International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

SEISMIC ANALYSIS AND DESIGN OF HIGH RISED BUILDING WITH FLOATING COLUMNS BY USING STAAD.PRO

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ABSTRACT:

Standard column design is used to sustain the weight of standard high-rise structures. The troublesome transfer of weight to the foundation from these columns is a real possibility. Over time, issues including uneven foundation settlement, excessively heavy columns, and an overly stiff structure might arise. This may cause structural problems, greater expenses, and more damage during earthquakes. There is a novel strategy that may aid in the prevention of such dangers. Floating columns are different from regular ones in that they do not directly support the foundation. Rather, they lessen the strain on the foundation by spreading the weight out more uniformly. Several advantages may result from this, including Less material consumption Reduced initial investment Enhanced structural adaptability Made to be more resistant to earthquakes. The use of floating columns to seismic analysis and construction design in tall structures is the subject of this investigation. In order to design tall structures that are safer, more efficient, and more environmentally friendly, it is important to weigh the pros and cons of this strategy.

Keywords: High-rise building, Floating columns, Seismic analysis, Structural design, Earthquake resistance, Sustainable design.

INTRODUCTION

General:

Seismic design and analysis for tall structures with floating columns is an intricate and crucial topic of structural engineering. Let's start with an overview of the important factors:

Floating Columns:

- Beams or transfer girders support columns that do not reach the foundation but instead stop at a middle level.
- Their adaptability in design makes them a common choice for ground-level parking, lobbies, or commercial spaces.
- On the other hand, they disrupt the load route, which could alter the building's reaction to seismic activity.

High-Rise Buildings:

Because of their height and bulk, these buildings are particularly vulnerable to seismic pressures. When designing them, it is important to take lateral stresses, especially earthquake-induced ones, into careful account .Complex dynamic behavior incorporating numerous modes of vibration is shown by high-rise structures during seismic occurrences.

Seismic Analysis:

Predicting how the structure will react to ground vibrations caused by earthquakes is the main objective. Modeling the building's structural system, which includes the transfer girders and floating columns, is part of this.

Implementing suitable seismic loads, taking into consideration both the seismicity of the site and the building's attributes.valuating the reaction of the structure, which encompasses displacements, tensions, and strains.

Design Considerations:

The building's ability to resist anticipated seismic pressures without collapsing is an important design consideration. To do this, the transfer girders and supporting beams need to be reinforced so they can manage the concentrated loads from the floating columns.

The building can be deformed without collapsing because it has sufficient ductility. Managing narrative trajectories in order to reduce harm to non-structural components.

STAAD.Pro:

Using STAAD.Buildings with floating columns may be modeled and analyzed using the popular structural analysis and design program, Pro. Engineers may use it to make accurate three-dimensional models of the structure.

use several types of loads, such as seismic loads.

Execute analyses that are both static and dynamic.

Make sure to adhere to the applicable codes while designing structural members.

LITERATURE REVIEW

SudhirK.Jain: Examined the revised IS l893 (Part-l): 2002 code [2]. It addresses the requirement to classify unclear sentences. There is an acknowledgment of the editing and topographical mistakes. Also provided are suggestions for the future code revision.
This paper makes the following points.

1. There are altered relative values of zone factors, and the number of zones on the seismic zone map has decreased from five to four.
2. The foundation soil factor and soil type determine the contour of the design spectrum.
3. At least

design force based in empirical fundamental period of the building even if the dynamic analysis gives a very high value of natural period and thus low seismic force.

2. Most India buildings are soft storey buildings as per coda definitions simply because the ground storey height is usually different from that in the upper storey.
3. In the load combination the load factor 0.90 for gravity load, l.5 for earthquake loads is used in RC structures.

Comments and suggestions on earthquake intensity, risk level, service life of structure, response spectrum etc is given.

Provisions on building torsion, treatment of soft-storied structures, treatment of buildings with masonry infill walls, etc., should be simplified, according to the author.

To make the application of earthquake engineering for structures in zone III much easier, M.S. AlphaSheth argued for a streamlined approach of detailing for conventional buildings in zones with moderate seismic danger. According to the author, ductile detailing in zone III might be made much easier to use, which would lead to its widespread use. To ensure that monolithic special reinforced concrete moment resisting frames (SMRF) are sufficiently strong and ductile to withstand moderate earthquake shaking without collapsing and severe shaking with some non-structural damage, IS l3920:l993 [7] provides the standards for design and details. The ductile detailing that is necessary for zones III, IV, and V is suggested by the code. The towns and cities in zone III experienced far less intense shaking. The response reduction factor R must be less than 5 for special RC moment resistance frames but may be more than 3.0 for RC moment resisting frames in order to make up for the toughness loss caused by loosening the ductile criterion. Sections on flexural members, columns, structural walls, and other similar components are detailed. The author draws the conclusion that zones II and III allow for less strict ductility details in building design.

