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OPTIMIZATION OF LATERAL FORCE RESISTING SYSTEM IN TALL BUILDINGS UNDER SESMIC LOADS IN DIFFERENT SEISMIC ZONES

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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 selected structural system should be such that it should be effectively utilized for structural requirements. Efficient lateral systems, decreases the lateral deformations caused by the seismic forces in the buildings. The distribution of the mass symmetrically reduces the torsional effect in the building.

In this work, it is proposed to carry out an analytical study, on multi-storeys buildings of 10, 20 and 30 stories, was carried out accounting for different seismic zones. The suitability and efficiency of different lateral systems that are commonly used as conventional frame, concrete infill, diagrid and shear wall were investigated. These buildinq1g models are analysed, using ETABS 2015 software, to the action of lateral forces employing linear static and linear dynamic approaches as per IS 1893 (Part I): 2002. The results of the analyses, in terms of lateral deformations, base shear, modal time period respective storey drifts.

KEYWORDS:.

INTRODUCTION

Mankind has always had a fascination for height and throughout our history; we have constantly sought to metaphorically reach for the stars. From the ancient pyramids to today’s modern skyscraper, a civilization’s power and wealth has been repeatedly expressed through spectacular and monumental structures. Today, the symbol of economic power and leadership is the skyscraper. There has been a demonstrated competitiveness that exists in mankind to proclaim to have the tallest building in the world. The design of sky scrapers is usually governed by the lateral loads imposed on the structure. As buildings have taller and narrower, the structural engineer has been increasingly challenged to meet the imposed drift requirements while minimizing the architectural impact of the structure. In response to this challenge, the profession has proposed a multitude of lateral schemes that are now spoken in tall buildings across the globe. For this purpose, 10, 20 and 30 storied building is considered in which diagrid system, conventional frame, shear wall frame and infill wall frame are provided with four seismic zones. Linear static analysis is also known as time seismic coefficient method. It is an important and accurate technique for structural seismic analysis especially when the evaluated structural response is linear. Linear static and dynamic analysis was carried out with four seismic zones (II, III, IV and V) for 10, 20 and 30 storied building.

MODELLING PARAMETERS

Building Description: Reinforced Concrete Frames of 10 storeys, 20 storeys and 30 storeys with plan size 18mx18m, with heights of 30m, 60m and 90m respectively are modelled.

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S. No.	Specifications	10,20&30 storey
1	Slab Thickness	150mm
2	Beam dimensions	
	10 STORIES	450x230mm
	20,30 STORIES	500X230mm
3	Column dimensions	450x600mm,
		750x500mm
4	Grade of concrete	M30
5	Grade of steel	Fe-500
6	Unit weight of concrete	$25kN/m^3$
7	Live loads	$3kN/m^2$
	(a) Floor load	$1.5kN/m^2$
8	Diagrid	500x500 mm
9	Type of structure	Diagrid two story module
10	Importance factor	1
11	Seismic zone	II,III,IV&V
12	Response reduction factor	5

Table 1 Data of RC Frames considered in study

unit weight of masonry	20kn/m3
modulus of elasticity E	3285.9Mpa
poisons ratio U	0.15
SHEAR MODULUS G	1428.65 MPa
thickness of wall	230mm

