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COMPARISION OF SEISMIC RESPONSE FOR SHEAR WALL BUILDING WITH CONVENTIONAL FRAMED BUILDING BY USING ETAB'S

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Abstract: The evolution of tall building structural systems based on new structural concepts with newly adopted high strength materials and construction methods have been towards "stiffness" and "lightness". Structural systems are become "lighter" and "stiffer". It is common knowledge that rather than directly standing the forces, it is better to reduce them and dissipate the magnitude of vibrations. Structure design of high rise buildings is governed by lateral loads due to wind or earthquake. Lateral load resistance of structure is provided by interior structural system or exterior structural system. The rapid growth of urban population and limitation of available land, the taller structures are preferable now a day. So when the height of structure increases then the consideration of lateral load is very much important. For that the lateral load resisting system becomes more important than the structural system that resists the gravitational loads. Recently the shear wall structural system has been widely used for tall buildings due to the structural efficiency and aesthetic potential provided by the unique geometric configuration of the system. The present work aims to demonstrate the response of symmetrical building considered with; RCC framed structure, shear wall system with different storey module the building studied in this work is a reinforced concrete moment resisting frame (G plus 12) designed for gravity and seismic using 1893:2002. And is studied using Non-linear time history analysis. Using ETAB'S structural analysis software. In the study the story displacement, Storey drifts, base shear of the structure and over turning moment were studied and the results obtained were compared with those obtained from others.
Keywords: Time history analysis, inter storey drift, yielded stiffness, Design basis earthquake

I. INTRODUCTION

1.1 High Rise Building

High-rise buildings are generally defined as buildings 35 meters or greater in height, which are divided at regular intervals into occupiable levels. Undeniably the high-rise buildings are also seen as a Define > Frame sections > Add Rectangular > OKwealth-generating mechanism working in an urban economy. High-rise buildings are constructed largely because they can create a lot of real estate out of a fairly small piece of land. Because of the availability of global technology and the growing demand for real estate, high rise buildings are seen as the most fitting solution to any city that is spatially challenged and can't comfortably house its inhabitants.

Fig. 1. High Rise Building

II. LITERATURE REVIEW

A lot of researches are being carried out in this field and we are discussing a few here as analysed the effect of various configurations of shear walls on high-rise structure[1]. studied on drift analysis due to earthquake load on tall structures. In this study regular shaped structures have been considered. [2] conducted the study and comparison of the difference between the wind behaviour of buildings with and without shear wall using Staad pro. [3] Comparative Study of Strength of RC Shear Wall at Different Location on Multi-Storied Residential Building, focus is to determine the solution for shear wall location in multi-storey building. [4]) studied on drift analysis due to earthquake load on tall structures. In this study regular shaped structures have been considered. Estimation of drift was carried out for rigid frame structure, coupled shear wall structure and wall frame structure[5].

III. METHODOLOGY

In this study comparison of shear wall building to the conventional building under seismic forces is done. Here G+12storey is taken, and same live load applied in both the buildings for its behaviour and comparison. The framed buildings are subjected to vibrations because of earthquake and therefore seismic analysis essential for these building frames. And analyze these structures using the nonlinear time history analysis

The detailed description of various steps being involved in modeling and simulation is shown below

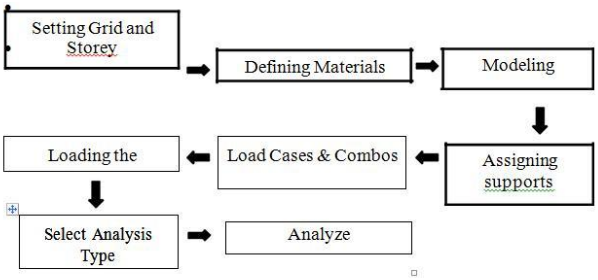

Fig. 2.Flowchart of welding process

Grid Setup

The first step in ETABS is to set the grid dimensions. This includes setting number of lines in X direction, Y direction and the spacing between grid lines. Then the storey data is defined which includes setting the number of stories, height of typical and bottom storey. The type of slab is also mentioned in the grid data

