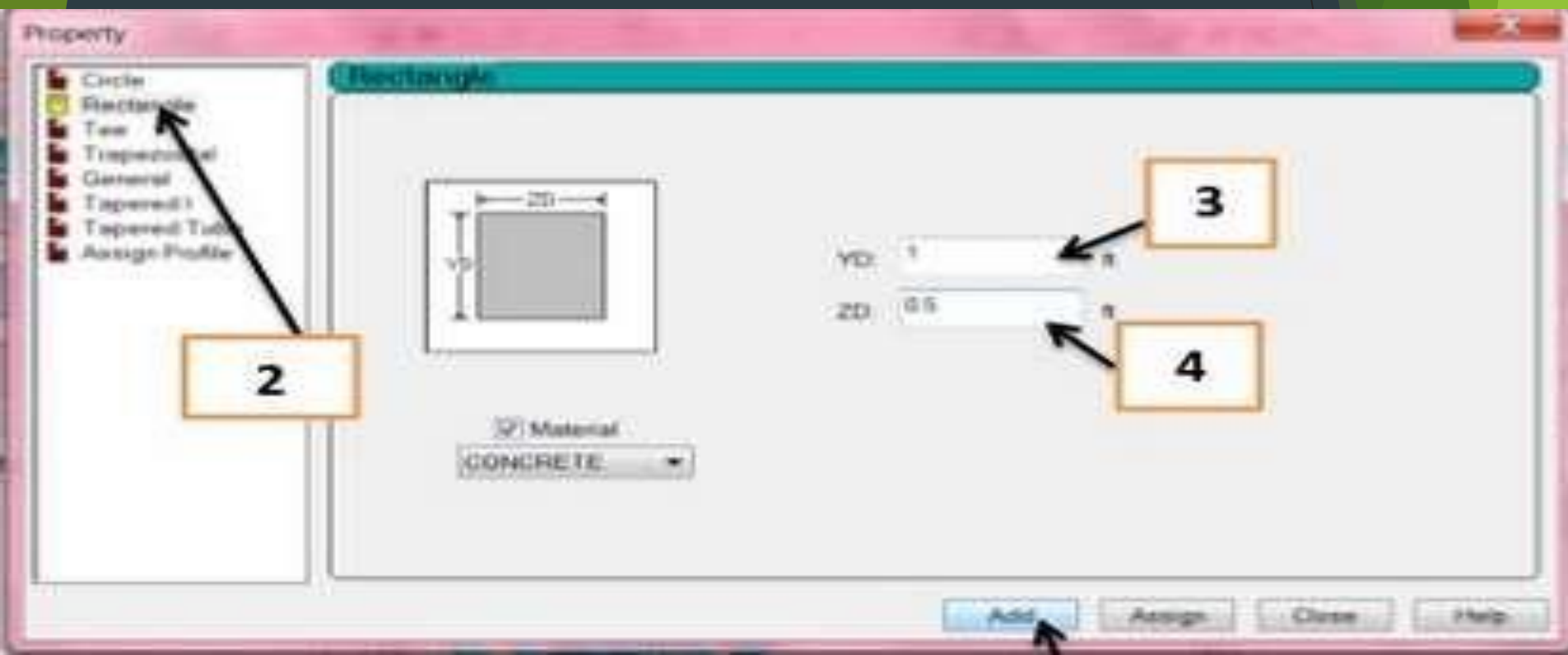
# WIZARD



Here various types of division of Structures is given for choice

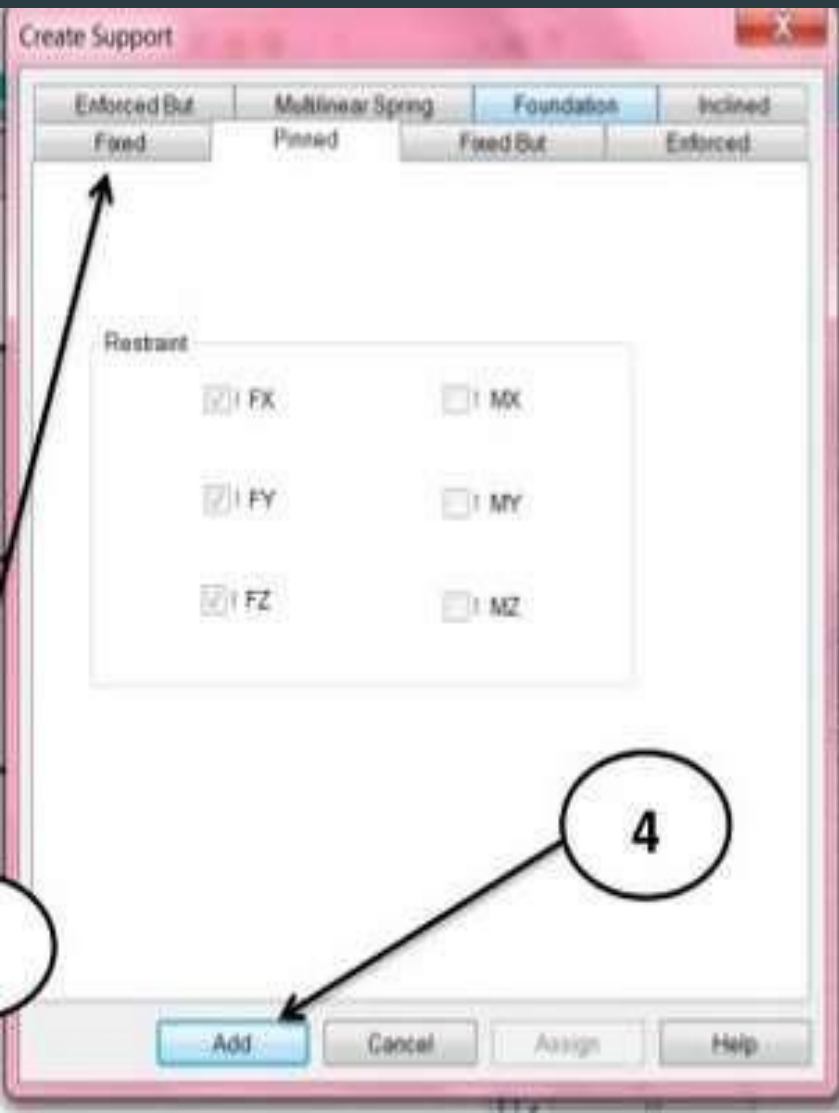
Here various types of Structures is given under each Main division for choice

Assigning a property means to provide dimensions such as width, thickness etc to beams columns slabs etc





