

# Structural Design with Softwares

**Prepared by  
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(Only for Educational Purpose)**

# CLASSICAL METHODS OF STRUCTURAL ANALYSIS

- Moments Distribution Method
- Slope Deflection Method
- Matrix Method
- FEM Approach



## **BASIC SOFTWARES for ANALYSIS**

- **STAAD Pro (A FINITE ELEMENT PACKAGE)**
- **ETABS (A FINITE ELEMENT PACKAGE)**
- **SAP (A FINITE ELEMENT PACKAGE)**
- **AUTO CAD for drawing purpose**

# STAAD PRO

- STAAD Pro is a commercial software used for Analysis and Design of Structures. STAAD Pro was developed for practicing engineers
- Generally CONCRETE Structure & STEEL Structures are analyzed and designed with STAAD Pro.
- It is good and user friendly for linear structures.
- 2D/3D Static Analysis
- Dynamic/Seismic Analysis
- Secondary Analysis



# ETABS

- ❖ Linear Static Analysis
- ❖ Modal Analysis
- ❖ Eigenvector Analysis
- ❖ Ritz-Vector Analysis
- ❖ Response Spectrum Analysis
- ❖ Time History Analysis
- ❖ Nonlinear Time History
- ❖ Initial P-Delta Analysis
- ❖ Nonlinear Static Analysis

# SAP

SAP is a general purpose finite element analysis program for structural analysis. The program can analyze structures that are subject to either static or dynamic loads. The structures can be described in terms of truss, frame, plate, shell, or brick elements or combinations of elements.

- ❖ NON LINEARITY (EITHER MATERIAL OR GEOMETRIC)
- ❖ DYNAMIC ANALYSIS FOR EARTHQUAKE LOAD
- ❖ P-DELTA ANALYSIS,PUSH OVER ANALYSIS



# Steps for design

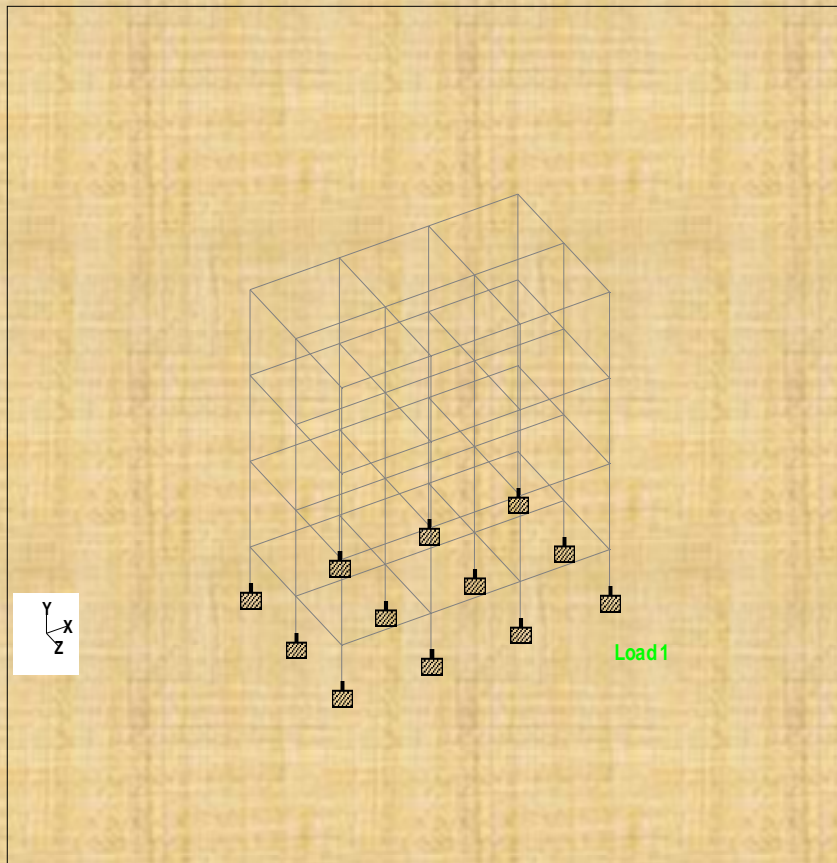
- Basic Geometry Generation
- Basic/Primary Load Case Generation As per IS:875 (part-II,III,IV) IS:1893(Part-I,IV),IS:800(2007/1984)
- Load Combination Generation as per IS:875(Part-V)(1987)
- Analysis of Structure as per Matrix Method of Analysis with Finite Element Method.
- Design of structure with proper Design Command

# Basic Geometry Generation

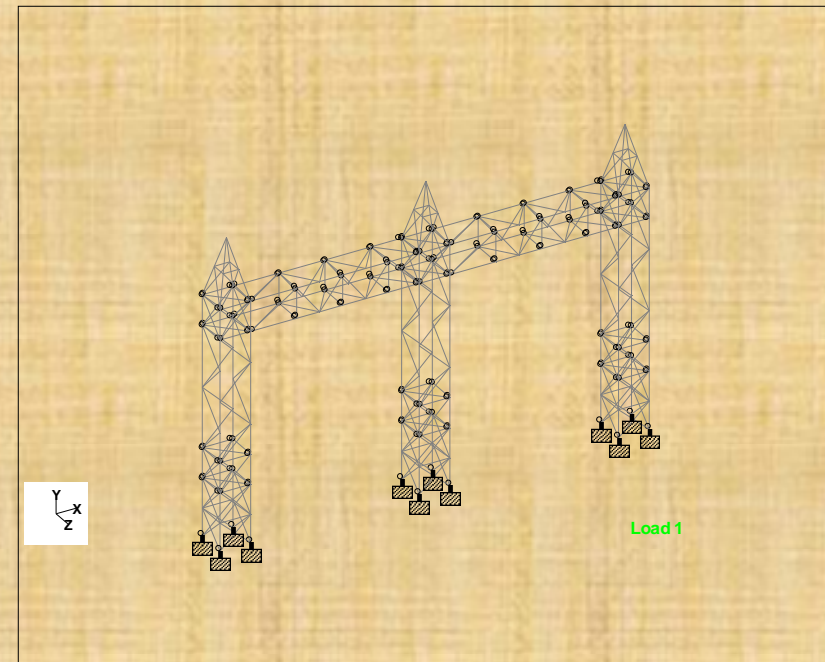
- ❖ NODE GENERATION
- ❖ NODAL CONNECTIVITY GENERATION
- ❖ BEAM/TRUSS/MEMBER SPECIFICATION
- ❖ ELASTIC PROPERTIES, MATERIAL CONSTANTS
- ❖ PLATE ASSIGNMENT (IF ANY)
- ❖ PROPER SUPPORT (BOUNDARY CONDITION) ASSIGNMENT
- ❖ ELEMENTAL STIFFNESS MATRIX
- ❖ GLOBAL STIFFNESS MATRIX