METHODOLOGY

The majority of structures may be thought of as acting like a vertical cantilever that is loaded laterally. It is common practice to calculate the magnitudes of earthquake forces by multiplying the seismic acceleration produced at a given level by the product of the seismic mass at that level (Dead Load + Long term Live Load). It is important to design in a way that the total lateral shear forces produced over a certain level can be consistently supported by the resistance at that level. The acceleration magnitude may be determined by referring to IS 1893[2].

Seismic Coefficient Method

When designing buildings to withstand earthquakes, one static strategy is to use the seismic coefficient method. Seismic coefficients KH and KV multiplied by the building's weight provide horizontal and/or vertical forces.

In addition to the vertical load caused by the weight of the structures, the stability and deformation of the structures, as well as the stress and strain of each structural part, are evaluated in relation to horizontal and vertical forces.

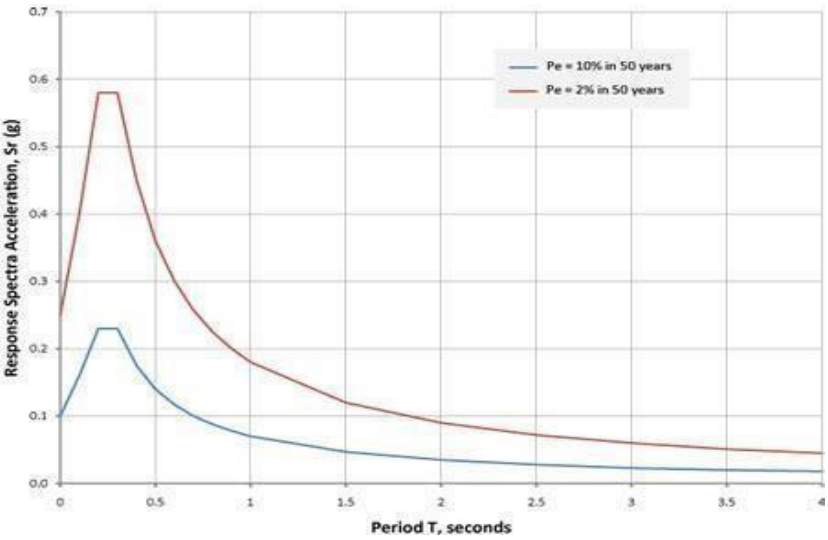
Considering the region's seismic activity and the structure's significant level, the seismic coefficients KH and KV are computed. Typical values for the horizontal seismic coefficient KH range from 0.2 to 0.3 for bridges over roads and railways, around 0.15 for dams, 0.15 to 0.25 for harbor and port facilities, and 0 to 6 for structures including nuclear power plants.

To get the inertia force F operating on a structure during an earthquake, take the total mass M of the structure and multiply it by the acceleration α. The result is F=M. By substituting the acceleration of gravity, g, into Equation (1), we may rewrite it as follows: F=(α/g). "Mg" is equal to (α/g). W

Therefore, the seismic coefficient can be recognized as a ratio of the acceleration of structures to the gravity acceleration.

3.2 Response Spectrum Method

More exact procedures were used more often with the introduction of personal computers and better structural analysis tools. Response spectrum analysis was among the most often used. Finding a response spectrum from recorded seismic activity is an essential step in the process. The information was then condensed into a seismic activity vs. natural frequency spectrum. Although acceleration was the most often used measurement, the seismic activity might be displacement or velocity. The structural model's detailed information was combined with the spectral values for each individual vibration mode. In order to find the overall structure's reaction, the separate data were merged using the right method. Figure following shows a typical response spectrum.



Indian Standard:

Period, which is the inverse of the circular natural frequency, and damping ratio are the variables that determine the response spectrum. The equations for displacement, velocity, and acceleration are derived from Duhamel's integral for a harmonic oscillator with one degree of freedom. The relevant spectrum values

the formulae get the highest possible absolute values. Spectral acceleration is shown to decrease exponentially with increasing period after the plateau zone is left behind. This implies that spectral accelerations may be quite small for structures with low initial frequencies. Nonetheless, structures that possess high fundamental frequencies tend to be located in one of two spectral regions: the sharp initial linear area or the plateau region.

Part 1 of the Indian Standard Criteria for Earthquake Resistant Design of Structures IS 1893: 2002 [2] does an excellent job of addressing the problem. Buildings should be able to withstand mild shocks without sustaining structural damage and large shocks without collapsing entirely, according to the Code's best efforts.