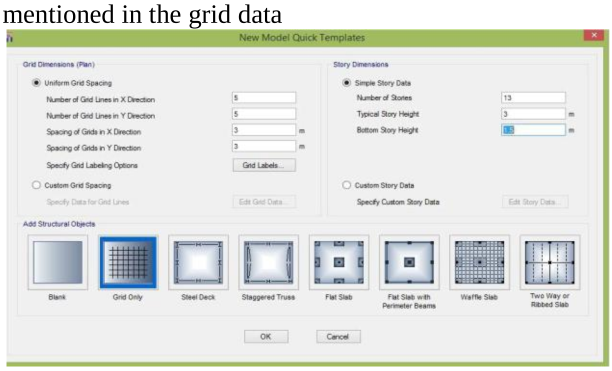

Fig. 3. Grid Setup

Defining Materials and Sections

The next step is to define material properties. This includes defining Modulus of Elasticity, Poisson's ratio, Coefficient of Thermal expansion, weight per unit volume, mass per unit volume, Bending reinforcement yield stress fy, Shear reinforcement yield stress fsy, type of design, Compressive strength etc

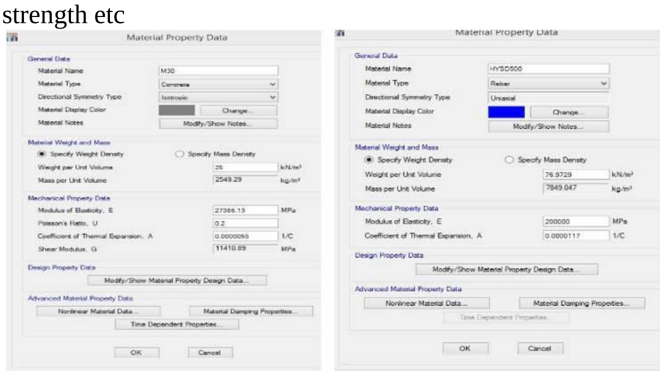

Fig. 6. Material Property Data

4.2.4 Definition of Sectional Properties of Beams and Columns After defining the material properties various sections are defined. Defining of sections involves defining depth, width, setting modifiers if any, defining the reinforcement of the section as column or beam etc.

Define > Frame sections > Add Rectangular > OK

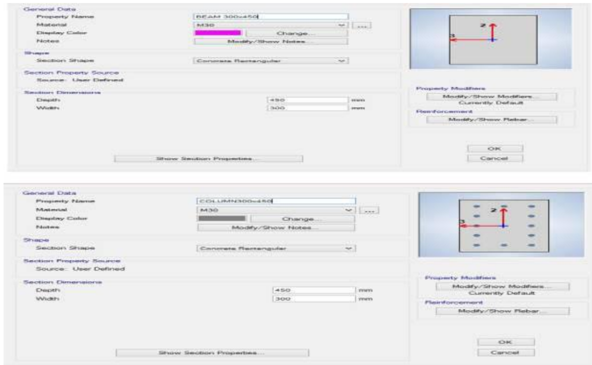

Fig. 4. Sectional property of beam & column

4.2.5 Definition of Sectional Properties of slab section

Define > Wall/Slab/Deck Sections > ADD NEW SLAB> OK

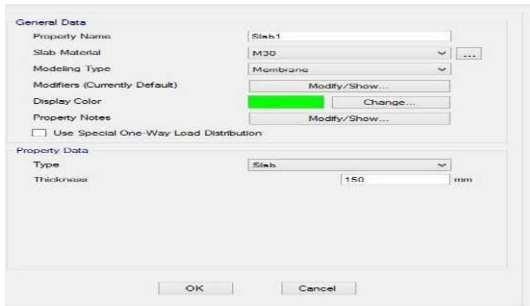

Fig. 5. Sectional property of slab section

4.2.6 Modelling

After defining the sections and materials a three-dimensional modal of the structure is created using various modelling tools and techniques available in the ETABS. ETABS offers some of most advanced modelling tools such as snaps, replicate, mirror insert storey, delete storey etc.

4.2.7 Assigning Supports

The next step after modelling a three-dimensional structure is assigning the supports. Various supports such as simply, fixed, pinned can be assigned to the structure. By default, pinned support is assumed by ETABS

Assign > Joint/Point > Restraints(Supports) > FIXED > OK

4.2.7 Assigning Supports

The next step after modelling a three-dimensional structure is assigning the supports. Various supports such as simply, fixed, pinned can be assigned to the structure. By default, pinned support is assumed by ETABS.