# STAAD Pro

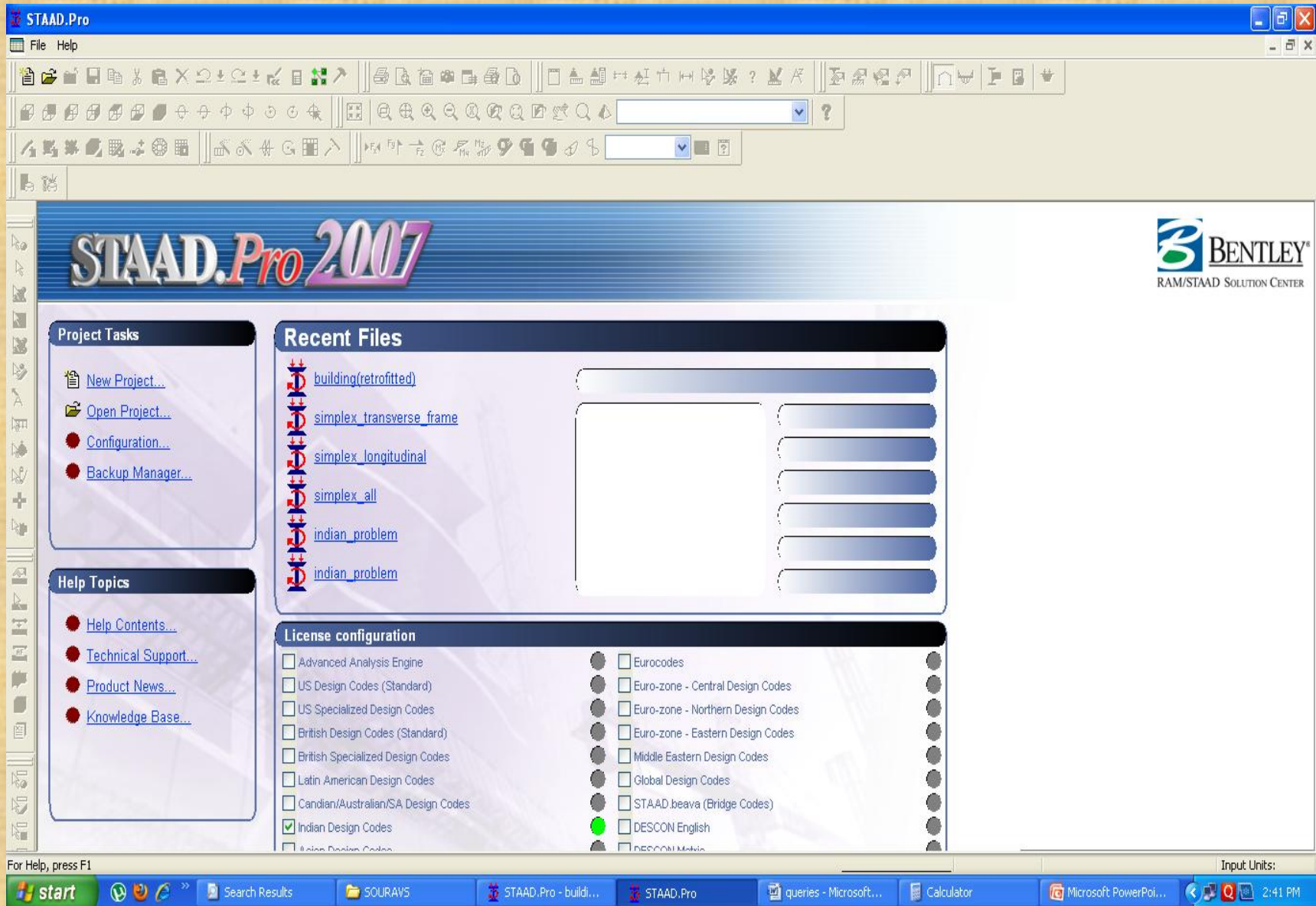


A TYPICAL RCC  
FRAMED STRUCTURE



A TYPICAL STEEL TRUSS  
STRUCTURE

# 1) Create New file or open a previous file





## 2) Create Nodes

STAAD.Pro - building(retrofitted)

File Edit View Tools Select Geometry Commands Analyze Mode Window Help

4: DEAD LOAD

Modeling Postprocessing Steel Design Concrete Design RAM Connection Bridge Deck Advanced Slab Design Piping

building(retrofitted) - <Untitled 1>

Geometry

Node

X m Y m Z m

13687	2.800	1.200	13.375
13728	5.425	1.200	13.375
13762	5.425	1.200	23.825
13803	-0.800	5.500	13.375
13805	2.800	5.500	13.375
13807	5.425	5.500	13.375
13817	5.425	5.500	23.825
13826	-0.800	8.500	13.375
13828	2.800	8.500	13.375
13830	5.425	8.500	13.375
13840	5.425	8.500	23.825
13847	-0.800	11.500	13.375

building(retrofitted) - Beams

Beam	Node A	Node B	Property Refn.
12520	13687	13805	3
12618	13728	13807	3
12697	13762	13817	3
12833	13803	14746	2
12834	13803	13805	2
12836	13805	14744	2
12837	13805	13807	2
12849	13817	14779	2
12851	13817	14783	2
12875	13805	13828	3
12877	13807	13830	3

