SEISMIC UPGRADATION OF TALL BUILDINGS

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ABSTRACT

High rises have involved interest for engineers for as long as century. All the more along these lines, the previous thirty years have seen various structures ascending starting from the earliest stage, resisting gravity. Burj Khalifa Dubai, Taipei, Petronas twin pinnacle, Empire state building are a portion of the living instances of designing wonders.

What befalls a structure when it arrives at such inconceivable statures separated from the awe that it will be, it additionally represents a gigantic measure of challenge for the auxiliary architect. Since then these structures are looked by administration stacking conditions. Two destroying powers of nature, wind and seismic tremor become truly basic for these structures. The harmony among firmness and pliability to be given turns into the controlling components to the plan of such structures. Routinely giving enough firmness against colossal burdens doesn't appear to fulfill the necessities. These structures are frequently given adequate pliability so as to disperse the gigantic measure of powers. In any case, there is a limit, with respect to how much malleability can be given in a structure. A fast figuring shows that the highest-level uprooting that can be securely borne by a 500 m tall structure is nearly 2m. The structure would not fall flat if its popular narrative dislodges by 2m.

Use of different sorts of dampers and isolators have been utilized in disseminating this vitality. Much exploration has gone into advancement of TMDs, ATMDs, BTMDs, and seismic base isolators. Examination has additionally gone into different kind of investigations method as more vigorous powerful examination, weakling investigation, time history investigation and execution-based investigation.

Here an endeavor has been made to explore the near benefits and negative marks of various sorts of auxiliary arrangements to comprehend their conduct under seismic and wind loads. The structure considered is of 50 stories. Different designs that have been considered incorporates propped frameworks, shear divider frameworks, dampers and isolators. The investigations results have been organized and plotted to comprehend their conduct. Time history examination and execution-based investigation by sucker investigation have additionally been concentrated to comprehend the conduct of structures.

1. INTRODUCTION

A tall structure can't be characterized in a solitary definition. There are different qualities dependent on which it very well may be disclosed specifically Height Relative to Context, Proportion and Tall Building Technologies. Height as well as the setting decides the structure to be delegated tall structures.

Once more, a tall structure isn't just about stature yet in addition about extent. In low metropolitan foundations the structure which gives a slim look are delegated tall structures. While now and again the huge/enormous impression Buildings that are tall are not considered as tall structure because of their size/floor territory.

The structure dependent on advancements of being a result of "tall" (e.g., explicit Vertical vehicle innovations, basic breeze propping as a result of stature, and so on.), at that point this Building can be classed as a tall structure. Albeit number of floors is a helpless marker of characterizing a tall structure because of the changing floor to floor stature between varying structures and capacities (e.g., office versus private use), a structure of maybe at least 14 stories or more than 50 meters in tallness could maybe be utilized as an edge for thinking of it as a "tall structure.

However, what befalls a structure when it arrives at such incredible statures separated from the astonishment that it will be, it likewise represents a tremendous measure of challenge for the auxiliary architect. Since then these structures are looked by administration stacking conditions. Two destroying powers of nature, wind and seismic tremor become truly basic for these structures. The harmony among firmness and malleability to be given turns into the managing variables to the plan of such structures. Customarily giving enough solidness against tremendous burdens doesn't appear to fulfill the necessities. These structures are regularly given adequate malleability so as to disperse the colossal measure of powers. Yet, there is a limit, with regards to how much pliability can be given in a structure.

1.1. STRUCTURAL SYSTEMS FOR TALL BUILDINGS

Following are the Structural systems for tall buildings:
1) Rigid frame systems
2) Braced frame and shear-walled frame systems
3) Outrigger systems
4) framed-tube systems
5) braced-tube systems
6) bundled-tube systems

1.2. OBJECTIVES

Following are the main objectives of the work:
- Comparison of behavior of different structures of reinforced concrete (framed structures, braced systems, shear walls systems).
- Comparison of Effects of Seismic & Wind Forces on High Rise Buildings with different structural configuration and to compare the key parameters.
- Study the impact of base isolation on the above structures.
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Study the impact of dampers for the above structures

2. METHOD OF ANALYSIS

2.1. STATIC ANALYSIS

The static method is the simplest one-it requires less computational effort and is based on the formulae given in the code. First, the design base shear is computed for the whole building and it is then distributed along the height of the building. The lateral forces at each floor level thus obtained are distributed to individual lateral load resisting elements.