Results and Discussions

3D views:

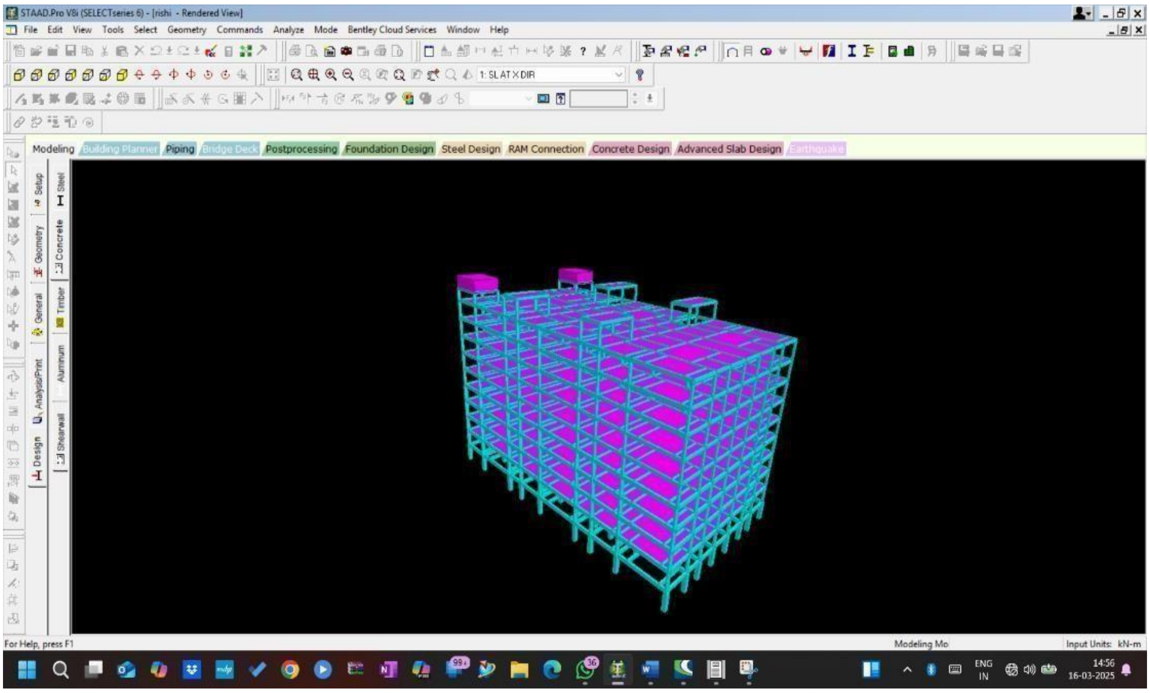


FIG 1: 3D VIEW OF THE STRUCTURE

Displacement:

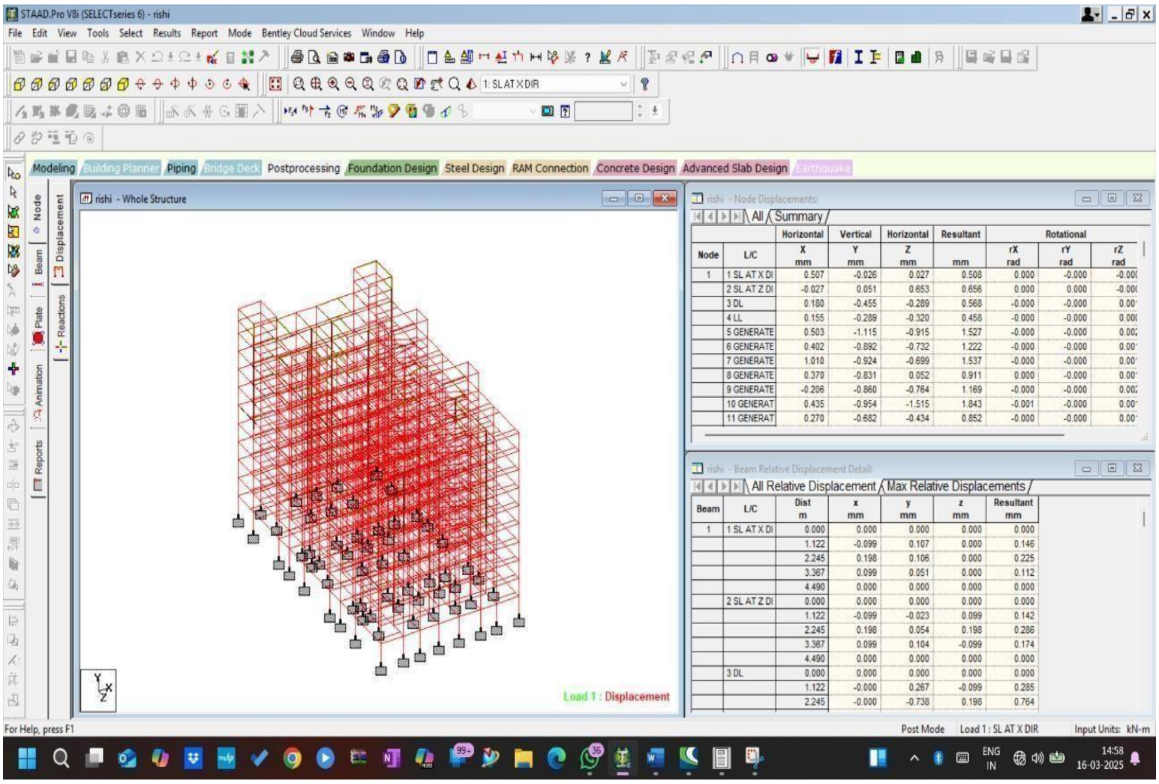


FIG 2: DISPLACEMENT

Axial Forces

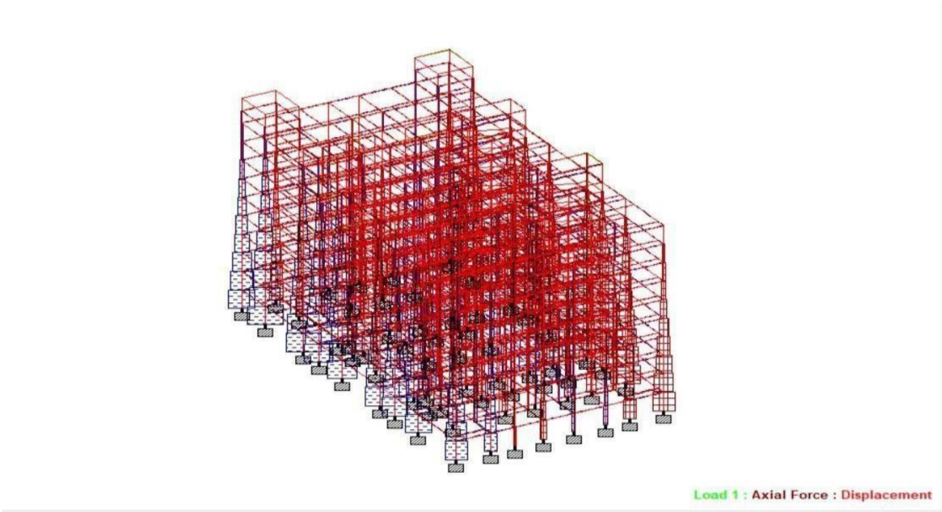


FIG 3: AXIAL FORCE DISPLACEMENT

Torsion:

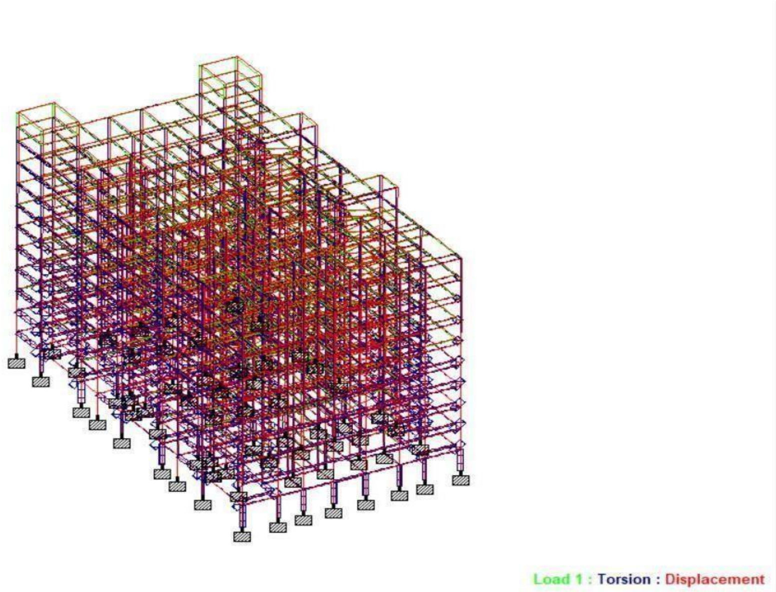


Plate stress

FIG 4: TORSION DISPLACEMENT

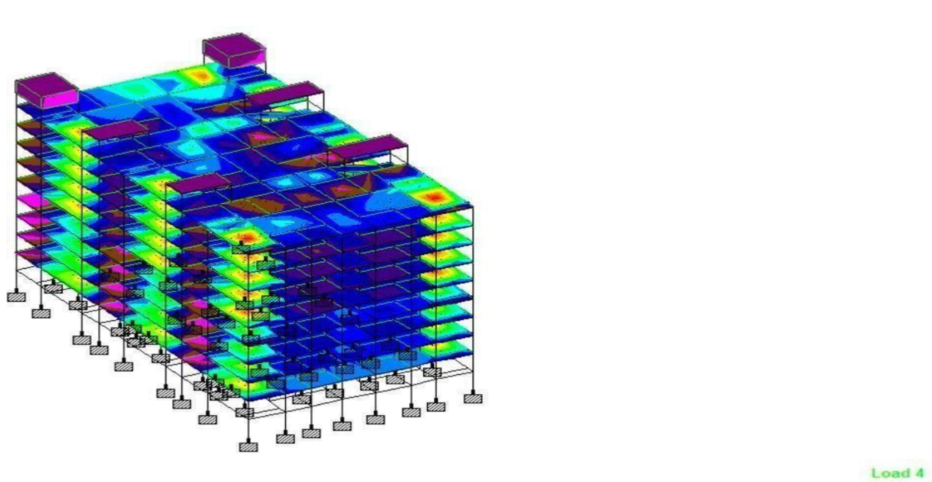


FIG 5: PLATE STRESS

Shear Displacement:

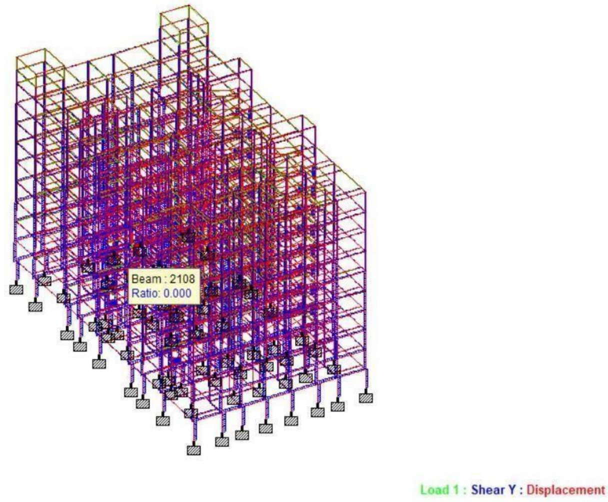


FIG 6: SHEAR DISPLACEMENT

Bending Moment:

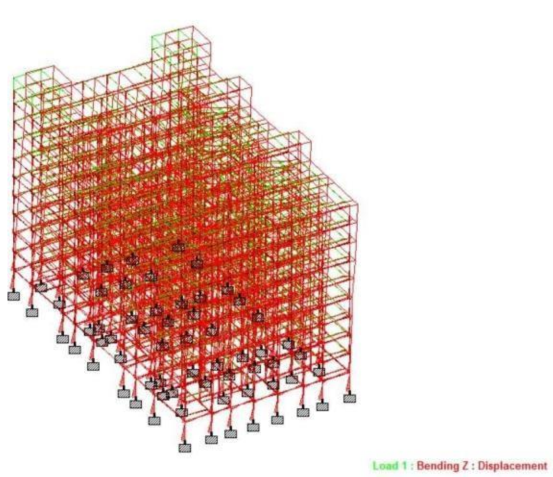


FIG 7: BENDING MOMENT

Beam stress:

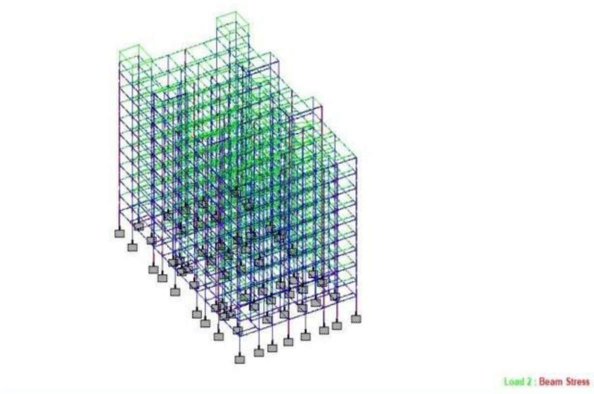


FIG 8: BEAM STRESS Beam Result

BEAM RESULT:

IS 456 - 2000 B E A M D E S I G N R E S U L T S

IS-456 L I M I T S T A T E D E S I G N
B E A M N O. 1 D E S I G N R E S U L T S

M20 Fe500 (Main) Fe415 (Sec.)

