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COMPARITIVE STUDY BETWEEN DIAGRID AND TUBE IN TUBE STRUCTURAL SYSTEM

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Abstract— ***The rapid growths of urban population and consequent pressure on limited space have considerably influenced the residential development of city. The high cost of land, the desire to avoid a continuous urban sprawl, and the need to preserve important agricultural production have all contributed to drive residential buildings upward. As the height of building increases the lateral force acting on building also increases.This lead to the innovation of implicit structural system. SL in the structure is the major phenomena considered in the high rise. In this the Structure is approached as a cantilever orthotropic box beam. Two different Structural systems Tube in Tube and Diagrid.At which angle of Diagrid it will perform better.it is concluded with the analysis done in ETABS 2016.***

Keywords— Diagrid, Tube in tube ,SL,Deflection, Earthquake loads, High-rise, Lateral displacement, Lateral loads, lateral bracings,Wind dynamics

INTRODUCTION

SHEAR LAG (SL)

SL effect is relevant to any slender box element that is loaded laterally such as box girder bridges. The beam theory assumes that a plane remains a plane after bending. This assumption results in a linear distribution of bending stress in the cross section of the beam. This assumption can only be true in a box section if the shear stiffness of the cross section is infinite or if there is no shear force in the box. If the shear force exists in the box, shear flow is developed across the flange and web panels. Due to the shear flow between the flange and the web of the box, the panels displace longitudinally in the way that the middle portion of the flange and web lag behind that of the portion closer to the corner of the box section. This nonlinear longitudinal displacement of the flange and web results in the axial stress distribution is called as SL effect.

TUBE IN TUBE

The main feature of tube in tube is that the columns are arranged in such a way that they are connected to each other. The structure is act as a hollow tube or a rigid orthotropic cantilever box. At the outer periphery of this systems the columns are very closely spaced as 3m to 4m. which acts as a tube only which is generally called as hull. And the inner tube consist of braced frames generally called as core. The hull and core system acts together to resists both the gravity load and lateral load.

DIAGRID

It is the easily recognizable structure. It is the space truss in which the perimeter grid is made up of series of triangulated systems. It is widely used in tall building because of its efficient and aesthetic potential. It is basically known for its flexibility unique configuration. Diagrid resists both its gravitational and lateral load efficiently.

There are three types of Diagrid structural System

1. Steel diagrid Structural System
2. Concrete diagrid Structural System
3. Timber diagrid Structural System

AIM AND OBJECTIVE

The objectives of the paper are as follow:

1. Two compare two different Structural System Diagrid and Tube in Tube.
2. To model two different structural System for each plan of 36X36 and 48X48 with different diagrid angles storey in ETABS.
3. To find out the optimal angle of diagrid which gives minimum SL effect in structures.
4. To compare SL ratio, lateral displacement and time period structure.

METHODOLOGY

Following steps are adopted in present study ,

In this study comparison of Diagrid and Tube in Tube Structural system is compared in terms of SLRatio, storey displacement and modal time period.

Following steps are adopted in this study.

1. Step 1: Selection of building geometry and modeling of diagrid and Tube in Tube structural system using ETABS 2016 software for the same plan.
2. Step 2: Selection of site condition and seismic zone.
3. Step 3: Application of loads and load combination to the structural model according to the standard codes.
4. Step 4: Analysis of each building frame models.
5. Step 5: Comparative study of results in terms of SL Ratio, storey displacement, and time period. By considering different storeys Angle for different Plan. i.e. 36X36 And 48X48
6. Step 6: Above structures are analysed by static method as well as dynamic method by response spectrum method and the results have to be compared.
7. Dynamic analyses is done for structure subjected to wind and seismic loads as per IS 875 (part 3) and IS 1893 (Part-1): 2002 respectively .
8. Determination of the best best angle for Diagrid by comparison of results of SL Ratio, lateral storey deflection and time period .