2.2. DYNAMIC ANALYSIS

Dynamic analysis shall be performed to obtain the design seismic forces and its distribution to different levels along the height of building and to the various lateral load resisting elements in following cases:

- Regular Building – Greater than 40 m height in zone IV and V and those greater than 90 m in height in zone II and III.
- Irregular building – All framed buildings higher than 12 m in zone IV and V, and those greater than 40 m height in zone II and III.
- For irregular building lesser than 40 m in height in zone II and III, dynamic analysis even though not mandatory, is recommended.

2.2.1. RESPONSE SPECTRUM METHOD

Response spectrum method is simply a plot of peak or steady state response (displacement, velocity or acceleration of a series of oscillators of varying natural frequency that are forced into motion by same base vibration or shock.

2.2.2. NON- LINEAR TIME HISTORY ANALYSIS

It is an analysis of dynamic response of structure at each increment of time, when its base is subjected to any specific ground motion time history (compatible time history for medium soil IS-1893:2002-Part 1)

2.3. PUSHOVER ANALYSIS (NON-LINEAR STATIC METHOD)

Pushover method of analysis is a technique in which a structural is modeled with non-linear properties (such as steel yield, plastic hinges) and permanent gravity load is subjected to an incremental load applied laterally from '0' value to prescribed ultimate displacement or until the structure become unstable to withstand the further forces
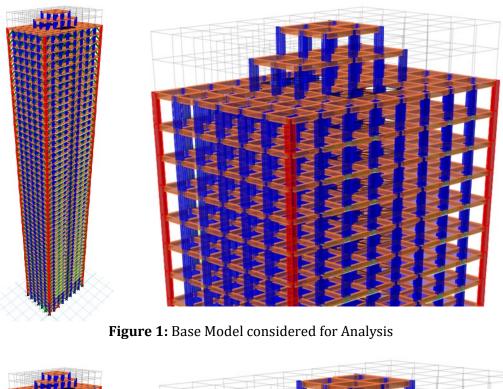
3. MODELS CONSIDERED FOR ANALYSIS

Following six types of models have been considered for analysis. It was attempted to choose models that are representative of actual building types that are being constructed nowadays. Type A is regular framed structure with columns. Type B hybrid braced framed structure wit

bracings of Type 1 in periphery and columns. Type C hybrid braced framed structure with bracings of Type 2 in periphery and columns. Type D is tube in tube.

Table 1: Structural Description

Model ID	Description
Type A	Regular Frame Structure
Type B	Hybrid braced framed structure with bracings in periphery
Type C	hybrid braced framed structure with bracings in periphery and columns
Type D	Tube structure with shear walls and columns
Type E	Tube in Tube structure with shear walls and columns
Type F	Simple framed structure with Tuned Mass Dampers
Type G	Simple framed structure with Base Isolation

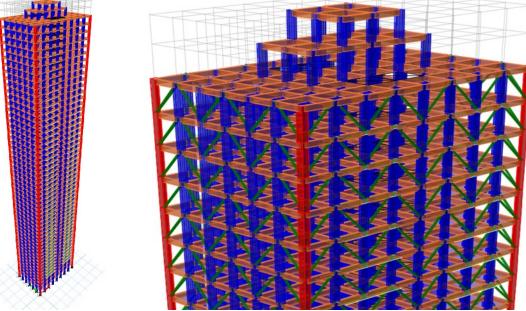**Figure 1:** Base Model considered for Analysis

Figure 2: Hybrid braced framed structure with bracings in periphery

4. MODEL PARAMETERS

For the analysis of multi storied building six types of models have been considered for analysis. Type A is regular framed structure with columns. Type B hybrid framed structure with shear wall in periphery and columns. Type C hybrid framed structure with shear wall in centre and columns. Type D is tube structure. Type E is hybrid framed structure with lift core in centre. Type F is tube in tube system. All the different types of models considered are analysed for 50 storey.