Table 2 Data of infill Frames considered in study

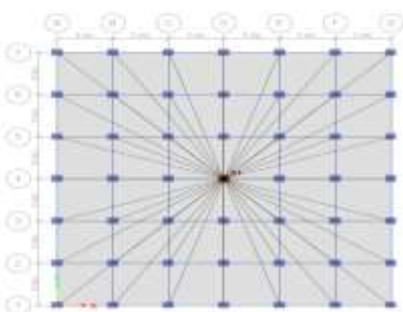

Fig 1: plan of Rcc frame model

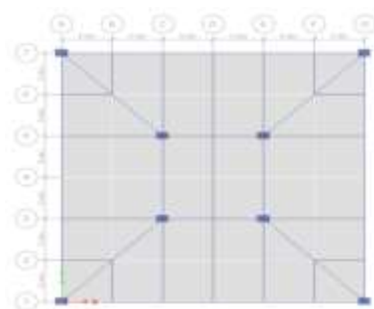

Fig 2: plan of Diagrid frame model

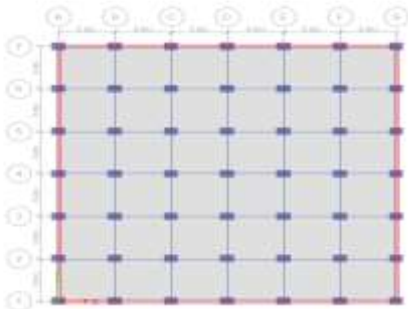
Fig 3: plan of infill frame model

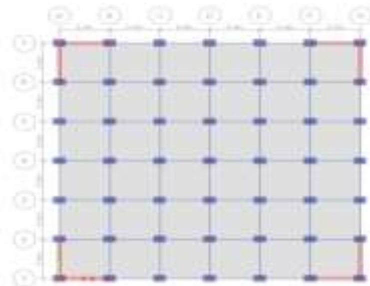
Fig 4: plan of shear wall frame model

ANALYSIS RESULTS

The Results obtained are of different parameters such as Storey drifts, Base shear,
Modal Periods etc. The results obtained by carrying out linear static and linear dynamic analysis for Buildings as listed.

RESULT FOR LINEAR DYNAMIC ANALYSIS OF 10 STORIES BUILDING

RESPONSE SPECTRUM						
	BARE FRAME	DRIFT	infill	DRIFT	diagrid	DRIFT
STORY 1	3.4	3.4	1.5	1.5	0.6	0.6
STORY 2	9.4	2.0	3.4	0.6	1.7	0.4
STORY 3	16	2.2	5.4	0.7	2.9	0.4
STORY 4	22.3	2.1	7.3	0.6	3.6	0.2
STORY 5	28.2	2.0	9.2	0.6	4.9	0.4
STORY 6	33.3	1.7	11	0.6	5.5	0.2
STORY 7	37.7	1.5	12.6	0.5	6.8	0.4
STORY 8	41.2	1.2	14	0.5	7	0.1
STORY 9	43.7	0.8	15.1	0.4	8.1	0.4
STORY 10	45.3	0.5	15.9	0.3	8.6	0.2

TABLE 3: showing displacement and story drift with response spectrum for 10 storie