LENGTH: 4489.8 mm SIZE: 300.0 mm X 600.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1122.5 mm	2244.9 mm	3367.4 mm	4489.8 mm
TOP REINF.	3519.47 (Sq. mm)	1623.68 (Sq. mm)	286.88 (Sq. mm)	1190.94 (Sq. mm)	3439.31 (Sq. mm)
BOTTOM REINF.	2342.68 (Sq. mm)	359.47 (Sq. mm)	455.34 (Sq. mm)	2433.16 (Sq. mm)	4507.56 (Sq. mm)

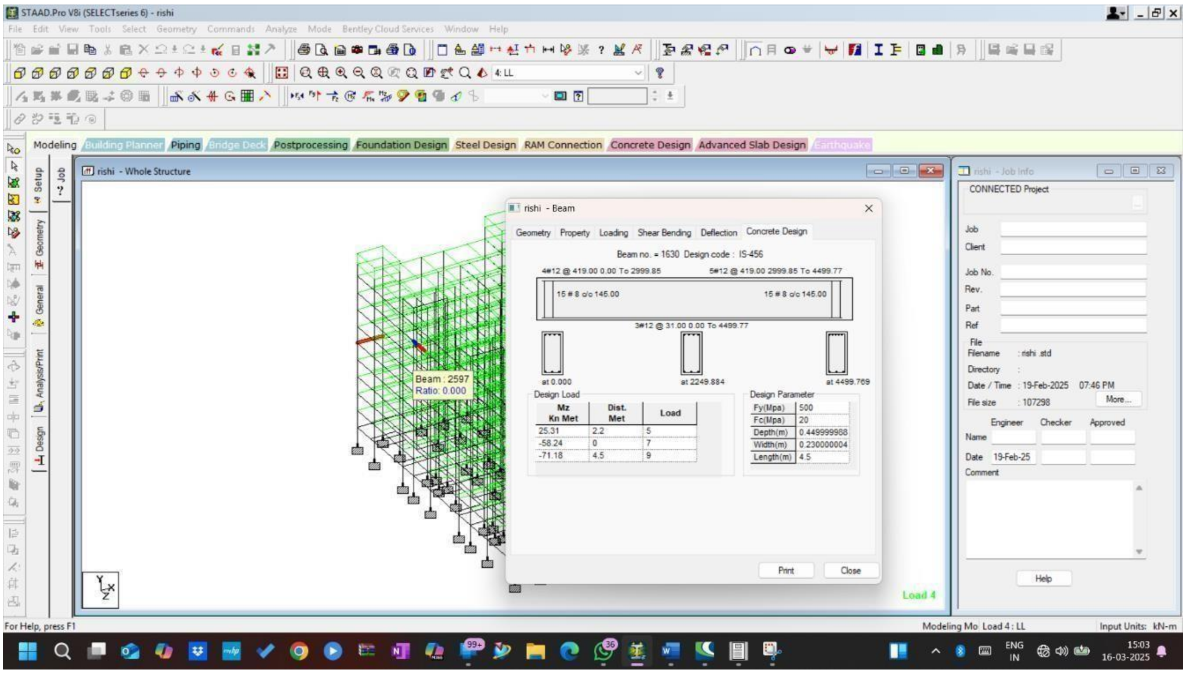
SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1122.5 mm	2244.9 mm	3367.4 mm	4489.8 mm
TOP REINF.	12-20í 2 layer(s)	6-20í 1 layer(s)	3-20í 1 layer(s)	4-20í 1 layer(s)	11-20í 2 layer(s)
BOTTOM REINF.	5-25í 1 layer(s)	3-25í 1 layer(s)	3-25í 1 layer(s)	5-25í 1 layer(s)	10-25í 2 layer(s)
SHEAR REINF.	2 legged 12í @ 200 mm c/c	2 legged 12í @ 70 mm c/c	2 legged 12í @ 105 mm c/c	2 legged 12í @ 160 mm c/c	2 legged 12í @ 200 mm c/c