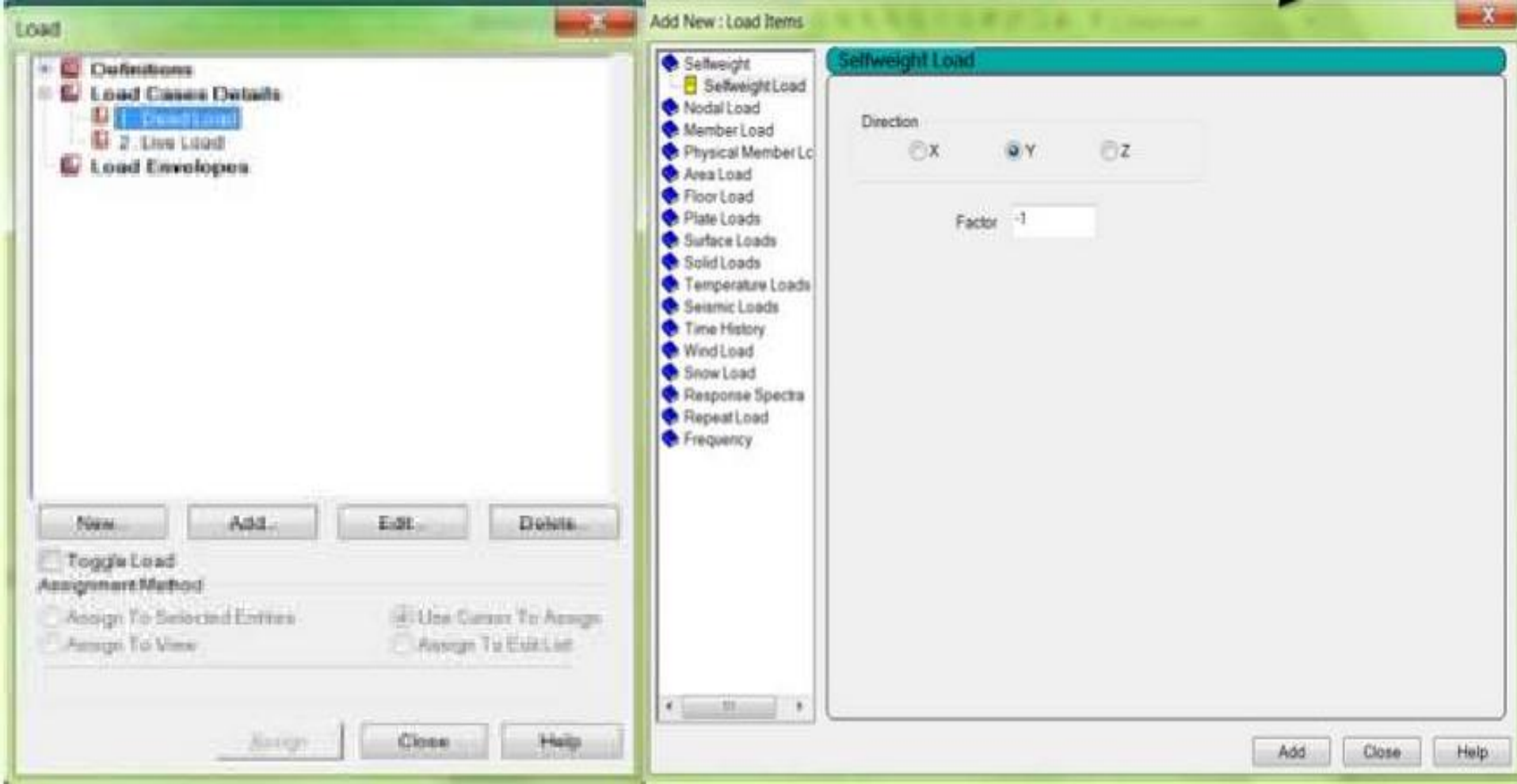
# SUPPORTS



1. There are three types of supports provided to a structure
  - Fixed support
  - Pinned support
  - Roller support
2. There are options provided in Staad for pinned and fixed supports while roller support has to be created by releasing the  $F_x$  and  $M_z$  components using fixed but.

# ASSIGNING LOADS

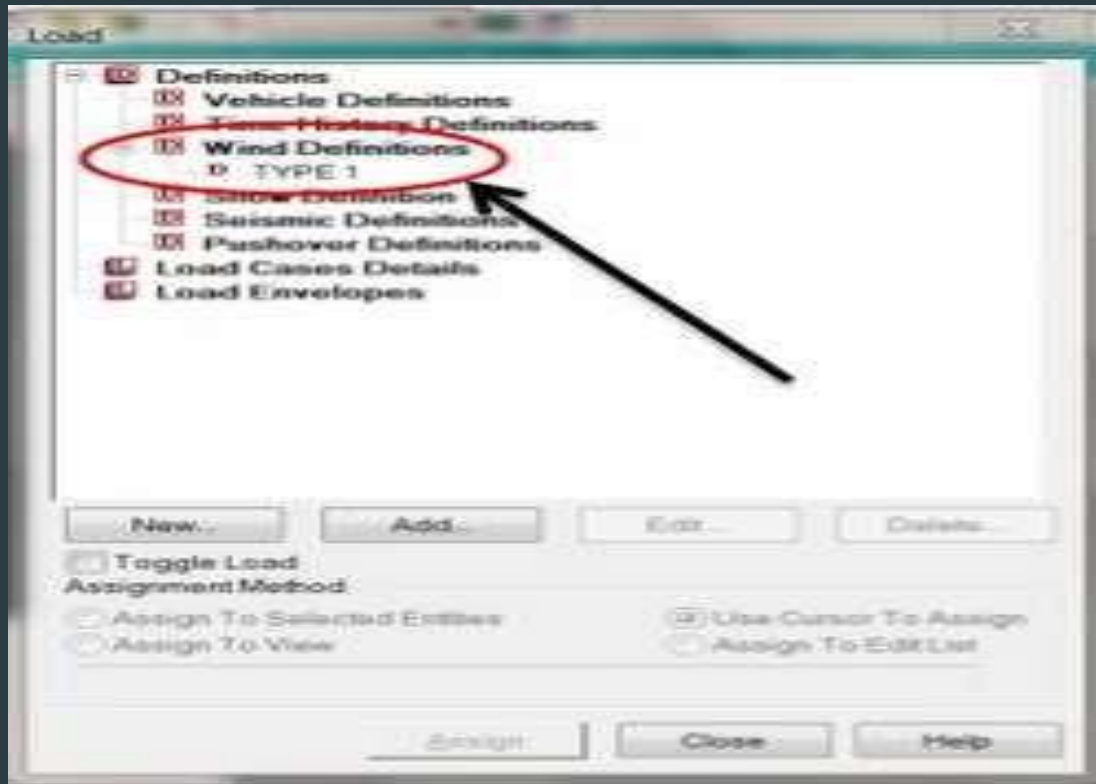
- Any structure is subjected to basically these types of loads-
  1. Dead load
  2. Live Load
- Dead load includes the self weight of the structure while live load consists of superimposed load.
- In addition to a structure is also subjected to wind and seismic or earthquake forces
- While designing a structure subjected to wind and earthquake forces we also have to provide definitions along with various load cases