Load 4

For Help, press F1

Modeling Mode Load 4: DEAD LOAD Input Units: KN-m

start Search Results SOURAVS STAAD.Pro - b... STAAD.Pro queries - Micro... Calculator Microsoft Powe... 1 - Paint 2:46 PM

### 3) Add Beams or Plates etc

The screenshot displays the STAAD.Pro software interface for a building model named 'building(retrofitted)'. The main window shows a structural frame with beams and columns, all labeled 'R2'. A coordinate system (X, Y, Z) is visible in the bottom left corner. The right-hand side features a 'building(retrofitted) - Beams' panel with a table of beam properties and an 'Assignment Method' section.

Ref	Section	Material
1	Rect 0.40x0.25	CONCRETE
2	Rect 0.35x0.25	CONCRETE
3	Rect 0.55x0.40	CONCRETE
4	Rect 0.40x0.25	CONCRETE
5	ISMB300	STEEL
6	ISMB150	STEEL
7	ISMB250	STEEL
8	Taper	STEEL

Assignment Method:

- ☐ Assign To Selected Beams
- ☐ Assign To Edit List
- ☒ Use Cursor To Assign
- ☐ Assign To View

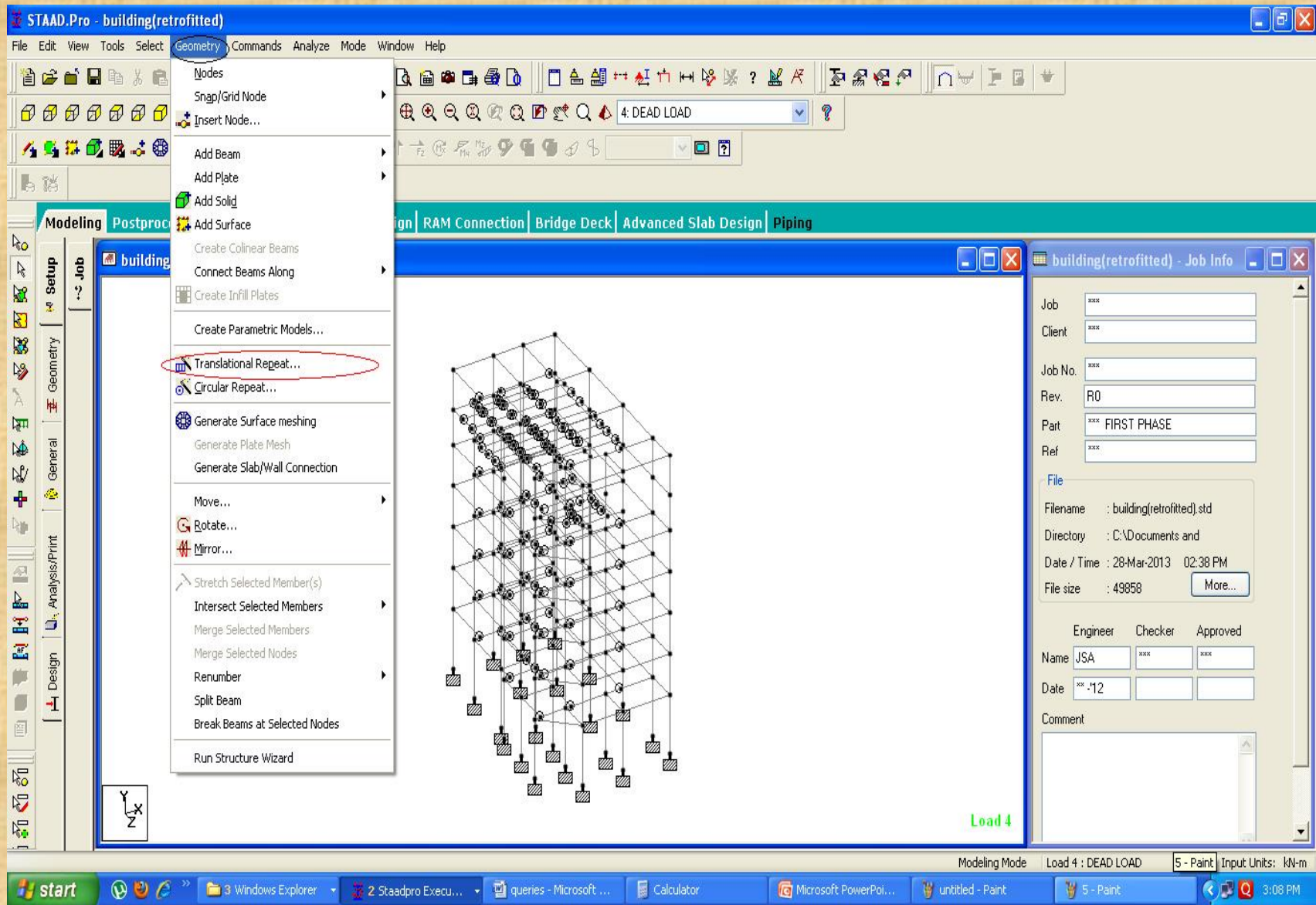
Input list: 13965 13977 13984 13991 13998 14042 14044 To 14047

Buttons: Assign, Close, Help

Bottom status bar: For Help, press F1 | Calculator | Modeling Mode | Load 4 : DEAD LOAD | Input Units: kN-m



## 4) Create whole structure



## 5) Assign Material Properties

The screenshot displays the STAAD.Pro software interface for a building model named 'building(retrofitted)'. The 'Commands' menu is open, showing the path: **Commands** > **Assign...**. The main window shows a 3D model of a building frame with nodes labeled R1 through R20. A 'DEAD LOAD' is applied to the structure. The 'Properties - Whole Structure' dialog box is open on the right, showing a list of sections and materials. The 'Section' column lists various rectangular and tapered sections, and the 'Material' column lists CONCRETE, STEEL, and TAPER. The 'Assignment Method' section shows 'Use Cursor To Assign' selected. The 'Assign' button is highlighted.