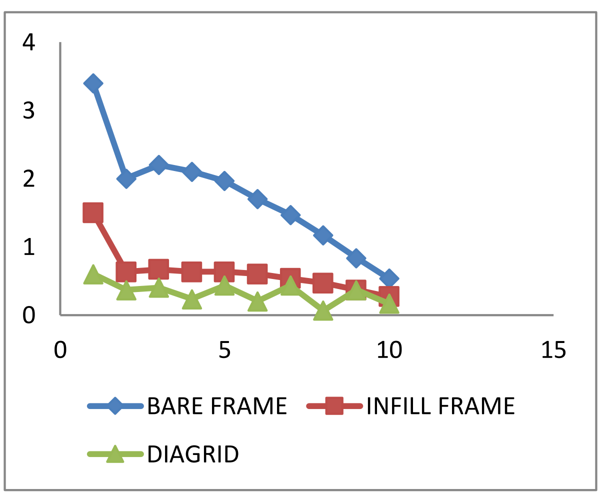

Fig 5: STORY DRIFT OF 10 STORIES FRAME

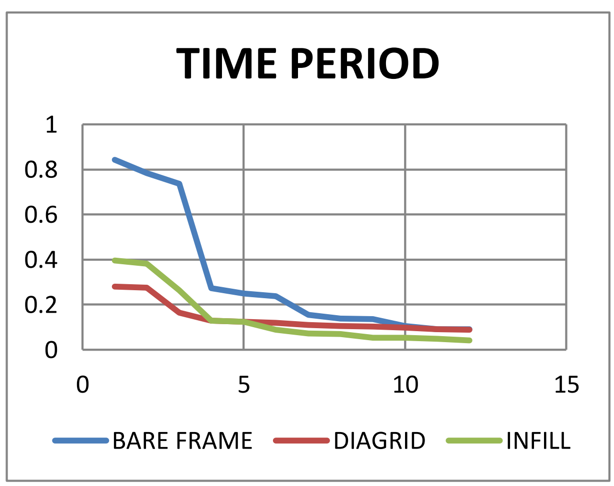

Fig 6: STORY DISPLACEMENT OF 10 STORIES FRAME

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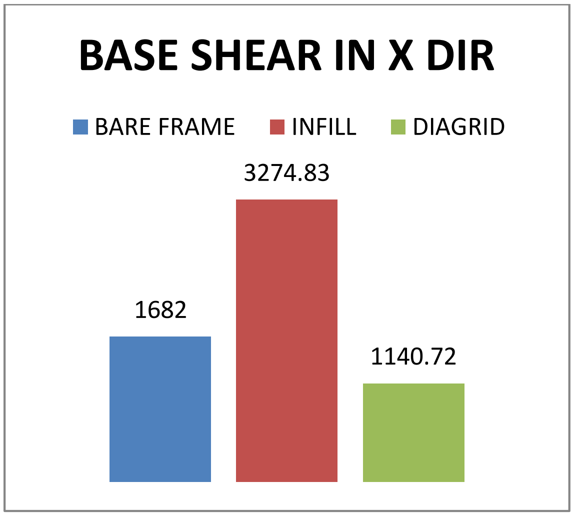

Fig 7: TIME PERIOD OF 10 STORIES FRAME

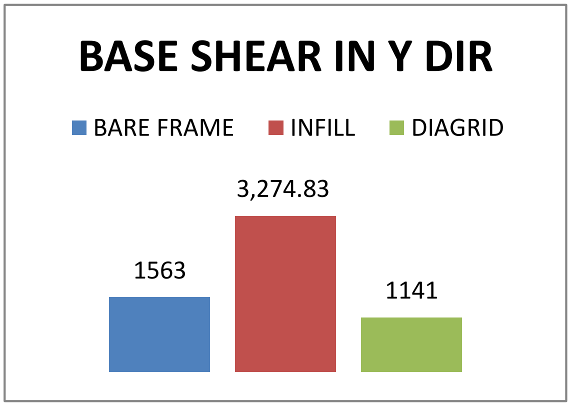

Fig 8: BASE SHEAR OF 10 STORIES FRAME

RESULTS FOR LINEAR DYNAMIC ANALYSIS OF 20 STORIES BUILDING

RESPONSE SPECTRUM						
	BARE FRAME	DRIFT	DIAGRID	DRIFT	INFILL	DRIFT
STORY 1	2.6	2.6	1.2	1.2	1.6	1.6
STORY 2	7.7	1.7	3.1	0.6	4	0.8
STORY 3	13.7	2.0	5	0.6	6.6	0.9
STORY 4	19.8	2.0	6.9	0.6	9.5	1.0
STORY 5	26	2.1	9.2	0.8	12.5	1.0
STORY 6	32	2.0	11.5	0.8	15.6	1.0
STORY 7	37.8	1.9	14.1	0.9	18.8	1.1
STORY 8	43.5	1.9	16.5	0.8	22.1	1.1
STORY 9	48.9	1.8	19.3	0.9	25.3	1.1
STORY 10	54	1.7	21.8	0.8	28.6	1.1
STORY 11	58.9	1.6	24.7	1.0	31.8	1.1
STORY 12	63.6	1.6	27.3	0.9	35	1.1
STORY 13	67.9	1.4	30.3	1.0	38.1	1.0
STORY 14	72	1.4	32.8	0.8	41.1	1.0
STORY 15	75.7	1.2	35.7	1.0	44	1.0
STORY 16	79	1.1	38.1	0.8	46.8	0.9
STORY 17	81.9	1.0	40.9	0.9	49.4	0.9
STORY 18	84.4	0.8	43.1	0.7	51.9	0.8
STORY 19	86.5	0.7	45.9	0.9	54.1	0.7
STORY 20	89.1	0.9	47.7	0.6	56.2	0.7

TABLE 4: showing displacement and story drift with response spectrum for 20 stories