- After creating various load cases we have to assign them to the structure. For this we have to first select that part of the structure on which load has to be assigned and then assign it to that part

# Continued...

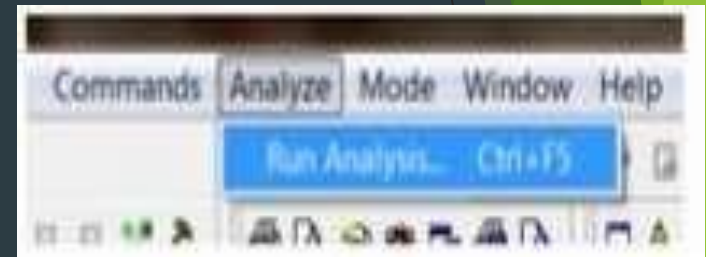
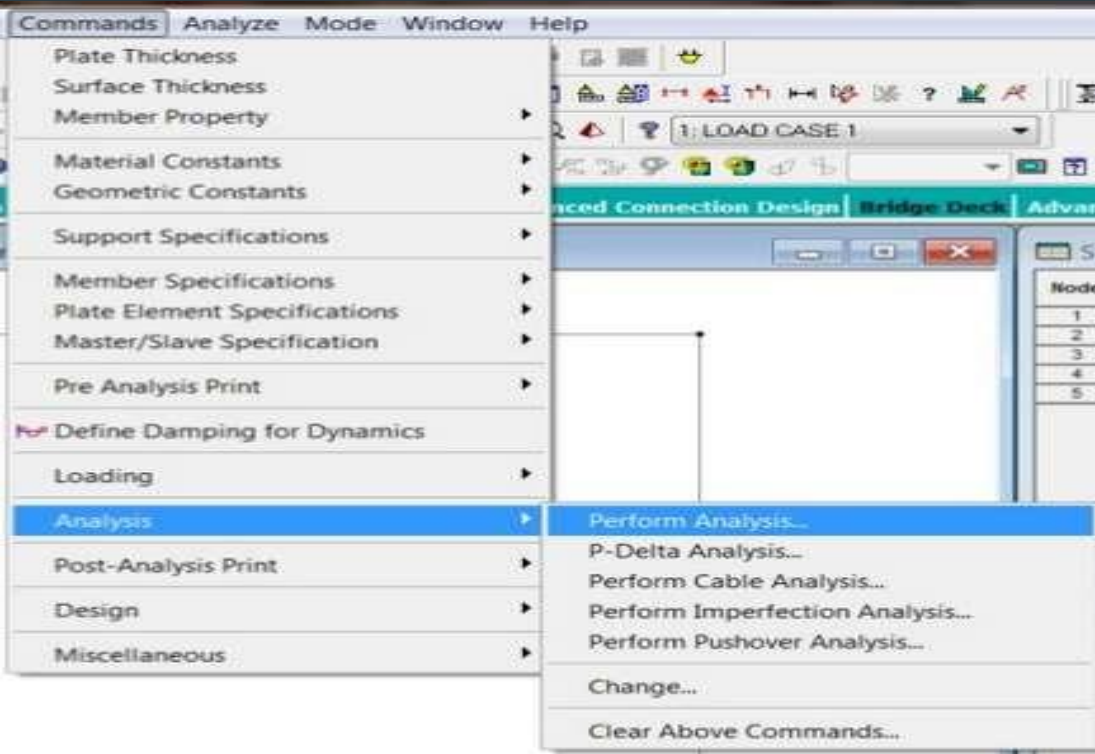
- In case of structures subjected to wind and earthquake forces wind and seismic definitions need to be provided.



- After providing these definitions only the load cases should be entered.

# ANALYSIS

- After all the above stated steps a structure has to be analyzed.
- Analysis of a structure means to find out the reactions and displacements and deflections at various nodes of a structure.
- After analysis we are able to see shear moment and deflection for each member.



After performing analysis another window which contains a report of analysis gets opened . This window shows the warnings and errors which might have occurred.