**STAAD.Pro - building(retrofitted)**

File Edit View Tools Select Geometry Commands Analyze Mode Window Help

Plate Thickness  
Surface Thickness  
Member Property  
Material Constants  
Geometric Constants  
Support Specifications  
Member Specifications  
Plate Element Specifications  
Master/Slave Specification  
Pre Analysis Print  
Define Damping for Dynamics  
Loading  
Analysis  
Post-Analysis Print  
Design  
Miscellaneous

Prismatic...  
Steel Table  
Aluminum Table...  
Tapered...  
User Defined Table...  
Assign...  
Clear Above Commands...

DEAD LOAD

Advanced Slab Design Piping

building(retrofitted) - Beams

Beam	Node A	Node B	Property Refn.	Mat
1				
2				
3				
4				
5				
6				
7				
8				
9				

**Properties - Whole Structure**

Section Beta Angle

Ref	Section	Material
1	Rect 0.40x0.25	CONCRETE
2	Rect 0.35x0.25	CONCRETE
3	Rect 0.55x0.40	CONCRETE
4	Rect 0.40x0.25	CONCRETE
5	ISMB300	STEEL
6	ISMB150	STEEL
7	ISMB250	STEEL
8	Taper	STEEL
9	Taper	STEEL

☒ Highlight Assigned Geometry

Edit... Delete...

Values... Section Database Define...

Materials... Thickness... User Table...