In the current study main goal is to compare the Static and Dynamic Analysis of different types of building.

Design Parameters- Here the Analysis is being done for G+50, (rigid joint regular frame) building by computer software using ETABS.

Design Characteristics - The following design characteristics are considered for Multi-storey rigid jointed frames

Seismic Load

As per IS: 1893, Noida is located in Seismic Zone IV.

Design base shear, V = Z I W Sa/2 R g

Wind Load

The wind velocity at Noida is 47m/s. The other parameter of wind load as per IS: 875 (Part-3).

Table 2: Model Parameters

S. No	Particulars	Dimension/Size/Value
1.	Model	G+50
2.	Seismic Zones	IV
3.	Floor height	3M
4.	Basement	4M
5.	Building height	161.6m
6.	Plan size	20mx12m
8.	Size of columns	0.3mx0.75m
9.	Size of beams	0.3mx0.75m &0.3mx0.6m
10	Shear Walls	0.23m
11.	Thickness of slab	125mm
12.	Earthquake load	As per IS-1893-2002
13.	Type of soil	Type -II, Medium soil as per IS-1893

5. ANALYSIS RESULTS AND DISCUSSIONS

The results of the models analysed have been tabulated and plotted here. More or less the results are as expected. The results are tabulated both individually for each type of building as well as for comparison between different models to study their comparative merit or demerit for each type of building.

Table 4: Base Shear (kN)

Base Shear (kN)							
Load	Type A	Type B	Type C	Type D	Type E	Type F	Type G
SPEC X	4268.132	4481.458	4475.327	4727.562	5139.829	4388.14	11369.01
SPEC Y	4268.117	4481.43	4475.322	4727.565	5063.677	4414.117	11137.94
WLX	5145.435	5145.435	5145.435	5145.435	5145.435	5145.435	5145.435
WLY	10080.85	10080.85	10080.85	10080.85	10080.85	10080.85	10080.85

Table 3: Seismic Parameter

Seismic Parameters				
Seismic Zone (Z)		IV	Soil Type (S)	Medium
Response Reduction Factor (R)		5	Importance Factor (I)	1
Seismic Weight (W)		480435.44	Zone Factor	0.24
Total Height (m)		170	Length along X (m)	32
Basement Height (m)		8	Width along Y (m)	21
Height of Mumty (m)		0	Effective Height (m)	170
Acceleration, g (mm/s^2)		9806.65	Default Scale Factor	980.67
EQX	-4431.816	0.00E+00	Scale X	**1.00**
EQY	0.00E+00	-4431.8159		980.67
SPECX	4431.8012	0.0012	Scale Y	**1.00**
SPECY	0.0006	4431.8136		980.67
Time Period and Base Shear				

Seismic Upgradation of Tall Buildings

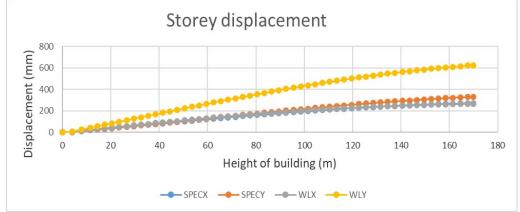| Detail		Time Period (s)		S_a/g	A_h	V_B	% A_h
Bare Frame		T_a	**3.531**	0.385	0.0092	4441	0.92%
Above Basement		T_a	**3.406**	0.399	0.0096	4605	0.96%
With Infil		T_x	**2.705**	0.503	0.0121	5798	1.21%
		T_y	**3.339**	0.407	0.0098	4697	0.98%
Avarage		$T_{avgx.}$	**3.118**	0.436	0.0105	5030	1.05%
		$T_{avgy.}$	**3.435**	0.396	0.0095	4565	0.95%
Above Basement		T_x	**2.577**	0.528	0.0127	6084	1.27%
		T_y	**3.182**	0.427	0.0103	4929	1.03%
Without Mumty		T_x	**2.705**	0.503	0.0121	5798	1.21%
		T_y	**3.339**	0.407	0.0098	4697	0.98%
Building Lateral Displacement Check							
Permissible	WLX	340	Actual	WLX		267.5	**SAFE**
	WLY	340		WLY		627	**FAIL**
	EQX	680		SPECX		272	**SAFE**
	EQY	680		SPECY		331.9	**SAFE**
Permissible	WLX	340	Actual	DL+WLX		267.5	**SAFE**
	WLY	340		DL+WLY		627	**FAIL**
	EQX	680		DL+SPECX		272	**SAFE**
	EQY	680		DL+SPECY		331.9	**SAFE**
Permissible	WLX	340	Actual	DL-WLX		267.5	**SAFE**
	WLY	340		DL-WLY		627	**FAIL**
	EQX	680		DL-SPECX		272	**SAFE**
	EQY	680		DL-SPECY		331.9	**SAFE**