MODELLING DATA

TABLE I

Modelling Parameters

Parameter	Specification
Type of Structure	Reinforced concrete structure
Location	Mumbai
Structure utility	Commercial
Number of storeys	48
Floor to floor height	3 m.
Plan Dimensions	36X36, 48X48
Analysis method	• Dynamic analysis(RSM) • Wind dynamic analysis
Codes used	• IS 456-2000, • IS 800-2007. • IS 875-2015. • IS 1893 Part 1-2016

TABLE II
Loading Considerations

Type of Load	Intensity of Load
Live load	3 KN/m^2
Floor load (SIDL)	1.5 KN/m^2
Wall load	11.04 KN/m^2
Parapet wall load	6.25 KN/m^2

TABLE III
Section Properties

Description	Size
Slab thickness	200 mm
Shear wall thickness	200 mm
Beam	400 mm x 600 mm
Column	
a) C1	800 mm x 800 mm
b) C2	1200 mm x 1200 mm
RCC Bracing	500X500

TABLE IV
Earthquake Load Parameters

Parameter	Specification
Seismic zone	2
Seismic coefficient	0.16
Response reduction factor (R)	5
Importance factor (I)	1

TABLE V
Wind Load Parameters

Parameter	Specification
Seismic zone	2
Seismic coefficient	0.16
Response reduction factor (R)	5
Importance factor (I)	1

In this present study , Two different plans are considered i.e. 36X36 and 48X48. For all different arrangements Angle of Diagrid varies with the height and analyzed for best possible combination using ETABS software are:

1. Diagrid Structural System .

2. Tube in Tube **S**tructural System .

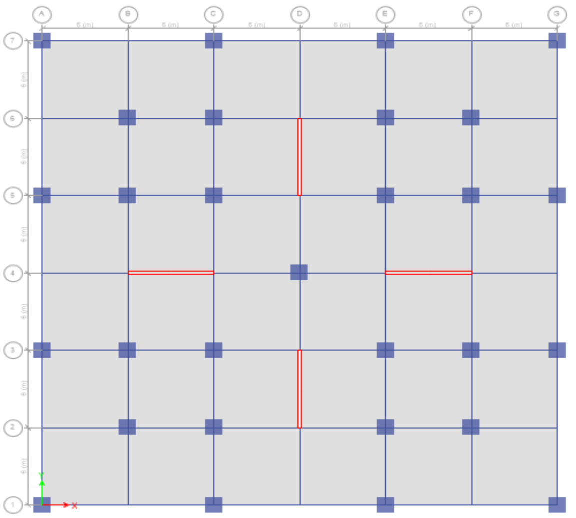

Fig. 2 Plan of Diagrid

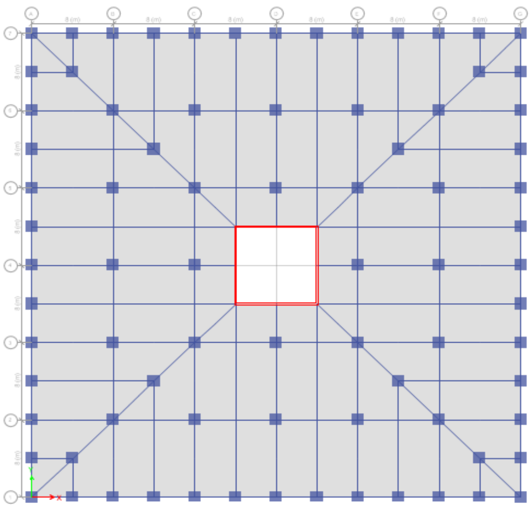

Fig. 1 Plan of Tube in tube

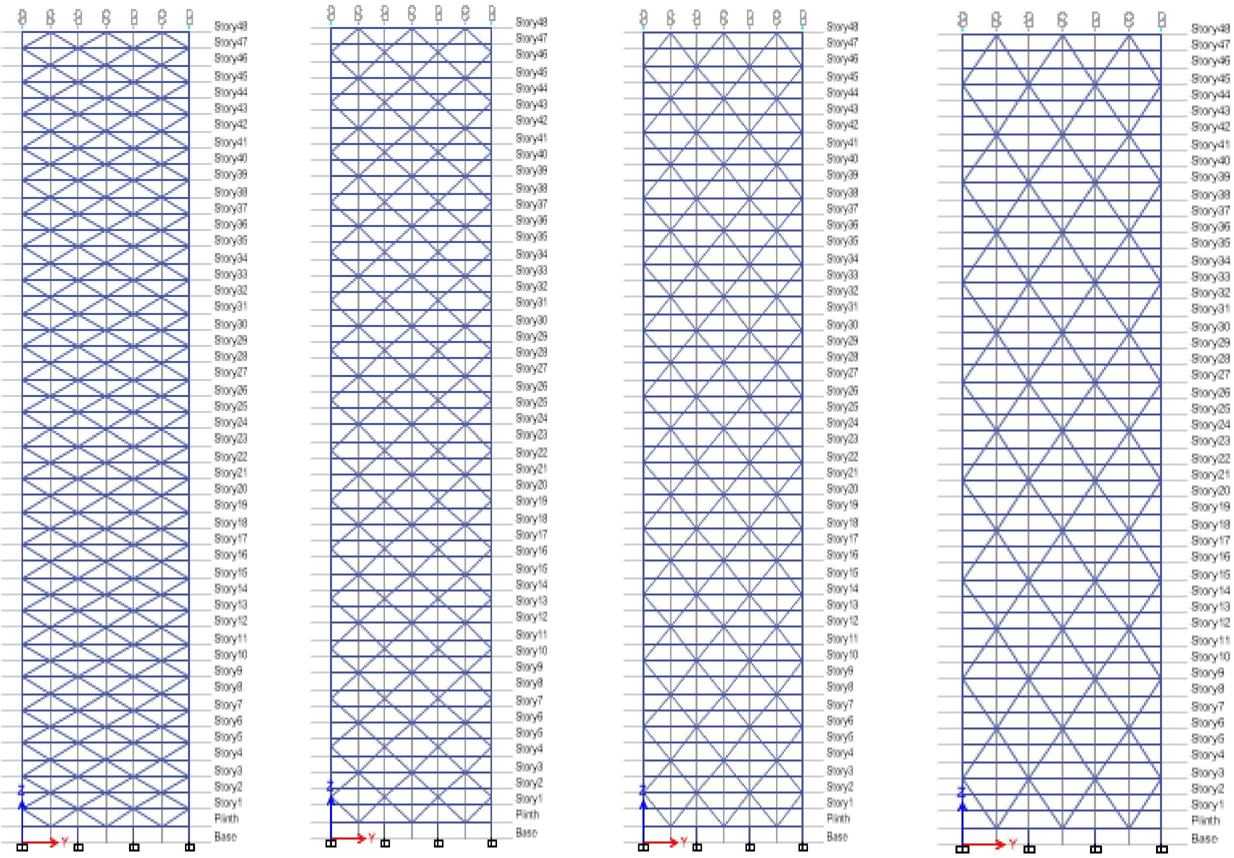

Fig. 3 Elevation of Diagrid structural System

For Different angle

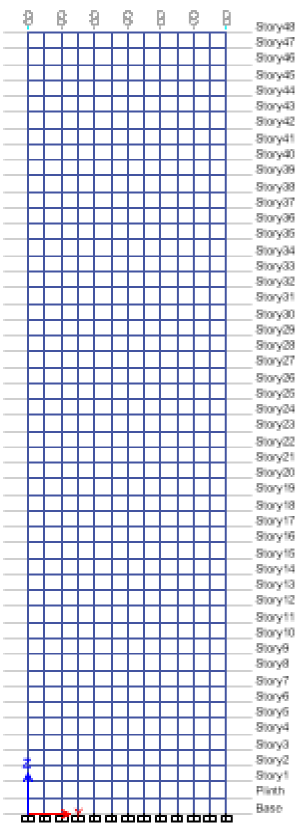

Fig. 5 Elevation of Tube in Tube in Tube Structural system (For Plan 36X36)