Assignment Method

☐ Assign To Selected Beams ☒ Use Cursor To Assign

☐ Assign To Edit List ☐ Assign To View

12520 12618 12697 12875 12877 12887 12932 12934 129

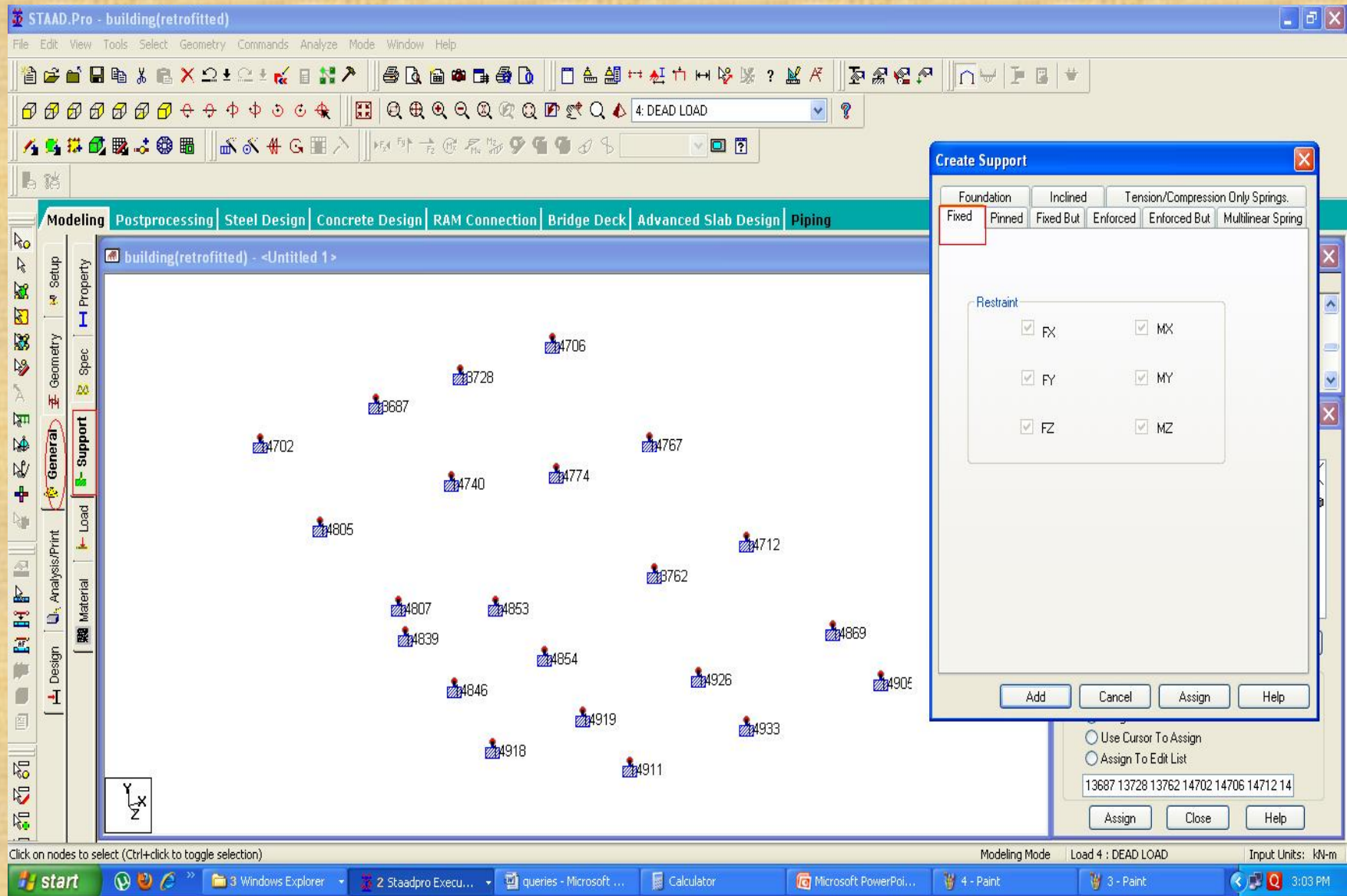
Assign Close Help

Modeling Mode Load 4 : DEAD LOAD Input Units: kN-m

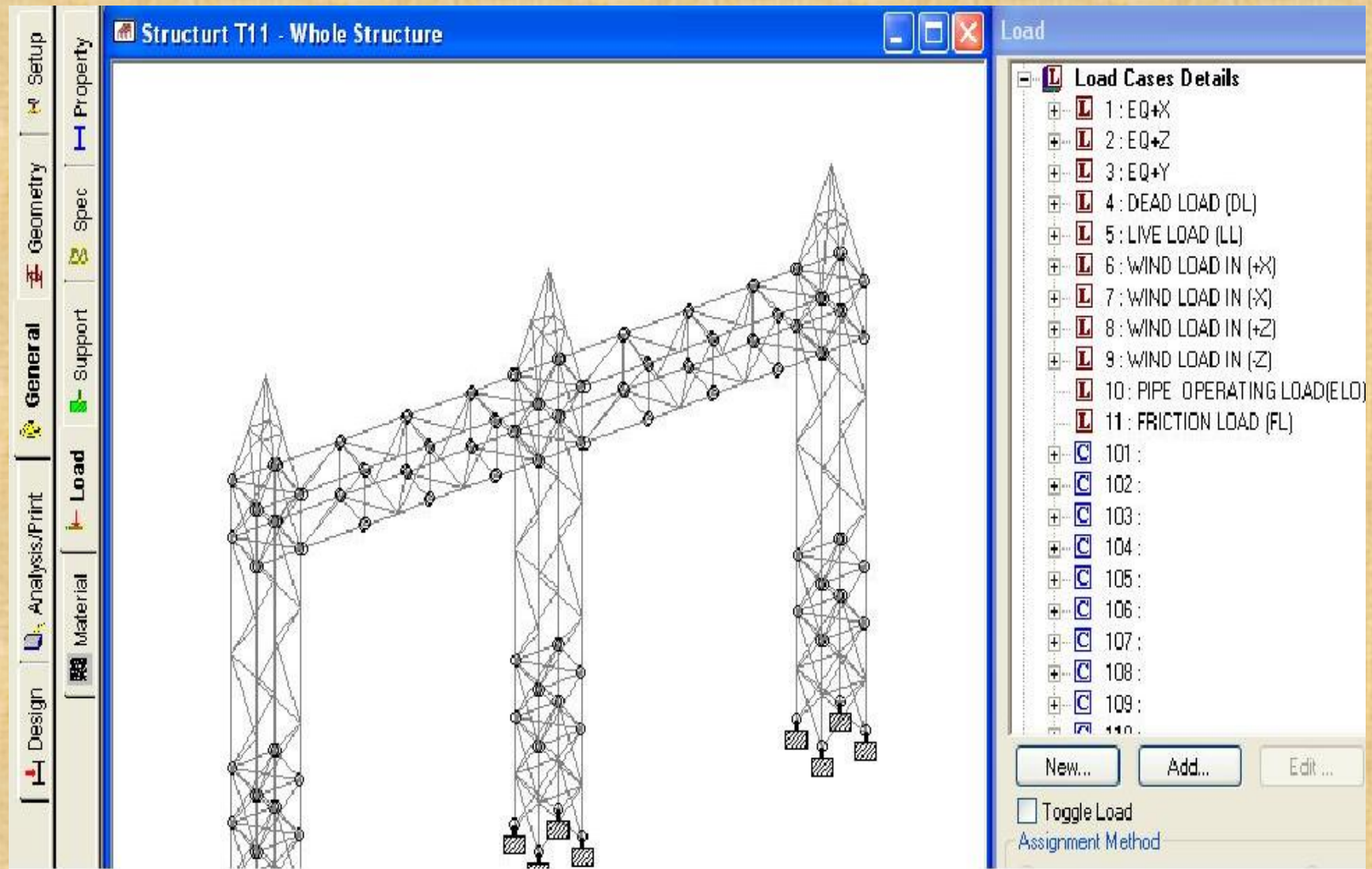
start 3 Windows Explorer 2 StAADpro Execu... queries - Microsoft ... Calculator Microsoft PowerPo... 4 - Paint 5 - Paint 3:13 PM