The screenshot shows the STAAD Analysis and Design software interface. The main window displays the output of an analysis run. The title bar reads "STAAD Analysis and Design". The window content shows the following text:

```
Free Disk Space: 73823362 KB
Input File: Structural.std

++ Processing Joint Coordinates. 1 5 1
++ Processing Member Information.
++ Reading Member Properties 1 5 1
++ Finished Reading Member Properties ... 0 sec
++ Processing Support Condition 1 5 1
++ Read/Check Data in Load Cases 1 5 1
++ Processing and setting up Load Vector. 1 5 1
++ Processing Element Stiffness Matrix. 1 5 1
++ Processing Global Stiffness Matrix. 1 5 1
++ Finished Processing Global Stiffness Matrix. 0 sec
++ Processing Triangular Factorization 1 5 1
++ Finished Triangular Factorization. 0 sec
++ Calculating Joint Displacements. 1 5 1
++ Finished Joint Displacement Calculation. 0 sec
++ Calculating Member Forces 1 5 1
++ Analysis Successfully Completed ++
++ Creating Displacement File (DSP)... 1 5 1
++ Creating Reaction File (REA)...
++ Calculating Section Forces
++ Creating Section Force File (EMD)
++ Creating Section Displace File (SCH)... 1 5 1
++ Done..

0 Error(s). 0 Warning(s)

++ End STAAD.Pro Run Elapsed Time = 0 Secs
++ Output Written to File:
Structural.out

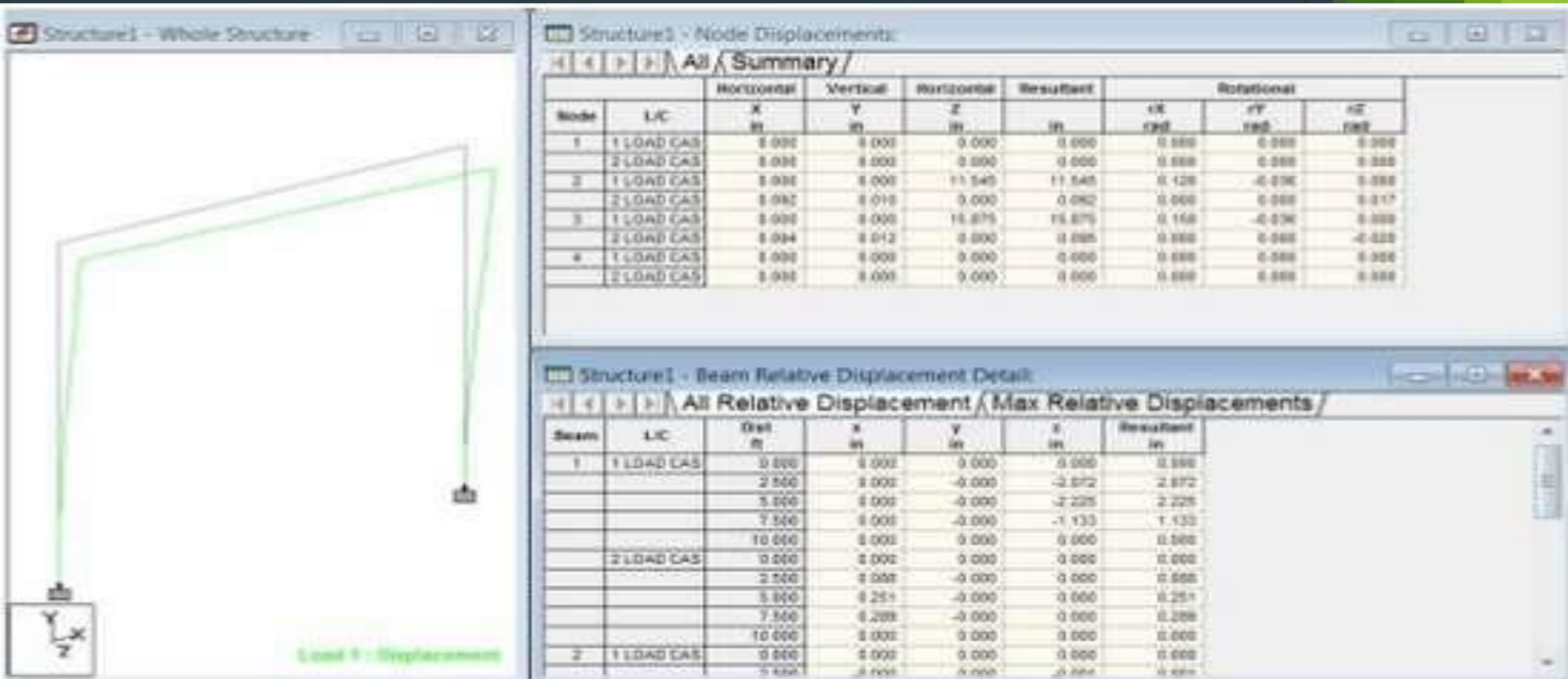
 View Output File
 Go to Post Processing Mode
 Stay in Modeling Mode
```

At the bottom right of the window, there is a "Done" button.



# Continued...

- In the post processing mode we are able to see the reactions, displacements, deflections, shear force and bending moments for various members



# DESIGN

- After analysis a structure has to be designed to carry loads acting on it considering a certain factor of safety .
- In India structures are designed by using various Indian codes for both concrete and steel structures.
- The design in STAAD.Pro supports over 70 international codes and over 20 U.S. codes in 7 languages.
- After designing the structure it is again analyzed and results of analysis for each beam and column is shown in the output file



# STATEMENT OF THE PROJECT

- 1. Utility of building : Residential building
- 2. No of storeys : G+4
- 3. No. of staircases : 5 no's
- 4. Shape of the building : rectangular
- 5. Type of construction : R.C.C framed structure
- 5. Type of walls : brick wall

# Geometric details:

- Ground floor :3.0M
- Floor height :3.0M
- Height of plinth :1.5M from below foundation
- 
- Depth of foundation :500MM

# Material details:

- Concrete Grade : M25
- All steel grade : Fe500 grade
- Type of steel bars : HYSD
- Bearing capacity of Soil : >180 KN/M2

# DIFFERENT TYPES OF LOADS ON THE STRUCTURES

- Dead loads
- Imposed loads
- Wind loads

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- Dead loads
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# Dead loads

- Involves self weight of
  - RCCslab
  - Beams & columns
  - Plinth
  - Walls

# Imposed loads

- Imposed also known live loads
- Loads over the floor i.e. Load of persons it is calculated as  $1 \text{ KN/m}^2$
- This load is applied over the length of structure

# Wind loads

- Wind is air in motion
- Wind loads are calculated according to IS:875(part 3)
- Intensity of wind and exposure are applied in the direction as required



# Load combinations

- The structures should be analysed for combination of loads as in practice we have numbers of loads in various directions act
- Some of the combinations to be checked are
- $1.5(DL+LL)$
- $1.5(DL+WL)$
- $1.5(DL+LL+WL)$

# OBJECTIVES OF STRUCTURAL DESIGN

- Structure designed should satisfy the criterion of ultimate strength.
- Structures should satisfy the serviceability
- It should satisfy the stability against overturning, sliding, and buckling

# The main objective of the design

are

- Foundation design
- Column design
- Beam design
- Slab design

# DESIGN PRINCIPLE, ASSUMPTION AND NOTATION ASSUMED

- ← The notation adopted through out the work is same as in IS456-2000
- ← Using partial safety factors for loads in accordance with clause 36.4 of IS456-2000
- ← Partial safety factor for material in accordance with clause 36.4.2 IS456-2000 is taken as 1.5 for concrete and 1.15 for steel
- ← Using partial safety factors in accordance with clause
- ▶ 36.4 of IS456-2000 combination of load
  - ▶ (D.L+LL) 1.5
  - ▶ (D.L+LL+WL) 1.2

# Density of materials

used

MATERIAL	Density
1.Plain concrete	24.0 kn /m <sup>3</sup>
2.Reinforced	25.0 k/m <sup>3</sup>
3.Flooring material(c.m)	20.0kn/m <sup>3</sup>
4.Brick masonry	19.0kn/m <sup>3</sup>
5.Fly ash	5.0kn/m <sup>3</sup>

LIVE LOADS: In accordance with IS875-86

1.Live load on slab	=3.0kn/m <sup>3</sup>
2.Live load on passage	=3.0kn/m <sup>3</sup>
3.Live load on stair	=3.0kn/m <sup>3</sup>

# Structural design

- For slab, depth is 125 mm provided.
- For beams, after calculations are done . the dimensions of beam is 230\*530mm factored load on beam is 15.87kn/m