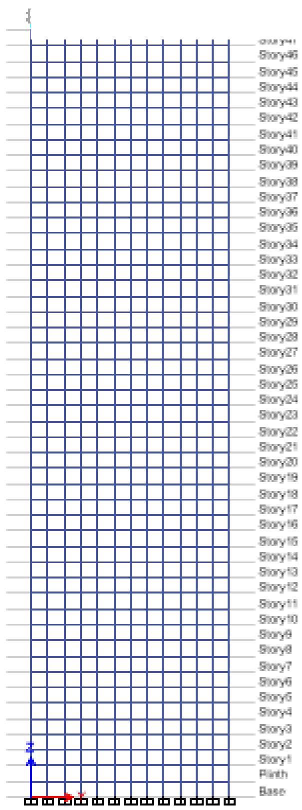

Fig. 4 Elevation of Tube in Tube in Tube Structural system (For Plan 48X48)

RESULTS

A. Shear Lag ratio :

TABLE VI
SLratio (36X36 PLAN)

Type of Structure	Angle	SLRatio	
		Ground Floor	24th Floor
Diagrid	33.69	1.76	.71
	45	1.82	.73
	53.13	1.87	.73
	63.33	1.94	.75
Tube in tube	-	6.5	4.3

TABLE VII
SLratio (48X48 PLAN)

Type of Structure	Angle	SLRatio	
		Ground Floor	24 th Floor
Digrid	41.63	1.64	0.53
	53.13	1.96	0.59
	60.64	2.46	0.69
	69.44	2.53	0.73
Tube in tube	-	6.52	3.92

B. Lateral Displacement :

TABLE VIII
Lateral Displacement Comparison

Type of Structure	Angle	Lateral Displacement(mm)	Angle	Lateral Displacement(mm)
		36X36 PLAN		48X48 PLAN
Digrid	33.69	45.315	41.63	65.33
	45	42.37	53.13	61.27
	53.13	41	60.64	48.24
	63.43	39.25	69.44	45.69
Tube in tube	-	50.1	-	73.11

C. Time Period :

TABLE IX
Time Period Comparison

Type of Structure	Angle	Time Period (Sec.)	Angle	Time Period (Sec.)
		36X36 PLAN		48X48 PLAN
Digrid	33.69	3.225	41.63	4.306
	45	3.1	53.13	4.071
	53.13	3.087	60.43	3.662
	63.43	3.024	69.44	3.662
Tube in tube	-	3.725	-	4.851

CONCLUSION

It is observed that

1. The angle 33.69, 41.63 and 45 shows the minimum SLratio.
2. As the angle of Diagrid increses the the SLratio also increases.
3. SLratio at mid height is 60% to 75% less than SLat base for all angles.
4. The angle between 63.43 the SLratio is 10% more than SL for 33.69 for plan 36X36 where as for angle 60.43 SL is 40.655 more than for angle 41.63 .
5. SLratio is almost 3 times more in Tube in Tube structures than in Diagrid Structures.
6. The lateral Displacement results are exactly opposites in Diagrid, As the angle of diagrid increases the displacement in the structures decreses.
7. Lateral Displacement is more in the lower Diagrid angle than in higher diagrid angle. Lateral Displacement between the angle 33.69 and 63.43 is almost 14% more for plan 36X36.
8. In plan 48X48 it is almost 30% between angle 41.63 and 69.44.
9. From both the plan the lateral displacement is almost 10 more in Tube in Tube structural system than in Diagrid.
10. The Time period in Diagrid is less for angle between 50 to 70 than 30 to 45
11. The time period for 48X48 plan is more than twice for the plan 36X36.
12. From both the plan the Time period is almost 10 more in Tube in Tube structural system than in Diagrid.
13. Angle 60 to 70 is the optimal angle for Diagrid.
14. Diagrid Structure performs efficiently than the Tube in tube structures in Every aspect aspects.

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