## 6) Add Boundary Conditions

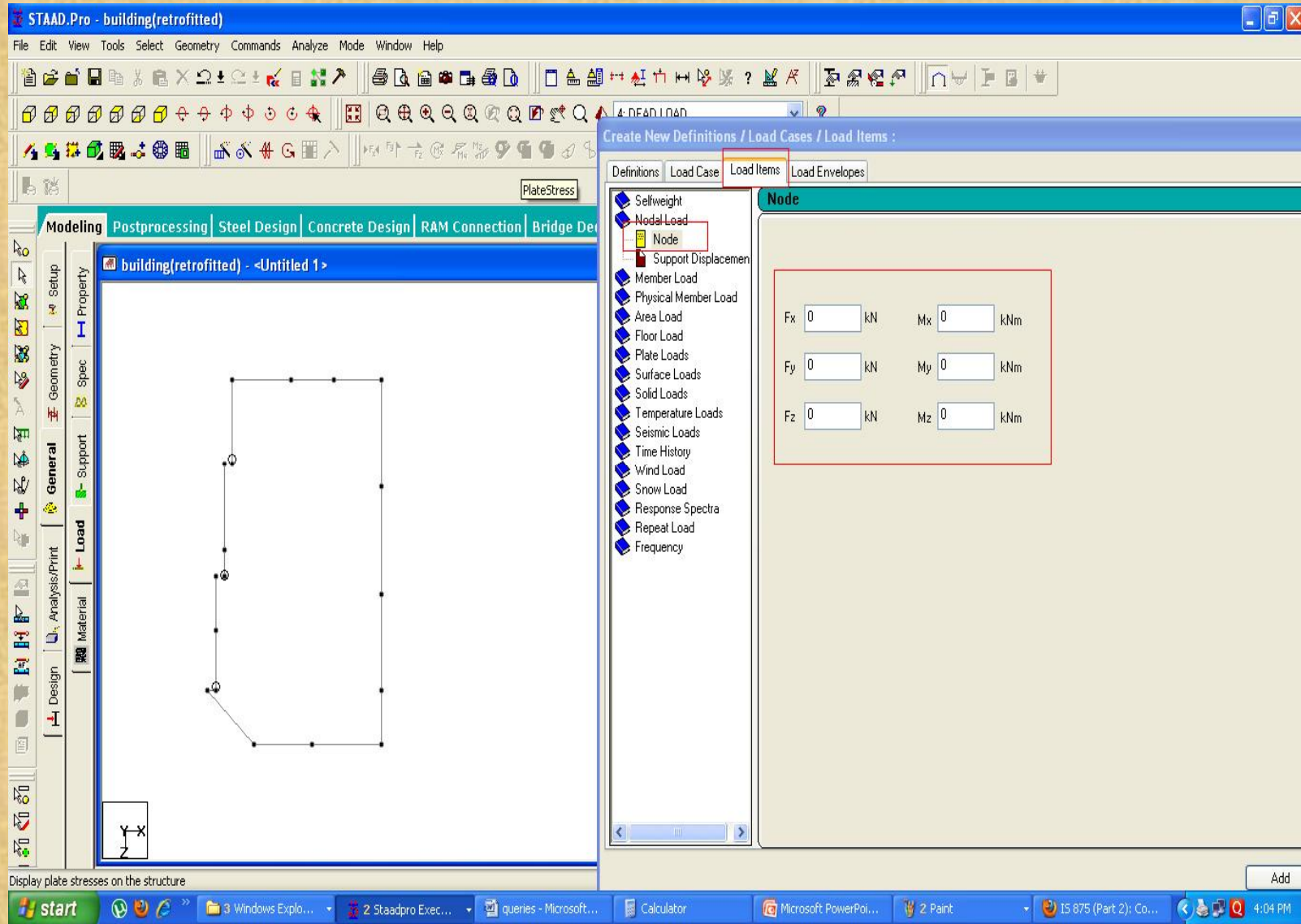


# Basic Loads and combination Generation

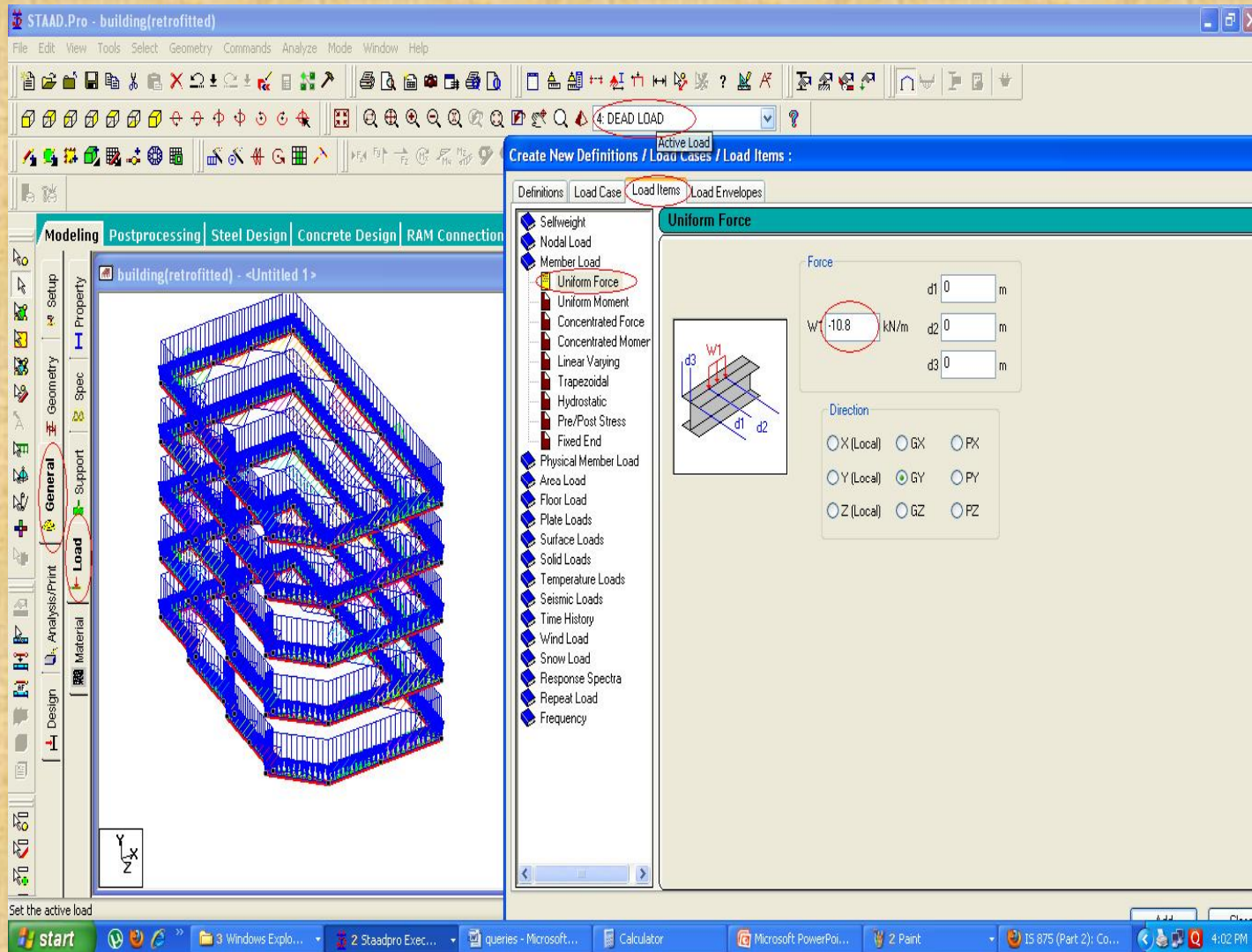




# Creation of Nodal Load

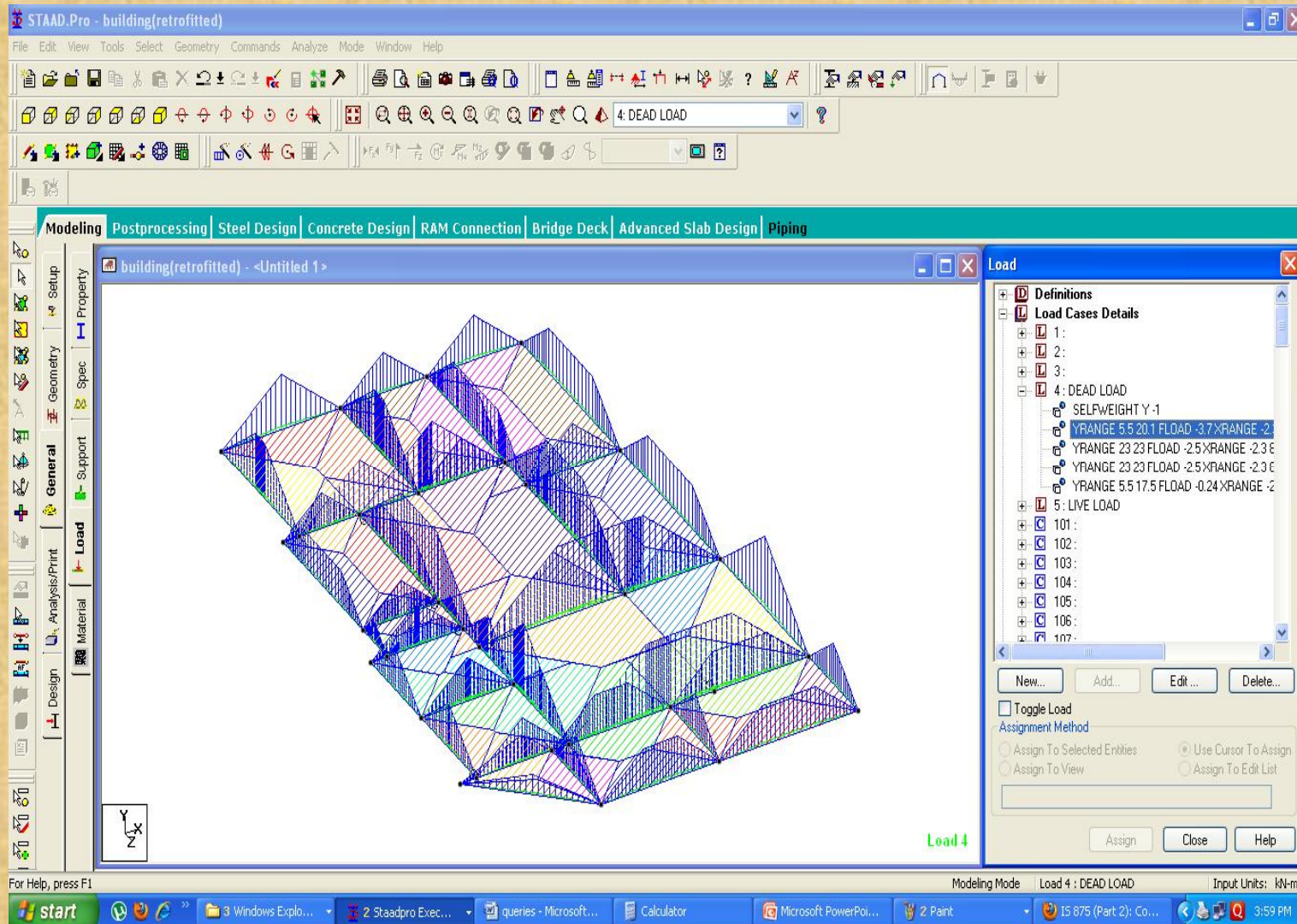


# Creation of UDL





# Creation of Floor Loads



# Creation of Load Combinations

STAAD.Pro - building(retrofitted)

File Edit View Tools Select Geometry Commands Analyze Mode Window Help

4: DEAD LOAD

Modeling Postprocessing Steel Design Concrete Design RAM Connection Bridge Deck Advanced Slab Design Piping

building(retrofitted) - Whole Structure

Load

- 101:
  - (1) x Load 4
  - (1) x Load 5
- 102:
  - (1) x Load 1
  - (0.3) x Load 2
  - (0.3) x Load 3
  - (1) x Load 4
  - (1) x Load 5
- 103:
  - (1) x Load 1
  - (-0.3) x Load 2
  - (0.3) x Load 3
  - (1) x Load 4
  - (1) x Load 5
- 104:
- 105:
- 106:
- 107:
- 108:

New... Add... Edit... Delete...

☐ Toggle Load

Assignment Method

☐ Assign To Selected Entities ☒ Use Cursor To Assign

☐ Assign To View ☐ Assign To Edit List

Assign Close Help

Load 4

for Help, press F1

Modeling Mode Load 4 : DEAD LOAD Input Units: kN-m

start 3 Windows Explo... 2 Staadpro Exec... queries - Microsoft... Calculator Microsoft PowerPoi... 11 - Paint 12 - Paint 4:12 PM



# Analysis Command of Structure

STAAD.Pro - building(retrofitted)

File Edit View Tools Select Geometry Commands Analyze Mode Window Help

Plate Thickness  
Surface Thickness  
Member Property  
Material Constants  
Geometric Constants  
Support Specifications  
Member Specifications  
Plate Element Specifications  
Master/Slave Specification  
Pre Analysis Print  
Define Damping for Dynamics  
Loading  
Analysis  
Post-Analysis Print  
Design  
Miscellaneous

Perform Analysis...  
P-Delta Analysis...  
Perform Buckling Analysis  
Perform Cable Analysis...  
Perform Imperfection Analysis...  
Perform Pushover Analysis...  
Change...  
Clear Above Commands...