Assign > Joint/Point > Restraints(Supports) > FIXED > OK

4.2.8 Defining Diaphragms

In order to account for the in-plane rigidity of the structure, slab sections are modeled as rigid diaphragms by using the 'rigid diaphragm' option in the assign menu. By modeling the slabs as rigid diaphragms, the masses of the floors are automatically lumped at their center of gravity (i.e. mass center). However, for the buildings of irregular configuration (i.e. L-type, C-type, Y-type, narrow buildings etc.) slabs sections are modeled as 'semi rigid diaphragms'.

4.2.9 Defining Load Cases and Combinations

The various loads such as Dead, Live, Earth quake and Wind are defined. Various combinations such as service, ultimate etc. are defined. ETABS generates automated load combination depending upon code.

Define > Static Load Cases > New Loads > OK

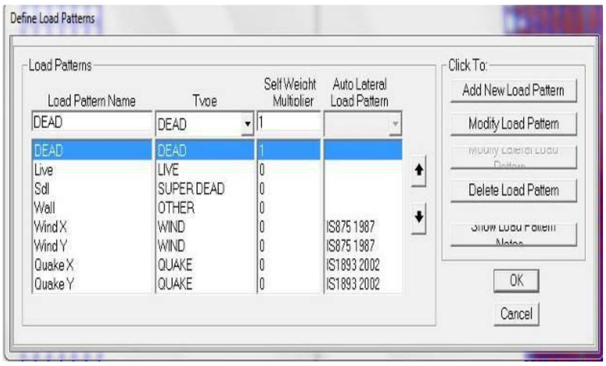

Fig.7. Applying static load cases

4.2.12 Time history functions

For this purpose, earth-quake ground acceleration records components of the Zone-II Earthquake record have been selected. Which is a low intensity earthquake zone of zone factor 0.10 which comes under the Zone-II according to the classification of seismic zones by IS 1893-2002 part-1. The records are defined for the acceleration points with respect to a time-interval of 0.005 second. The acceleration record has units of m/sec2 and has a total number of 26,706 acceleration data coordinates out of which the most critical data points which are of the highest intensity are the first 10,000 acceleration data coordinates have been considered.

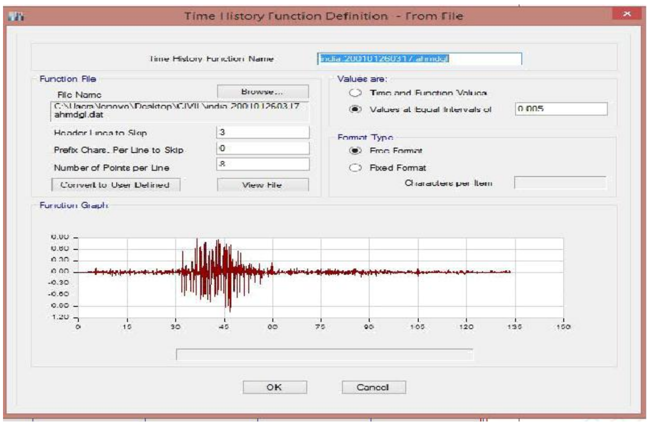

Fig.9. Time History Functions

4.2.13 Analyze

After the above steps are done, the structure is analyzed against various types of loads and combinations. After the analysis has been carried out deformed shape of the structure is shown. The various forces can be viewed.

Analyze > Check Model > Run Analysis > OK

4.3 STUDY OF BUILDINGS

4.3.1 BUILDING DESCRIPTIOSTRUCTURAL SYSTEM OF THE ALL THE MODELS

4.3.3 Model 1: In the first model, a storied reinforced concrete frame building situated in zone II, is taken for the purpose of study. The plan area of building is 15 x 15m with 3m as height of each typical story. It consists of 5 bays in X-direction and 5 bays in Y-direction. The total heights of the buildings were 37.5m.