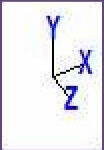
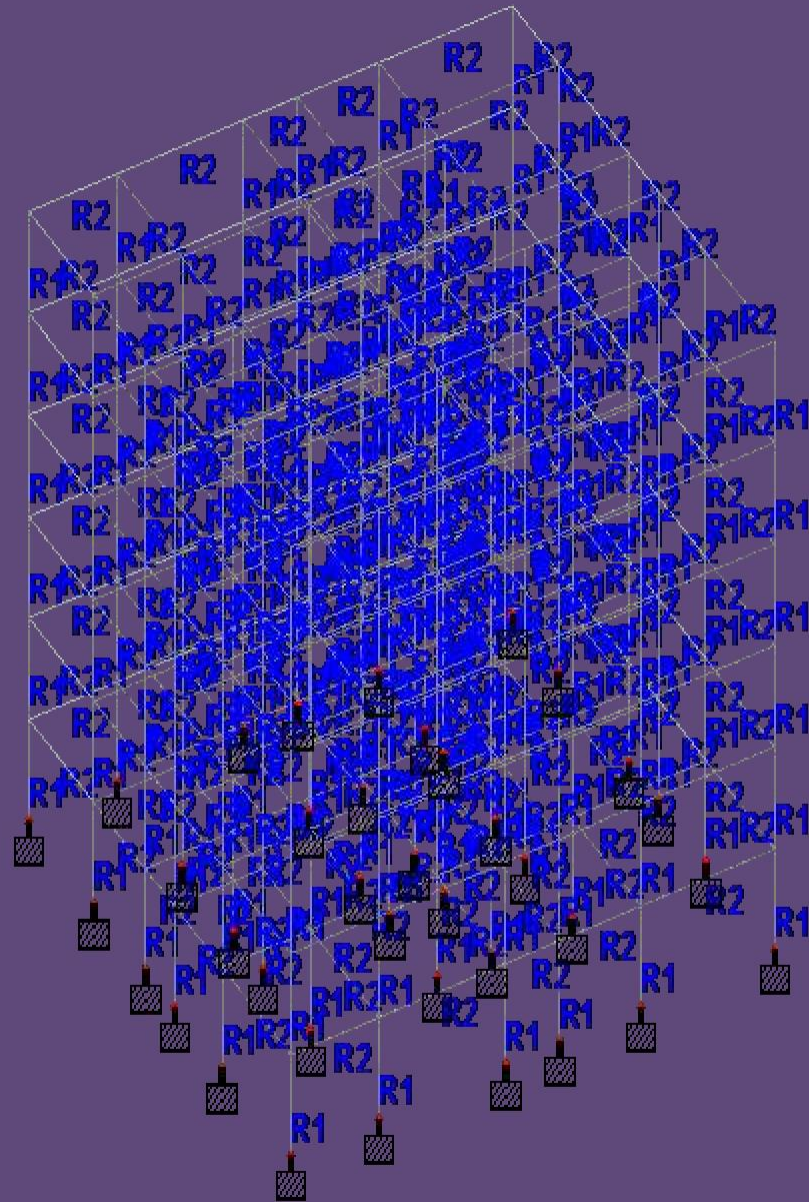
- Shape of column is rectangular
- For columns, the dimension of column is 300\*600mm
- Factored load on column 1090.10kn
- For footings, the bearing capacity of soil is 175kn/m<sup>2</sup>
- To provide the dimensions of footing is 12.5m\*2.7m

# ANALYSIS

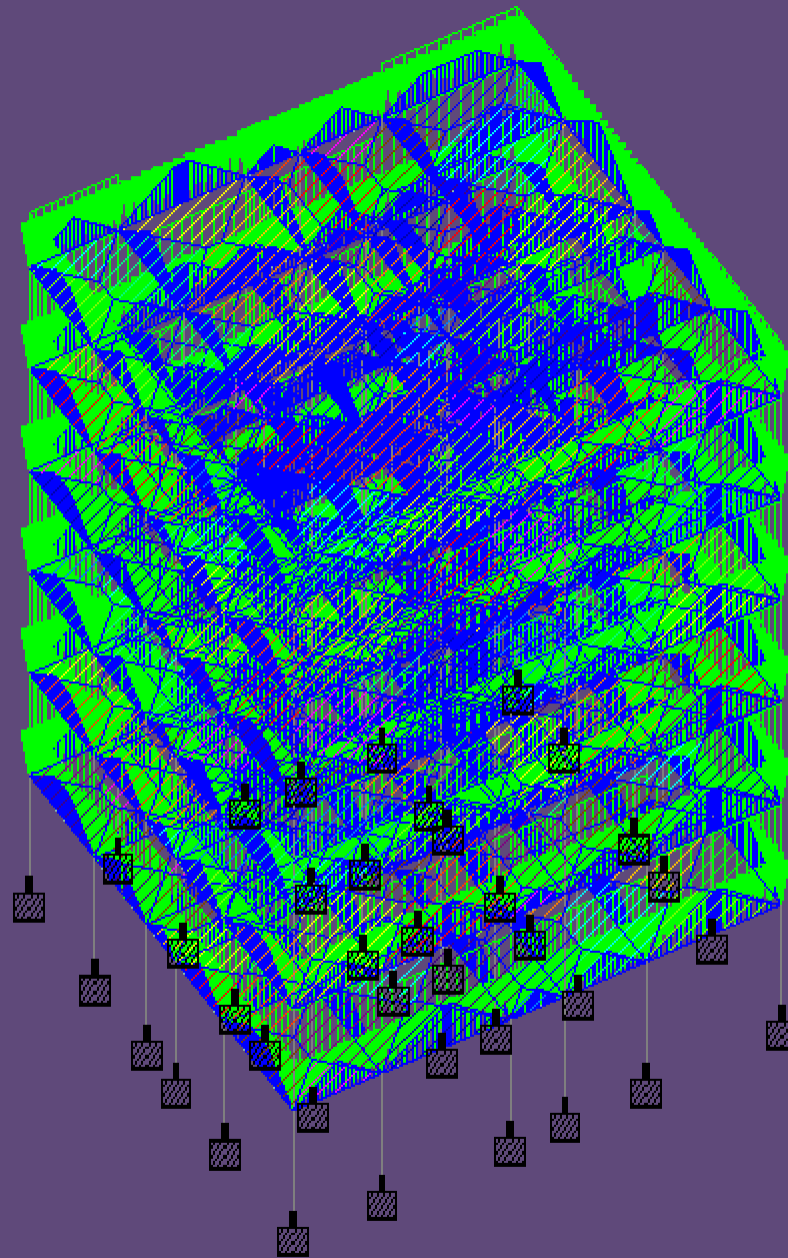
- Analysis is done using STAD PRO developed by BENTLEY
- Once the loads and load combinations are assigned to the structures, analysis is to be done
- Analysis is done for RCC structure