Modeling Postprocessing Setup Beam Geometry Plate Solid Surf... General Analysis/Print Paramet... Design Composi... Physical

building(retrofitted) - Nodes

Node	X m	Y m	Z m
13687	2.800	1.200	13.375
13728	5.425	1.200	13.375
13762	5.425	1.200	23.825
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building(retrofitted) - Beams

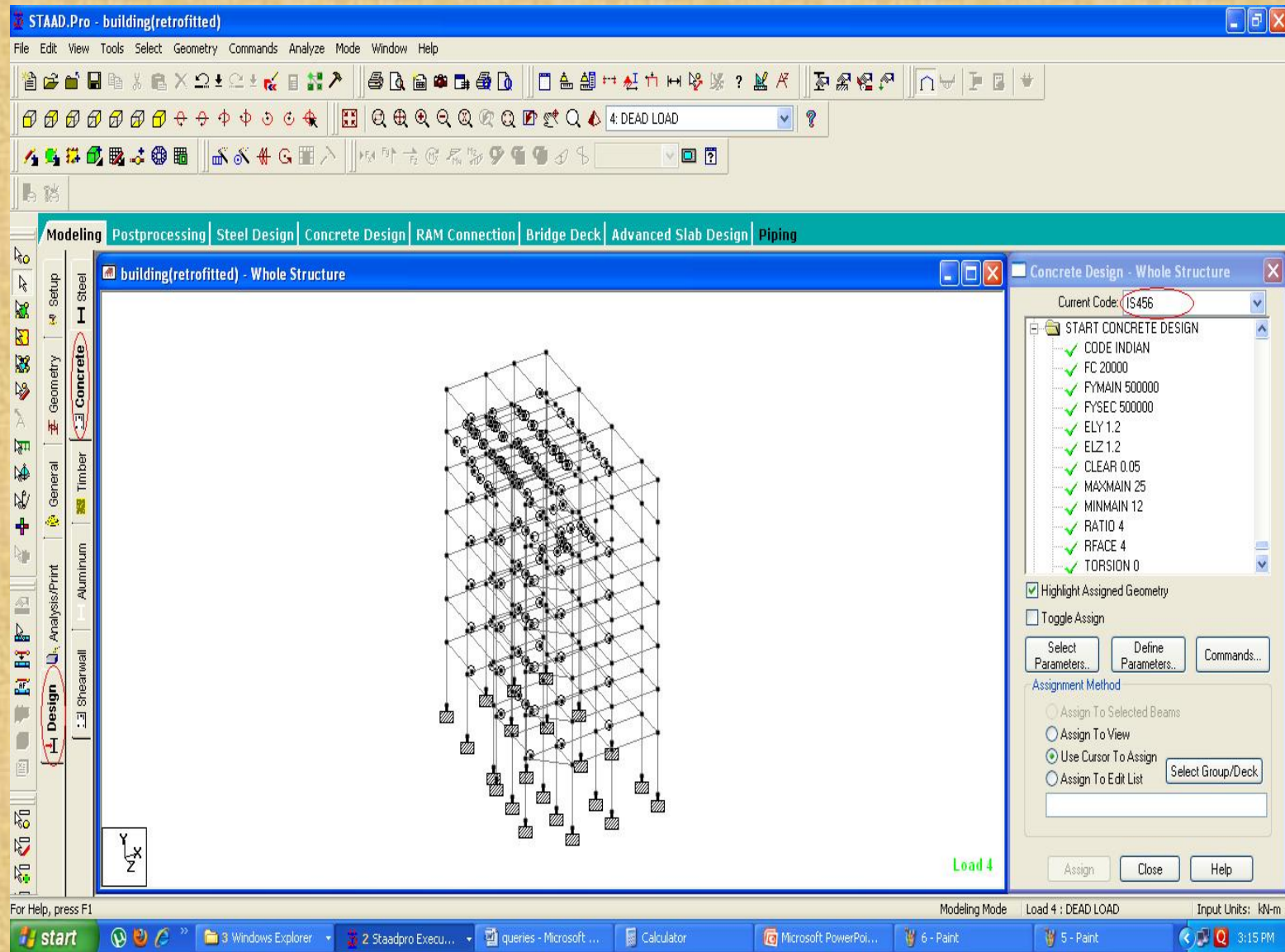
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12837	13805	13807	2
12849	13817	14779	2
12851	13817	14783	2
12875	13805	13828	3
12877	13807	13830	3

Load 4

Modeling Mode Load 4 : DEAD LOAD Input Units: kN-m

start 3 Windows Explo... 2 Staadpro Exec... queries - Microsoft... Calculator Microsoft PowerPoi... 2 Paint IS 875 (Part 2). Co... 4:08 PM

# Design with proper Design Command





# Typical Design Output File

The screenshot shows the STAAD.Pro software interface. The main window displays a 3D wireframe model of a structure. The output window, titled "indian\_problem - STAAD Output Viewer", shows the "CONCRETE DESIGN" results for a column. The results include the following data:

Column	Reinforcement	Length (mm)	Cross Section (mm x mm)	Cover (mm)
M30	Fe415 (Main)	1500.0	250.0 x 250.0	25.0

Guiding Load Case: 2 END JOINT: 1 SHORT COLUMN

REQD. STEEL AREA : 950.00 Sq.mm.  
 REQD. CONCRETE AREA: 61550.00 Sq.mm.  
 MAIN REINFORCEMENT : Provide 4 - 20 dia. (2.01%, 1256.64 Sq.mm)  
 (Equally distributed)  
 TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 250 mm

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KN8-MET)

Puz : 1126.61 Muz1 : 23.65 Muy1 : 23.65

INTERACTION RATIO: 0.95 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KN8-MET)

WORST LOAD CASE: 2  
 END JOINT: 1 Puz : 1217.91 Muz : 30.44 Muy : 30.44

Total Page : 7

**THANK YOU**