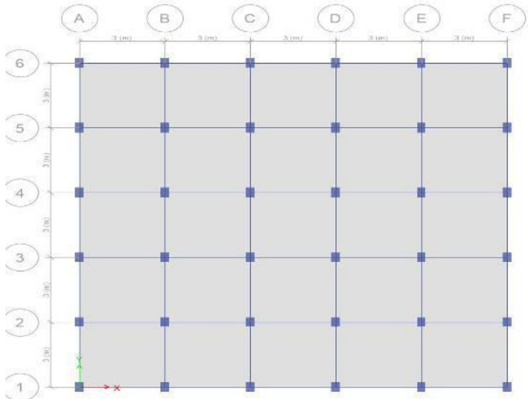

Fig.8. Model Plan of conventional framed building

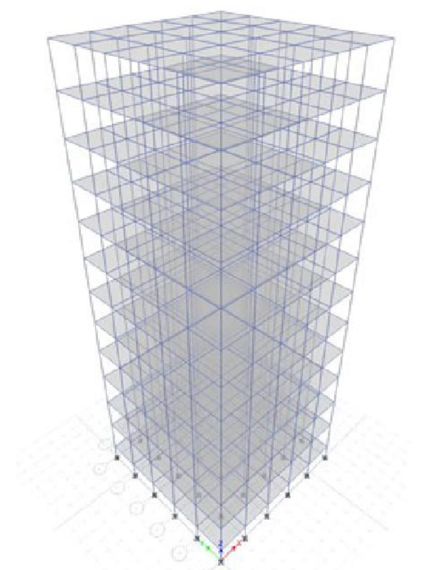

Fig.10. Isometric Views of conventional framed building

4.3.4 Model 2: In the Second model, shear wall building situated in zone II, is taken for the purpose of study. The plan area of building is 15 x 15m with 3m as height of each typical storey. It consists of 5 bays in X-direction and 5 bays in Y-direction. The total heights of the buildings were 37.5m.

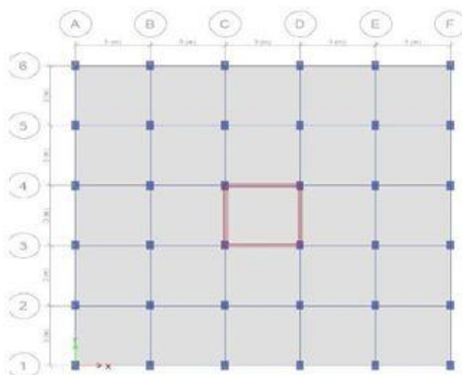

Fig.11. Model Plan View of shear wall core building

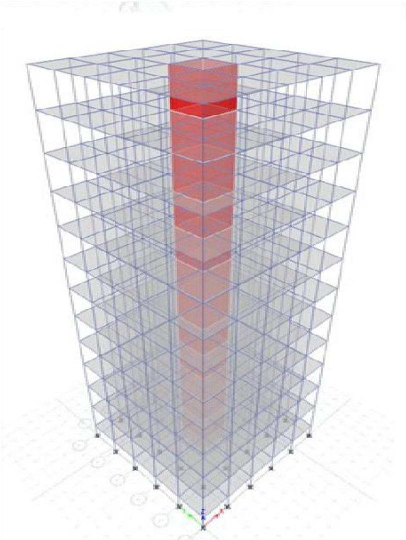

Fig.12. Isometric Views of shear wall Model

4.3.5 Model 3: In the third model, shear wall building situated in zone II, is taken for the purpose of study. The plan area of building is 15 x 15m with 3m as height of each typical storey. It consists of 5 bays in X-direction and 5 bays in Y-direction. The total heights of the buildings were 37.5m.