Assign the properties  
of structures



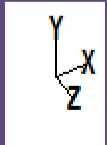
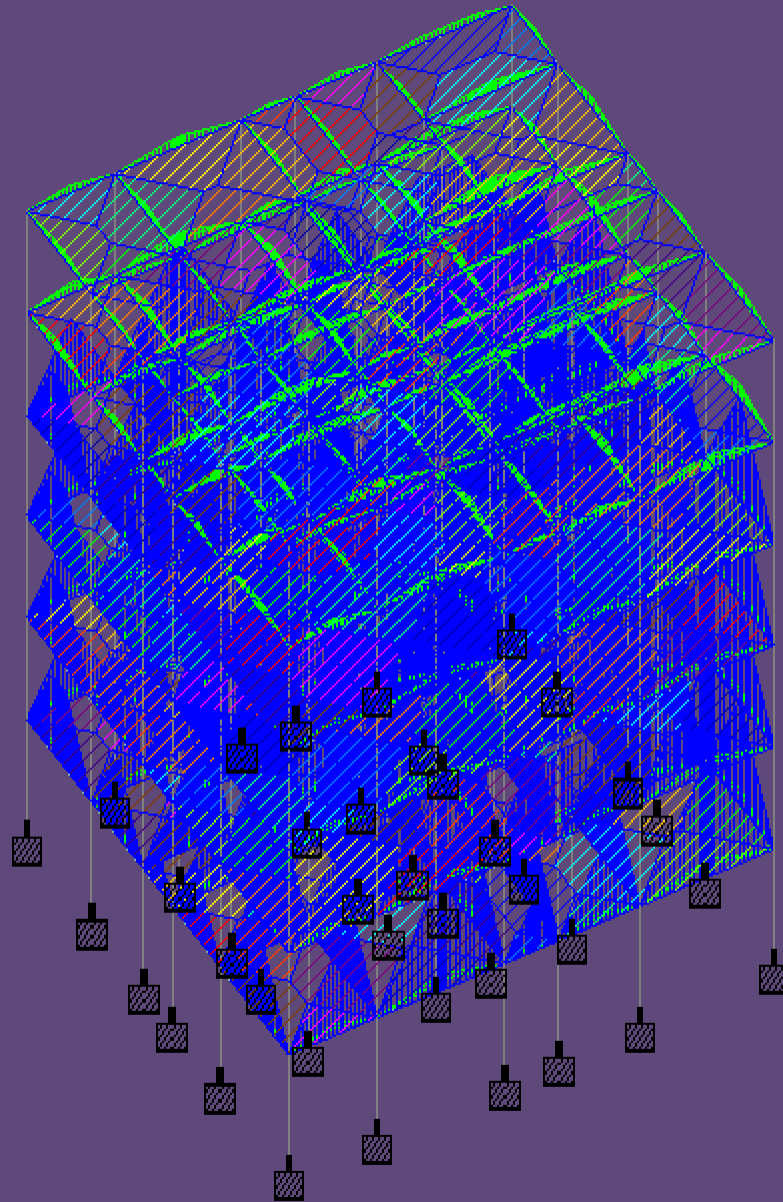
# ASSIGN LOADS ON THE SLAB



Load1

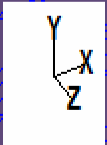
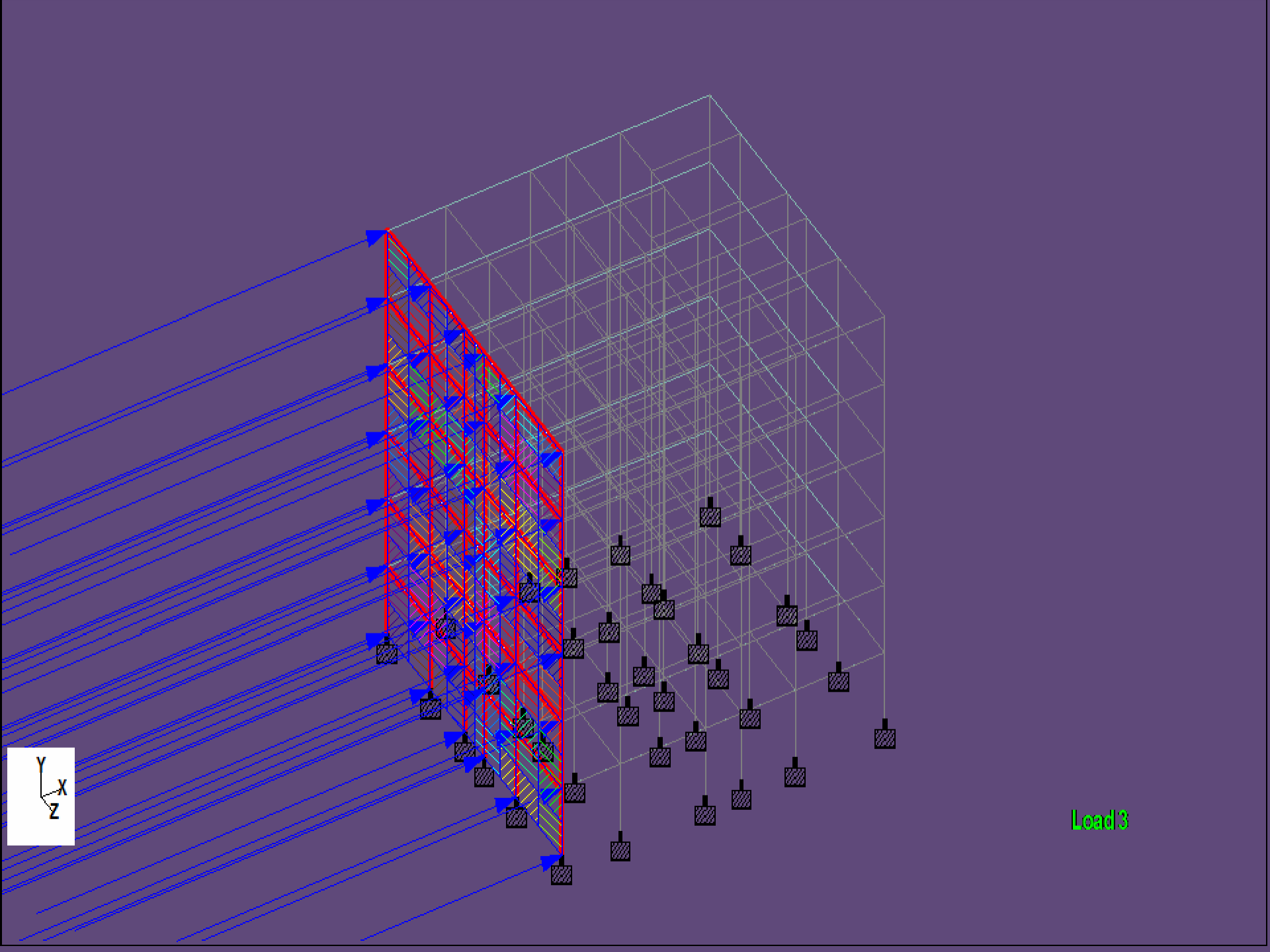