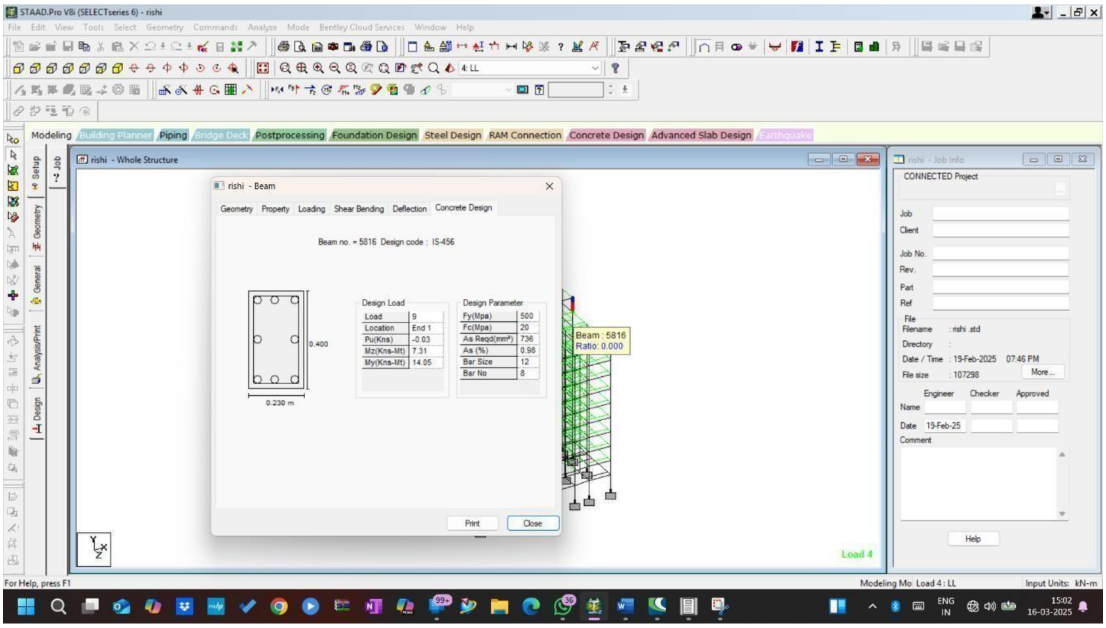
SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 845.0 mm AWAY FROM START SUPPORT
VY = 368.40 MX = 6.45 LD= 5
Provide 2 Legged 12í @ 160 mm c/c

Beam Reinforcement:



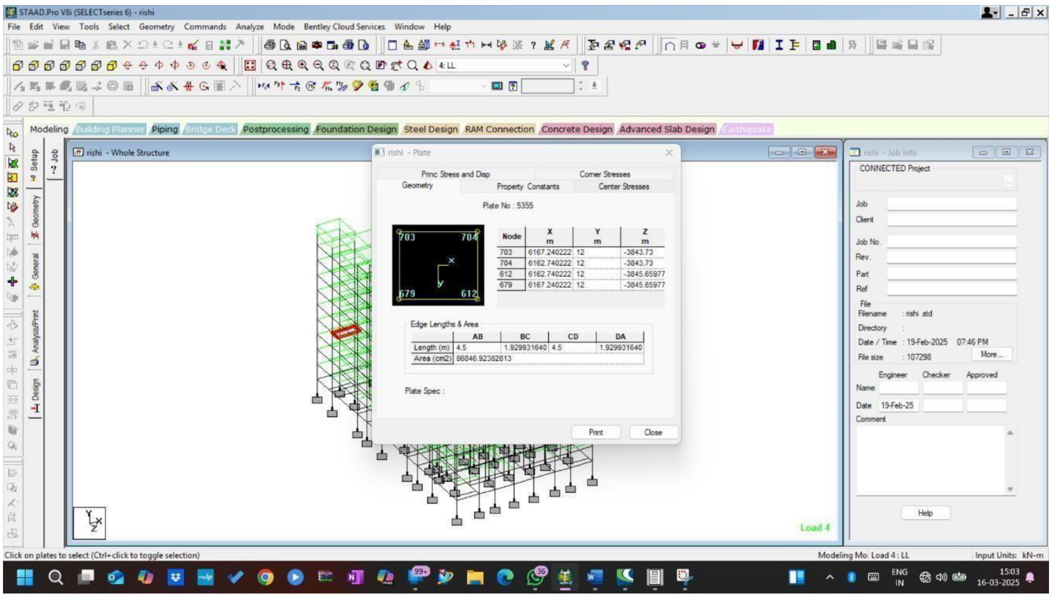
Column Reinforcement:



Column Result

```
=============================================================
IS 456 - 2000   C O L U M N   D E S I G N   R E S U L T S
=============================================================


============================================================================
            IS-456    L I M I T    S T A T E    D E S I G N
        C O L U M N   N O.    206  D E S I G N   R E S U L T S

      M20                    Fe500 (Main)               Fe415 (Sec.)

LENGTH:  3000.0 mm   CROSS SECTION:  600.0 mm X  600.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:     5 END JOINT:      1  SHORT COLUMN


REQD. STEEL AREA    :      6516.37 Sq.mm.
REQD. CONCRETE AREA:     353483.62 Sq.mm.
MAIN REINFORCEMENT : Provide  36 - 16 dia. (2.01%,    7238.23 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 255 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :   5624.99   Muz1 :    542.26   Muy1 :    542.26

INTERACTION RATIO: 0.97 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:      5
END JOINT:      1 Puz :   5889.19   Muz :    592.11   Muy :    592.11    IR: 0.86
============================================================================
```