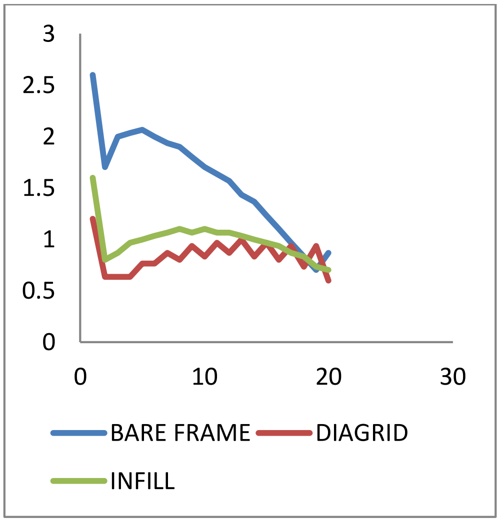

Fig 10: STORY DRIFT OF 20 STORIES FRAME

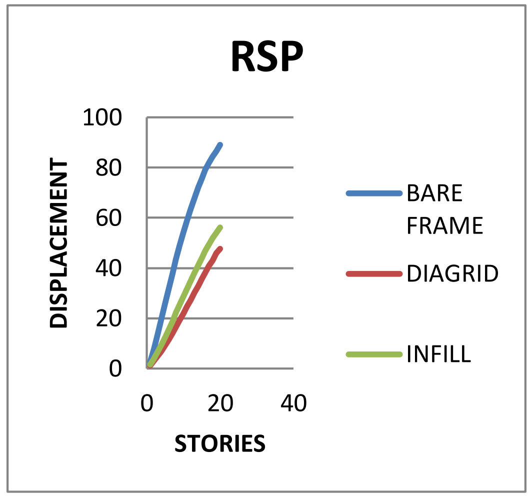

Fig 11: STORY DISPLACEMENT OF 20 STORIES FRAME

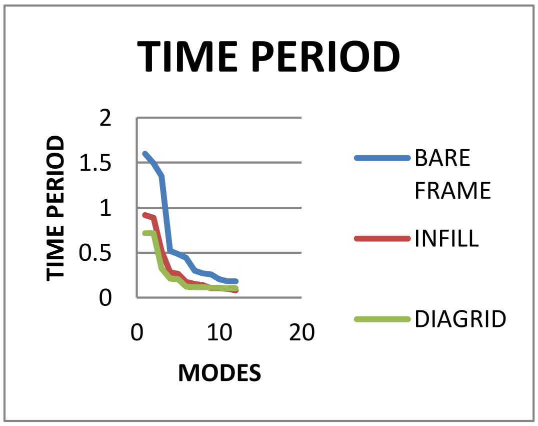

Fig 12: TIME PERIOD OF 20 STORIES FRAME

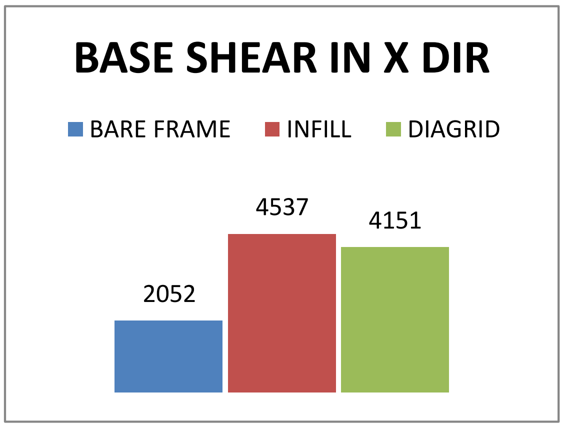

Fig 13: BASE SHEAR OF 20 STORIES FRAME

RESULTS FOR LINEAR DYNAMIC ANALYSIS OF 30 STORIES BUILDING

RESPONSE SPECTRUM								
	BARE FRAME	DRIFT	infill	DRIFT	diagrid	DRIFT	shear wall	DRIFT
STORY 1	2.6	2.6	1.5	1.5	0.9	0.9	1.2	1.2
STORY 2	7.6	1.7	3.8	0.8	2.7	0.6	3.9	0.9
STORY 3	13.6	2.0	6.4	0.9	4.5	0.6	7.5	1.2
STORY 4	19.9	2.1	9.2	0.9	6.3	0.6	11.8	1.4
STORY 5	26.2	2.1	12.2	1.0	8.5	0.7	16.7	1.6
STORY 6	32.6	2.1	15.3	1.0	10.7	0.7	21.9	1.7
STORY 7	38.8	2.1	18.6	1.1	13.3	0.9	27.4	1.8
STORY 8	45	2.1	22.1	1.2	15.8	0.8	33	1.9
STORY 9	51.1	2.0	25.6	1.2	18.7	1.0	38.7	1.9
STORY 10	57.1	2.0	29.2	1.2	21.5	0.9	44.5	1.9
STORY 11	63.1	2.0	32.9	1.2	24.6	1.0	50.2	1.9
STORY 12	68.9	1.9	36.6	1.2	27.7	1.0	55.8	1.9
STORY 13	74.6	1.9	40.4	1.3	31	1.1	61.4	1.9
STORY 14	80.1	1.8	44.3	1.3	34.3	1.1	66.9	1.8
STORY 15	85.6	1.8	48.1	1.3	37.8	1.2	72.3	1.8
STORY 16	91	1.8	52.1	1.3	41.3	1.2	77.6	1.8
STORY 17	96.2	1.7	56	1.3	44.9	1.2	82.7	1.7
STORY 18	101.3	1.7	60	1.3	48.5	1.2	87.7	1.7
STORY 19	106.2	1.6	63.9	1.3	52.3	1.3	92.6	1.6