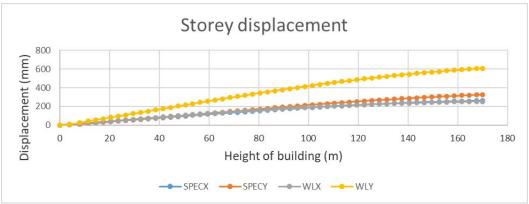**Figure 3:** Storey displacement Type A
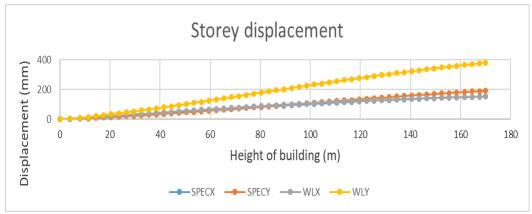

Figure 4: Storey displacement Type B

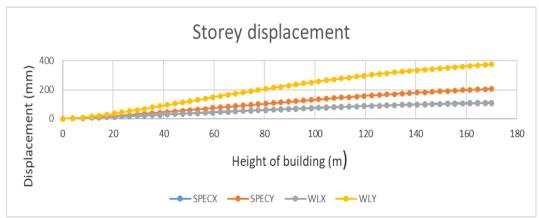**Figure 5:** Storey displacement Type C
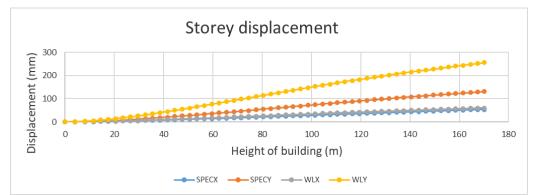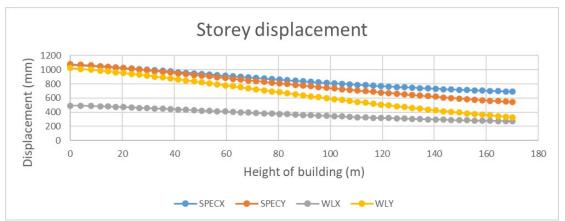

Figure 6: Storey displacement Type D
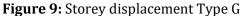

Figure 7: Storey displacement Type E

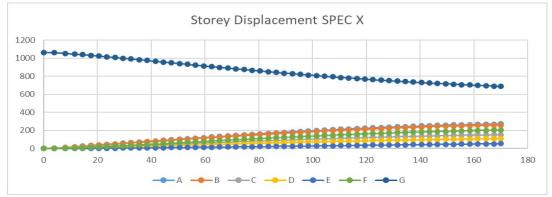**Figure 8:** Storey displacement Type F
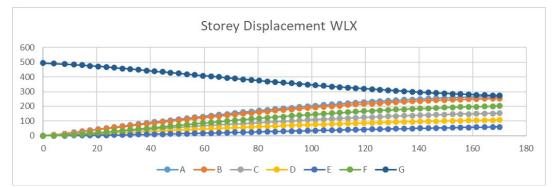
Figure 9: Storey displacement Type G
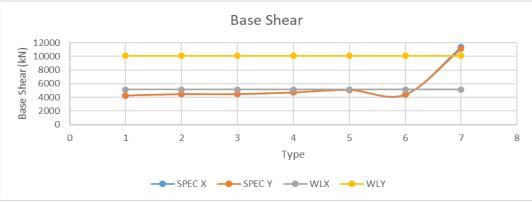