# LOAD ASSIGN ON THE WALLS



Load/2

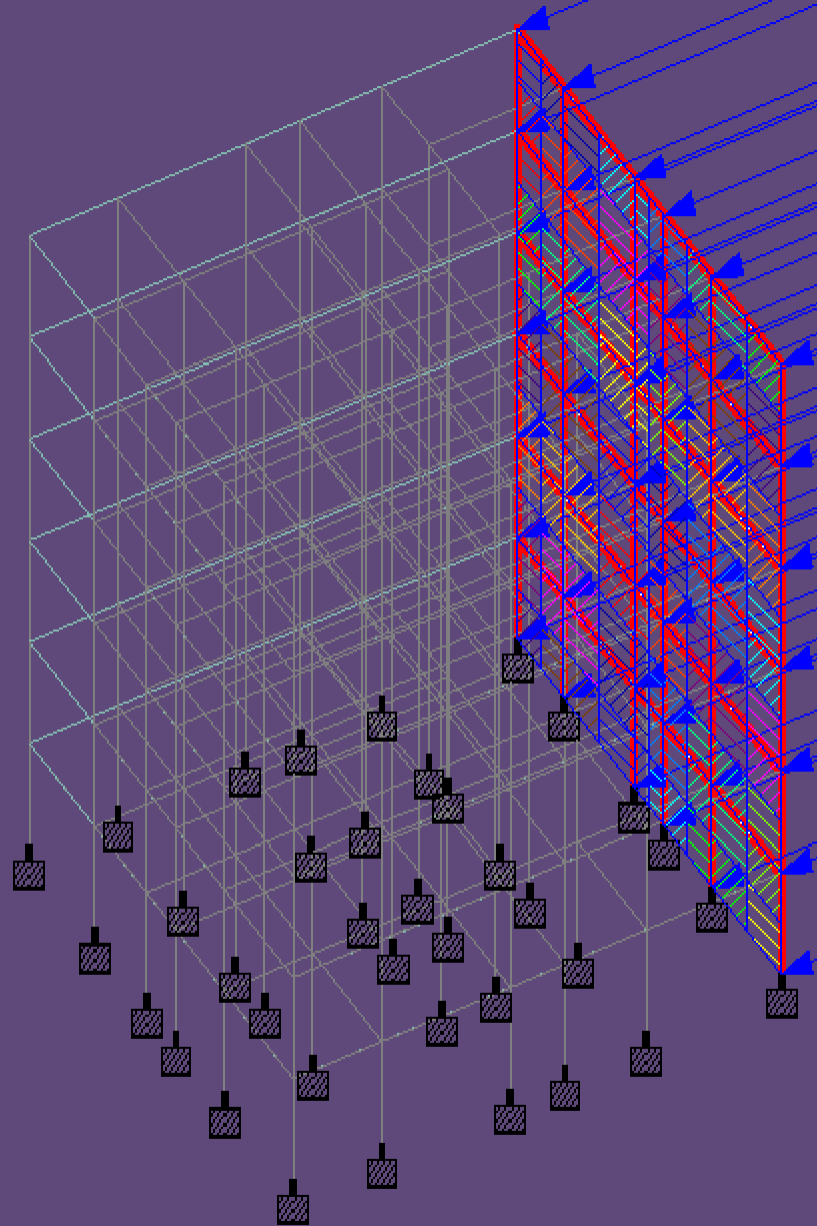
ASSIGN WIND LOAD ON  
THE STRUCTURES  
(X+VE DIRECTION)



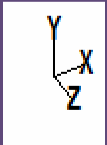
Load3



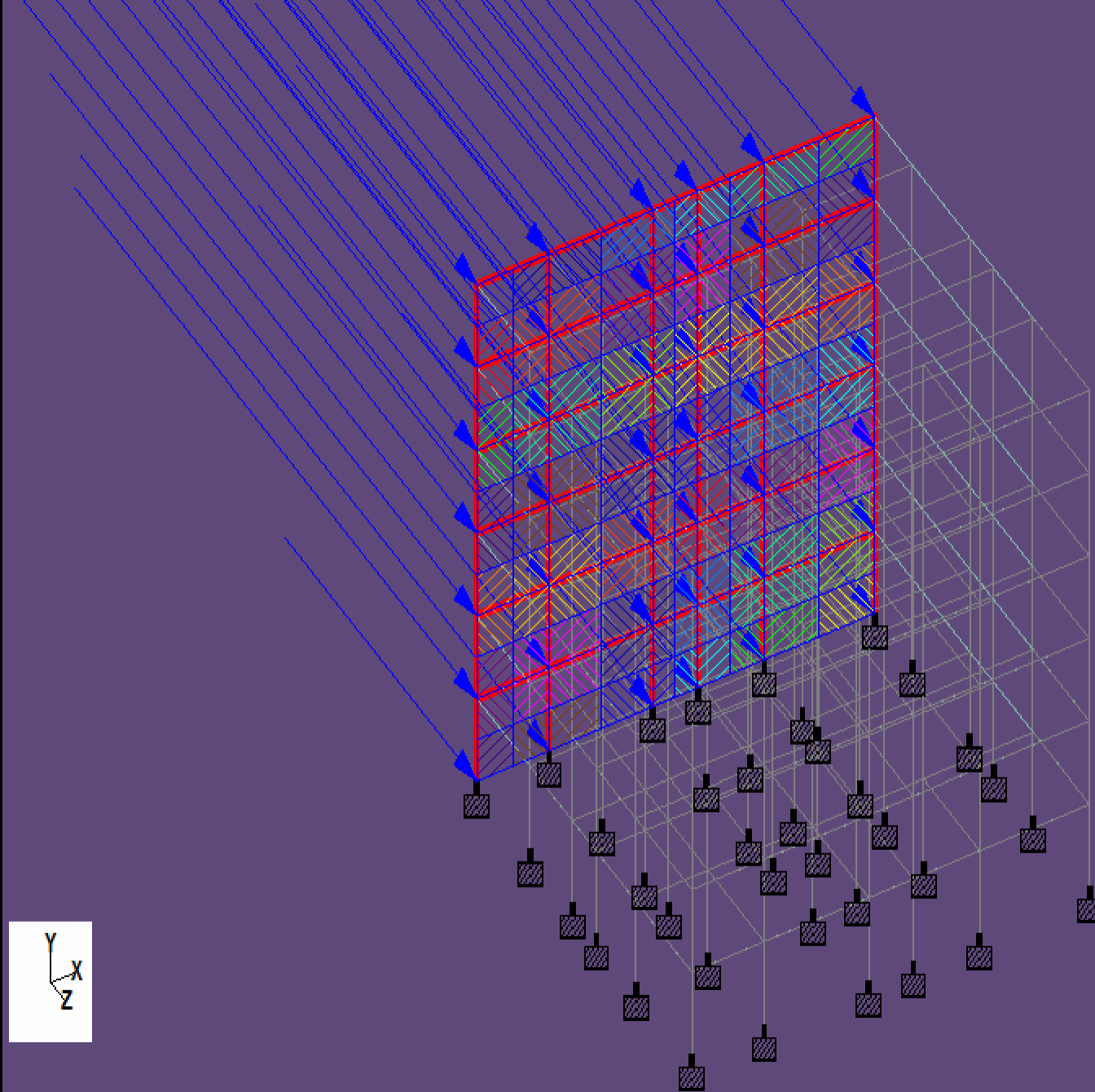
# ASSIGN WIND LOAD ON THE STRUCTURES (X-VE DIRECTION)