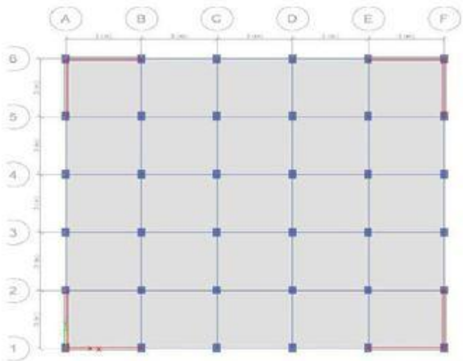

Fig.13 Model Plan View of shear wall coupled Buildings

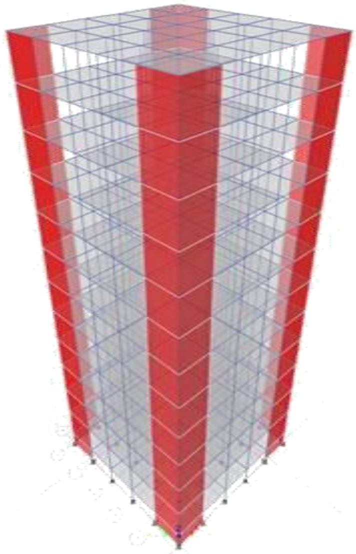

Fig.14. Isometric Views of shear wall coupled Model

TABLE I. CALCULATIONS OF SEISMIC LOADS

Mass no	WI(KN)	hi(m)	WIxhI^2	WIxhi^2/£^{b}h=1WIxhi^2	Qi(KN)
1	1524.3	37.5	2143546.8	0.113	128.5
2	3741.9	34.5	4453796.4	0.235	267.2
3	3741.9	31.5	3712900.2	0.196	222.3
4	3741.9	28.5	3039358.2	0.160	181.98
5	3741.9	25.5	2433170.4	0.128	145.5
6	3741.9	22.5	1894336.8	0.100	113.7
7	3741.9	19.5	1422857.4	0.075	85.3
8	3741.9	16.5	1018732.2	0.053	60.2
9	3741.9	13.5	681961.2	0.036	40.9
10	3741.9	10.5	412544.4	0.021	23.8
11	3741.9	7.5	210481.8	0.011	12.5
12	3741.9	4.5	75773.4	0.004	4.5
13	3741.9	1.5	8419.2	0.0004	0.45
		/£^{b}h=1WIxhi^2	18896725.2		

6.1.1 DISPLACEMENT RESULTS (X-DIRECTION)

TABLE II. DISPLACEMENT RESULTS OF ALL THE MODELS

	FRAME	SHEAR CORE	SHEAR CORNERS	SHEAR COUPLED
Base	0	0	0	0
Story1	0.2	0.1	0.1	0.1
Story2	1.6	0.6	0.5	0.7
Story3	3	1.4	1.2	1.6
Story4	4.5	2.3	2	2.7
Story5	6	3.4	3	3.8
Story6	7.5	4.5	4.1	5.1
Story7	8.9	5.7	5.2	6.3
Story8	10.2	6.9	6.3	7.5
Story9	11.5	8	7.4	8.7
Story10	12.6	9.1	8.5	9.7
Story11	13.5	10.1	9.6	10.7
Story12	14.3	11.1	10.5	11.5
Story13	14.7	12	11.5	12.3

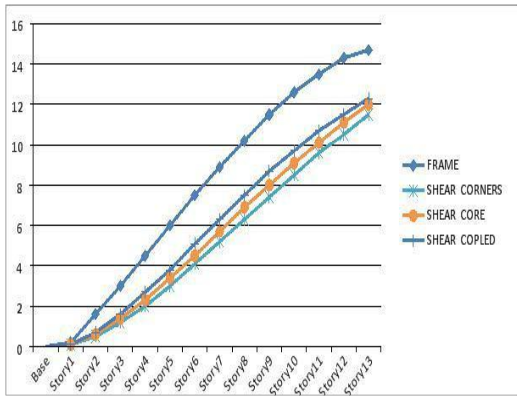

Fig.15.Displacement Results in X direction

6.1.2 DISPLACEMENT RESULTS (Y-DIRECTION)

TABLE III. DISPLACEMENT RESULTS (Y-DIRECTION)

	FRAME	SHEAR CORE	SHEAR CORNERS	SHEAR COUPLED
Base	0	0	0	0
Story1	0.3	0.1	0.1	0.2
Story2	2	0.8	0.7	0.9
Story3	4	1.9	1.6	2.1
Story4	6	3.1	2.7	3.5
Story5	8	4.5	4	5.1
Story6	10	6	5.4	6.7
Story7	11.9	7.5	6.8	8.2
Story8	13.7	9	8.2	9.8
Story9	15.4	10.5	9.6	11.2
Story10	16.9	11.8	10.9	12.5
Story11	16.9	11.8	10.9	12.5
Story12	19.1	14.2	13.3	14.6
Story13	19.7	15.2	14.4	15.5

6.1.3 DRIFTS RESULTS(X-DIRECTION)

TABLE.IV. DISPLACEMENT RESULTS OF ALL THE MODELS

	FRAME	SHEAR CORE	SHEAR CORNERS	SHEAR COUPLED
Base	0	0	0	0
Story1	0.000142	0.000068	0.000058	0.000074
Story2	0.000451	0.000164	0.000137	0.000193
Story3	0.000488	0.000252	0.000221	0.000295
Story4	0.000495	0.000315	0.000282	0.000359
Story5	0.000495	0.000357	0.000326	0.000397
Story6	0.000488	0.000383	0.000356	0.000414
Story7	0.000474	0.000394	0.000372	0.000415
Story8	0.00045	0.000393	0.000378	0.000404
Story9	0.000416	0.000383	0.000374	0.000382
Story10	0.000371	0.000365	0.000363	0.000352
Story11	0.000312	0.000272	0.000276	0.000262
Story12	0.000241	0.000215	0.000221	0.000212
Story13	0.000157	0.000112	0.000107	0.000122