Figure 10: Storey displacement Type A

Figure 11: Storey displacement Type A
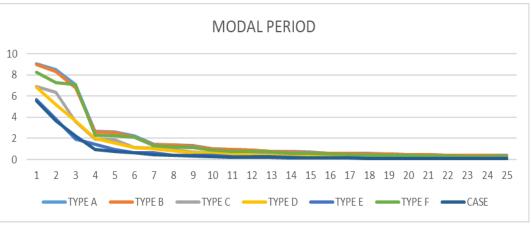

Figure 12: Base Shear (kN)

Figure 13: Modal Period

6. CONCLUSIONS

Seven kinds of models have been considered for investigation alongside one contextual analysis. It was endeavored to pick models that are illustrative of genuine structure types that are being built these days. Care was taken to join the central ideas overseeing the plan of mixture creative tall structures being developed nowadays. Type An is customary encircled structure with sections. Type B mixture surrounded structure with supporting in the fringe at each straight on each floor. Type C crossover confined structure with propping in the outskirts at various coves and various stories. Strikingly this sort works superior to normal supporting. Type D is tube structure. Type E is Tube in Tube framework. Type F was demonstrated with Tuned Mass Dampers. Type G was displayed with Base Isolators. Furthermore, one complete structure with 5BHK level having bars, sections and shear dividers demonstrated in the structure was likewise investigated for examinations.

A gander at the correlation plots for reactions of the apparent multitude of types recommend the accompanying ends. Type G, model with base separation has the most extreme base shear just as story removal at the base. This is the admissible uprooting so as to disperse the vitality which is advantageous for the structure.

In diminishing request of base shear, we have the models separately as Type E (Tube in Tube), Type D (Tube), Type B (Bracing Type 1), Type C (Bracing Type 2), Type F (Model with Tuned Mass Dampers) lastly Type A (Regular Framed). It is intriguing to take note of that Type A despite everything pulls in the least base shear and is the most lightweight structure.

Both the supported structures indicated one exceptionally fascinating conduct. Type C, where supporting has been done at a hole of not many floors is a lot lighter than Type B, where propping has been done at each floor. Yet, the story removal of Type C is greatly diminished than Type B. We may reason that, in the event that supporting framework is picked, at that point propping as given by Type C is generally appropriate for tall structures. Type B while compelling somewhat isn't a lot of prudent.

Tube in Tube frameworks, as in the event of Type E pulls in much base shear than Tube structures as in Type D, however the dislodging is significantly less. This is ideal where our structure is adequately hefty just as unbending. Shear dividers are viable in structures just up to certain stature limits, as a rule inside 35 – 40 stories, yet structures as Tube or Tube in Tube perform far superior to standard shear divider structures.

Type F is our model with Tuned Mass Dampers. It is seen that the mass of the structure isn't expanded by more than 1 – 2 percent of the mass of the standard structure, yet its relocations are extensively decreased. This is in effect obviously approved by the reaction of Type F model which has practically same base shear as Type A, however considerably less story removal than Type A.

The methodology for plan of structures for wind and quake are askew separated. Wind powers are by and large push powers that attempts to overturn or curve the structure vertically. They are material on the uncovered substance of the structures. So as to defend the structure for wind, one extremely straightforward arrangement can be to make the structure heavier. Heavier the structure, better its capacity to oppose wind powers.

In any case, tremor powers are very surprising. They are essentially latency powers, which rely upon the mass of the structures. The structures on activity of tremor powers infrequently overturn or tumble down. They really breakdown simply under its own vertical pivot. Since quake powers rely on the weight/mass of the structure, heavier

the structure, more seismic tremor drive it pulls in. The thought is to make the structure lighter. Lighter the structure, better it is for the structure to oppose seismic tremor powers.

To have the option to adjust, these two opposing standards of configuration is a genuine test for auxiliary architects.

SOURCES OF FUNDING

CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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None.

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