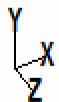
Load4



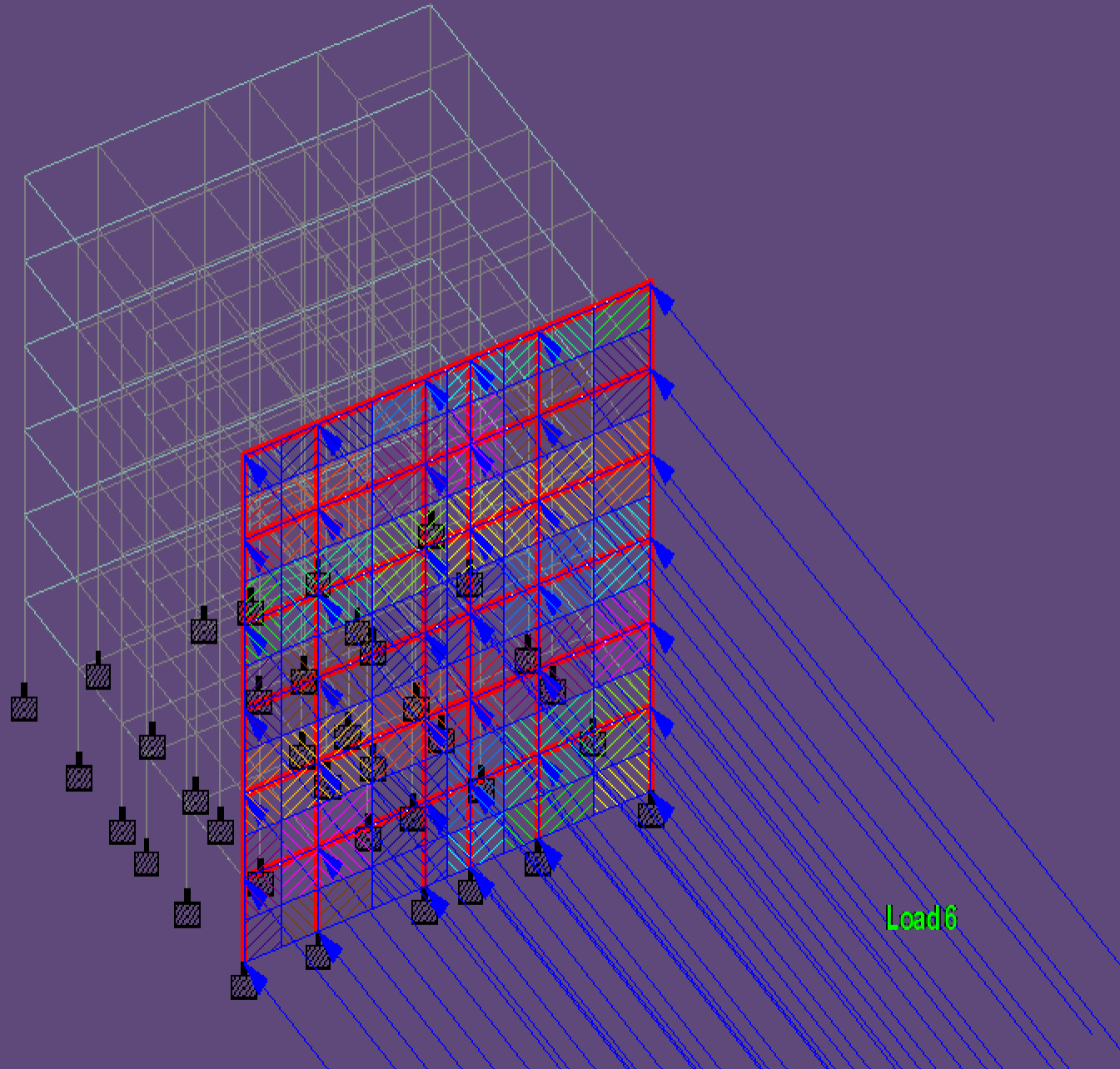
ASSIGN WIND LOAD ON  
THE STRUCTURES  
(Z +VE DIRECTION)



Load5



ASSIGN WIND LOAD ON  
THE STRUCTURES  
(Z-VE DIRECTION)



Load 6



# CONCLUSIONS:

- The design of slab, beam, column, rectangular footing and staircase are done in limit state method which is safe at control of deflection and in all aspects
- Using staad.pro software, the design consideration has been taken as per the is codes. The design is safe in all conditions
- On comparison with drawing, manual design and the geometrical model using staad.pro the area of AST required for the beam, column, footing and slab are comparatively similar to that of the requirement

# ADVANTAGES OF STAAD.Pro

Following are the advantages of STAAD.Pro

1. Covers all aspects of structural engineering
2. Broad spectra of design codes
3. International codes
4. Quality assurance
5. Reports and documentation



## Firms

- Structural engineering
- Structural consultant
- Multi-discipline E/A and A/E
- Departments in construction companies, owner/operators, and government agencies

# CONCLUSION

- Staad pro is widely used by most of the organization for their construction needs.
- Unfortunately, well skilled staad pro engineers are very hard to search.
- If we believe in the prediction of the industry experts then those students who will be getting trained on staad pro in the current and upcoming two years will have bright and successful career ahead in the real estate and construction domain
- By attending this training in STAAD.Pro we were able to learn various features of STAAD.Pro which will be very helpful in the near future





**Thank you**