STORY 20	111.1	1.6	67.9	1.3	55.9	1.2	97.3	1.6
STORY 21	115.7	1.5	71.9	1.3	59.7	1.3	101.9	1.5
STORY 22	120.2	1.5	75.8	1.3	63.4	1.2	106.3	1.5
STORY 23	124.4	1.4	79.7	1.3	67.2	1.3	110.5	1.4
STORY 24	128.5	1.4	83.5	1.3	70.9	1.2	114.5	1.3
STORY 25	132.3	1.3	87.3	1.3	74.7	1.3	118.4	1.3
STORY 26	135.9	1.2	91	1.2	78.3	1.2	122	1.2
STORY 27	139.2	1.1	94.7	1.2	82.1	1.3	125.5	1.2
STORY 28	142.1	1.0	98.2	1.2	85.6	1.2	128.8	1.1
STORY 29	144.8	0.9	101.6	1.1	89.4	1.3	131.9	1.0
STORY 30	149.3	1.5	103	0.5	92.7	1.1	134.9	1.0

TABLE 5: showing displacement and story drift with response spectrum for 30 stories

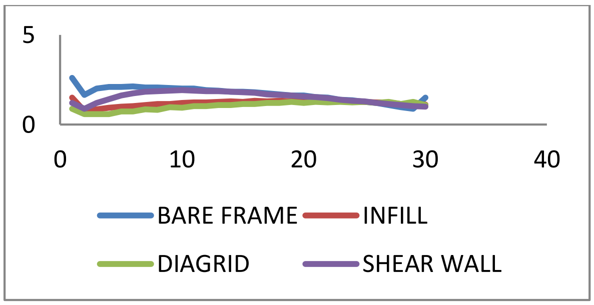

Fig 15: STORY DRIFT OF 30 STORIES FRAME

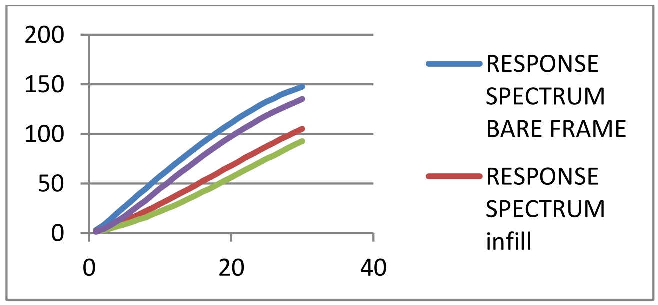

Fig 16: STORY DISPLACEMENT OF 30 STORIES FRAME

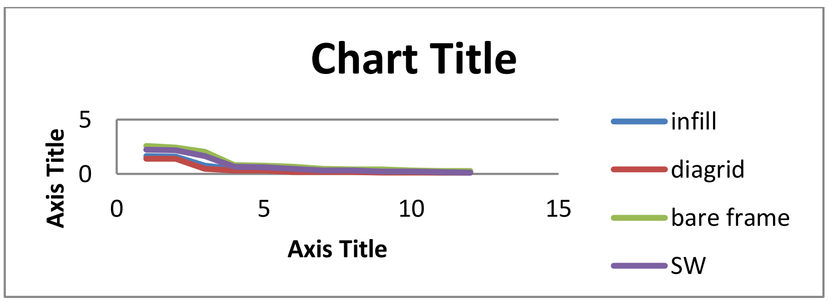

Fig 17: TIME PERIOD OF 30 STORIES FRAME

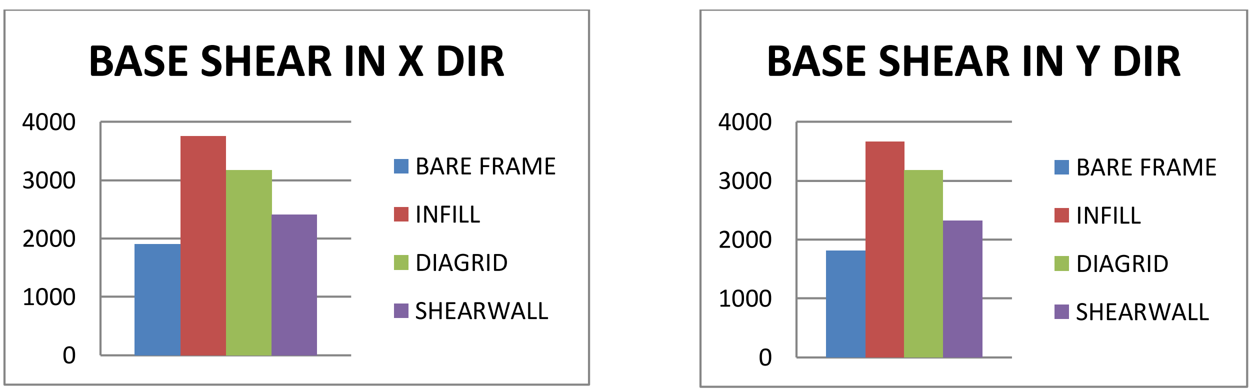

Fig 18: BASE SHEAR OF 30 STORIES FRAME IN X AND Y DIRECTION.

CONCLUSIONS

Today's complex-shaped tall buildings require more complicated system design, analysis and construction. Not only architectural but also structural and other related performance issues should be considered holistically to produce higher quality built environments. Well-organized coordination between architects and engineers is essential.

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- For ten story buildings, In order to control the seismic response diagrid were modeled and the results showed that there is a drastic decrease in storey displacements by 81% and 46% compared to 10 stories bare frame and infill frame and storey drifts by 60% and 33% compared to other symmetric building.
- In present work, due to using infill wall it gives good ductility and increase in strength carrying capacity and initial stiffness of Rcc frame .the reduction of story drift by 40% compared to 10 stories normal Rcc framed structure.
- For twenty story buildings, In order to control the seismic response diagrid were modeled and the results showed that there is a drastic decrease in storey displacements by 47% and 16% compared to 20 stories bare frame and infill frame.
- For thirty story buildings, In order to control the seismic response diagrid were modeled and the results showed that there is a drastic decrease in storey displacements by 37% ,31% and 12% compared to 30 stories bare frame, shear wall frame and infill frame.