Table: 9 Drifts results of all the models

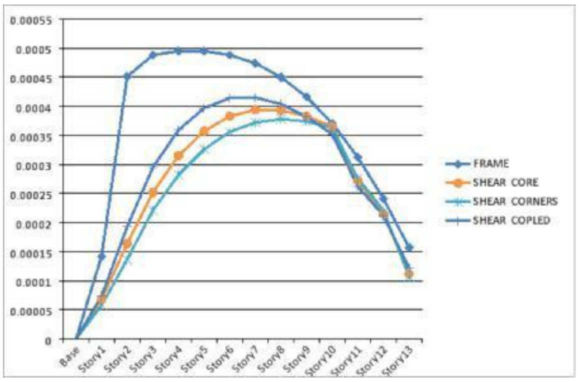

Fig.16.Drift of Models

6.1.4 TIME PERIOD RESULTS

TABLE: .V . TIME PERIOD RESULTS OF THE ALL MODELS

MODES	FRAME	SHEAR CORE	SHEAR CORNERS	SHEAR COUPLED
1	1.341	0.941	0.876	1.007
2	1.095	0.848	0.795	0.896
3	1.05	0.771	0.562	0.692
4	0.442	0.257	0.226	0.292
5	0.357	0.257	0.213	0.264
6	0.347	0.237	0.137	0.199
7	0.258	0.153	0.102	0.143
8	0.205	0.121	0.098	0.132
9	0.205	0.114	0.061	0.097
10	0.183	0.109	0.061	0.087
11	0.145	0.085	0.06	0.082
12	0.143	0.074	0.043	0.006

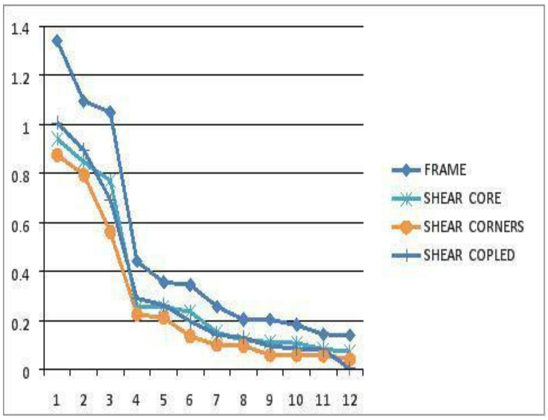

Fig.17.Time Period of buildings in x direction

CONCLUSIONS

As the lateral loads are resisted by diagonal columns, the top storey displacement is very much less in shear wall at corner structure as compared to the simple frame building.

For high-rise buildings, in order to control the seismic response shear wall at corner were modelled and the results showed that there is a drastic decrease in storey displacements storey drift, time period and material consumptions.

As time period is less, lesser is mass of structure and more is the stiffness, the time period is observed less in structure which reflects more stiffness of the structure and lesser mass of structure.

The storey drift is very much less for shear wall at corner structural system as compared to the simple frame building.

Shear wall at corner provide more resistance in the building which makes system more effective.

The design of both structures is done by using same member size but that member sizes are not satisfied to design criteria in case of simple frame structure and failure occurs with excessive top storey displacement. So, the higher sizes of members are selected to prevent the failure criteria.

Shear wall at corner structural system provides more flexibility in planning interior space and façade of the building. Shear wall at corner structural system provides more flexibility in planning interior space and façade of the building.

The overall results suggested that shear wall at corner is excellent seismic control for high-rise symmetric Buildings.

Most of the present structural systems are highly advanced in terms of structural efficiency and aesthetic quality, but lacks the much-needed geometric versatility. As we have seen, the latest mutation of tubular structures, has in addition to strength and aesthetics, that extra quality of geometric versatility, making it the most suited structural system to this respect. Thus, with an optimal combination of qualities of aesthetic expression, structural efficiency and geometric versatility is indeed the language of the modern-day builder.

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