Slab placement:



Element or slab Design:

ELEMENT DESIGN SUMMARY

ELEMENT		LONG. REINF (SQ.MM/ME)	MOM-X /LOAD (KN-M/M)	TRANS. REINF (SQ.MM/ME)	MOM-Y /LOAD (KN-M/M)
566	TOP :	156.	4.38 / 18	156.	1.44 / 14
	BOTT:	156.	-5.95 / 12	156.	-1.22 / 16
571	TOP :	156.	0.56 / 18	156.	0.31 / 14
	BOTT:	156.	-0.66 / 12	156.	-0.16 / 16
572	TOP :	156.	0.10 / 2	156.	0.42 / 2
	BOTT:	156.	-1.09 / 5	156.	-5.25 / 5
575	TOP :	156.	4.22 / 18	156.	1.46 / 14
	BOTT:	156.	-4.45 / 12	156.	-0.85 / 16
577	TOP :	156.	0.60 / 18	156.	0.05 / 2
	BOTT:	156.	-1.05 / 7	156.	-0.25 / 10
579	TOP :	156.	0.05 / 1	156.	0.00 / 0
	BOTT:	156.	-0.72 / 5	156.	-4.20 / 5
5066	TOP :	156.	4.70 / 14	156.	1.99 / 14
	BOTT:	156.	-4.54 / 16	156.	-0.82 / 1
5067	TOP :	156.	0.02 / 18	156.	0.10 / 16
	BOTT:	156.	-1.73 / 7	156.	-0.27 / 9
5068	TOP :	156.	0.07 / 2	156.	0.41 / 2
	BOTT:	156.	-0.58 / 5	156.	-5.30 / 5
5069	TOP :	156.	3.98 / 14	156.	1.91 / 9
	BOTT:	156.	-3.61 / 16	156.	-0.66 / 1
5070	TOP :	156.	0.27 / 2	156.	0.05 / 2
	BOTT:	156.	-2.11 / 7	156.	-0.68 / 5
5071	TOP :	156.	0.00 / 0	156.	0.00 / 0
	BOTT:	156.	-0.68 / 5	156.	-3.53 / 5
5073	TOP :	156.	4.07 / 18	156.	1.92 / 14
	BOTT:	156.	-4.54 / 7	156.	-0.79 / 1
5074	TOP :	156.	0.40 / 18	156.	0.29 / 5
	BOTT:	156.	-1.81 / 7	156.	0.00 / 0
5075	TOP :	156.	0.02 / 2	156.	0.27 / 2
	BOTT:	156.	-0.29 / 5	156.	-4.29 / 5
5076	TOP :	156.	3.69 / 14	156.	1.86 / 9
	BOTT:	156.	-3.25 / 7	156.	-0.60 / 1

CONCLUSION:

To make the necessary adjustments to the STAAD Pro seismic analysis model for a G+8 building's floating column, please adhere to the following steps:

1. Create a structural model.

Columns that float: Floating columns should be represented as vertical components with appropriate boundary constraints.

Give the G+8 structure precise floor heights and the placement of its floating columns in the floor level definition.

2. Seismic Thresholds

The seismic zone, soil type, importance factor (I), and response reduction factor (R) should be defined according to IS 1893.

Quantification of Seismic Stress

When dealing with seismic load, it is recommended to use Response Spectrum Analysis or Time History Analysis.

• At each level of the building, apply the lateral seismic forces.

3. Things to Think About When Creating Floating Columns

Take into consideration the torsional effects caused by seismic forces on floating columns in the shear and torsional analysis.

• Reinforcement: Take biaxial moments into account when designing for flexure and axial stresses.

• Lateral Support: Make sure that the floating columns are adequately supported laterally by beams or braces.

Beam and slab design

• Design of the beams: to withstand flexure and shear as well as gravity.

• Slab Design: Ensure slabs can transfer lateral forces to beams and columns.

execution in STAAD Pro

Define seismic mass and use Response Spectrum analysis to model seismic loads.

Use a mixture of loads (such as *1.5(DL + LL + EL)**).

The flexure, shear, and torsion of floating columns should be examined.

¬ Validation

• Check Seismic Drift to ensure lateral displacement limits are met.

• Review torsional effects and reinforcement detailing.

¬ STAAD Pro Output

Review reinforcement and design checks for beams and columns under seismic loading.

Final Report

 Write out a brief report outlining the design's assumptions, outcomes, and seismic analysis.

Seismic design modifications for floating column G+8 buildings may be accomplished by following these procedures in STAAD Pro, which adhere to the standards set forth by IS 456-2000 and IS 1893-2002 (part 1) regulations.

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