- As the lateral loads are resisted by diagonal columns, the top storey displacement is very much less in diagrid structure as compared to the other frame building.
- As time period is less, lesser is mass of structure and more is the stiffness, the time period is observed less in diagrid frame structure which reflects more stiffness of the structure and lesser mass of structure.
- The overall results suggested that diagrid structure is excellent seismic control for high-rise symmetric Bu

SCOPE FOR FURTHER STUDY

1. To study the shear lag effect on tall structure exhibit a considerable degree of shear-lag with consequential reduction in structural efficiency.
2. To study the Wind effects on tall building frames-influence of dynamic parameters.
3. In the present study, openings were not considered in infills. Presence of opening in infills significantly reduces the stiffness and strength of the infilled frames. Suitability of the proposed strengthening schemes must be verified for Masonry-infilled frames with openings with walls.

REFERENCES

[1] Smith, B. S. and Coull, A.Tall Building Structures: Analysis and Design“, John Wiley & Sons, Inc., 1991
[2] A. Coull & E.stafford Smith, „Tall Buildings, with particular reference to shear wall structures“, Pergamon Press, 1967
[3] Mir M. Ali,Performance characteristics of tall framed tube buildings in seismic zones“, Elsevier Science Ltd,1996
[4] Journal of Structural Engineering vol. 120 Nos. 1-4, 1994, P 1221- „ Simple Method for Approximate Analysis of framed tube structures“
[5] S.M.A. Kazini, R. Chandra, “Analysis of Shear-walled Buildings “
[6] Chen, Genda, and Jingning Wu. 2001. “Optimal Placement of Multiple Tune Mass Dampers for Seismic Structures.” Journal of Structural Engineering 127 (9): 1054–1062.
[7] Moon, Kyoung Sun. 2008. “Optimal Grid Geometry of Diagrid Structures for Tall Buildings.” Architectural Science Review 51 (3): 239–251.
[8] Pankaj Agarwal and manish shrikhande, (2006), "earthquake resistant design of structures", eastern economy edition publisher of engineering books.
[9] R. Clough, and J. Penzien (1993), “Dynamics of Structures”, Second Edition, McGraw-Hill, Inc., ISBN 0-07-011394 .