COMPARATIVE STUDY OF DIFFERENT GEOMETRICAL PATTERNS FOR DIAGRID STRUCTURE

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Abstract : ***The evolution of tall building structural systems based on new structural concepts with newly developed high strength materials and newly construction methods have been towards become a structure system stiffer and lighter. Structure design of high rise buildings is governed by lateral loads like to wind or earthquake. Lateral load resistance of structure is provided in interior structural system or exterior structural system. Mostly lateral load are affect at exterior face of structure so Lateral load resistance of structure is provided at exterior face. This dissertation is based on linear dynamic analysis of various five type of geometry pattern of Diagrid structure on various Storeys like G+24, G+30 and G+36. Here rectangular floor plan of 36m x 36m considered. Staad-pro software is used for modelling and analysis of structures. All structural members are considered as per IS 800:2007, Seismic loads are as per IS 1893(Part 1): 2002 and wind loads are as per IS: 875(Part-3)-1987. Here total 15 types of Diagrid structure are carried out for project, under comparison of various parameters. Finally compared that all five parameters and identified Most efficient pattern under that particular parameters.***

IndexTerms – Diagrid structure, response spectrum, wind load, staad-pro, base shear, model time period, Introduction

I. INTRODUCTION

Now a day the Diagrid structure (diagonal grid structure) is widely used in high rise buildings. Diagrid structure are very popular in architectures and structure designers because for architectures Diagrid structure is gives aesthetic view and for structure engineers, it is useful for resist lateral load and increase efficient of structure. Diagrid structure is very popular for Tall buildings to resist lateral loads like wind and earthquake load. Lateral load resistance by interior system or exterior system. In which shear wall core and braced frame are interior system and frame tube, tube in tube, outer periphery bracings are exterior system. In Diagrid building vertical columns are eliminate. Because diagonal member are carry gravity load as well as lateral load. The Diagrid is a formwork of diagonally intersection of metal, concrete, wooden and steel beams are used for construction of buildings. It required less steel then normal conventional steel building. Hearst tower in New York uses 21 present less steel than a standard design. There is no need to horizontal and vertical member at outer side of building. So requirement of steel become less. Due to Diagrid structure Increase a stability to resist lateral load and gravity load. That type of load resistant stability is increase Due to triangulation load transfer. For triangular Diagrid load transfers there are ring beam provide at each floor and diagonal members are connected with that ring beam. So all type load like lateral load, gravity/self-weight or moment are transfer by triangulation. Effect of shear force, effect of moment and effect of gravity load transfer

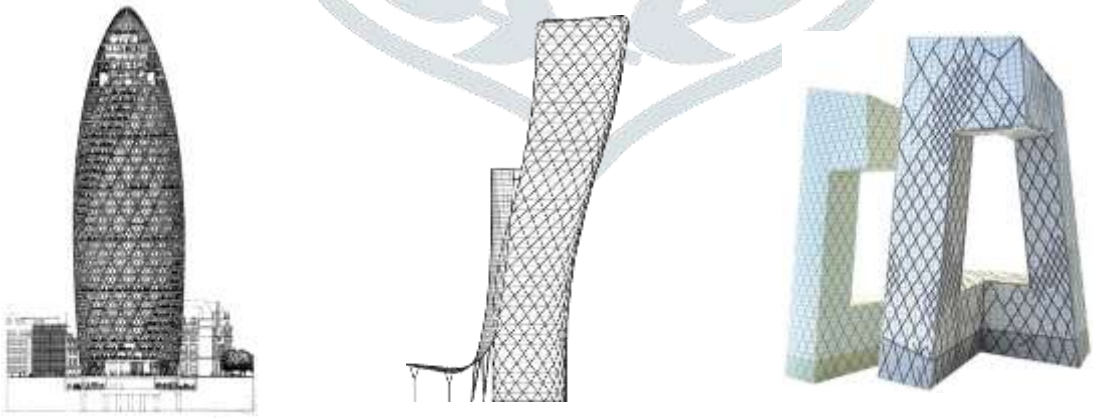


Figure1.layout of unique diagrid structures

II. THEORETICAL BACKGROUND

In which, comparison of various geometry patterns of Diagrid structure with different parameters. For that purpose there are five type of different patterns and three different height of building are considered for comparative analysis. Various Diagrid patterns are given below,

- **Pattern 1**: constant angle of 72° throughout all building.
- **Pattern 2**: various angles from bottom story to top story are 74°, 72°, 63° and 56°.
- **Pattern 3**: constant angle of 72° and non-uniform diagonal patterns.
- **Pattern 4**: constant angle of 80° but diagrid pattern are not stiffer.
- **Pattern 5**: secondary bracing system (SBS) provide throughout all building with angle of 63°

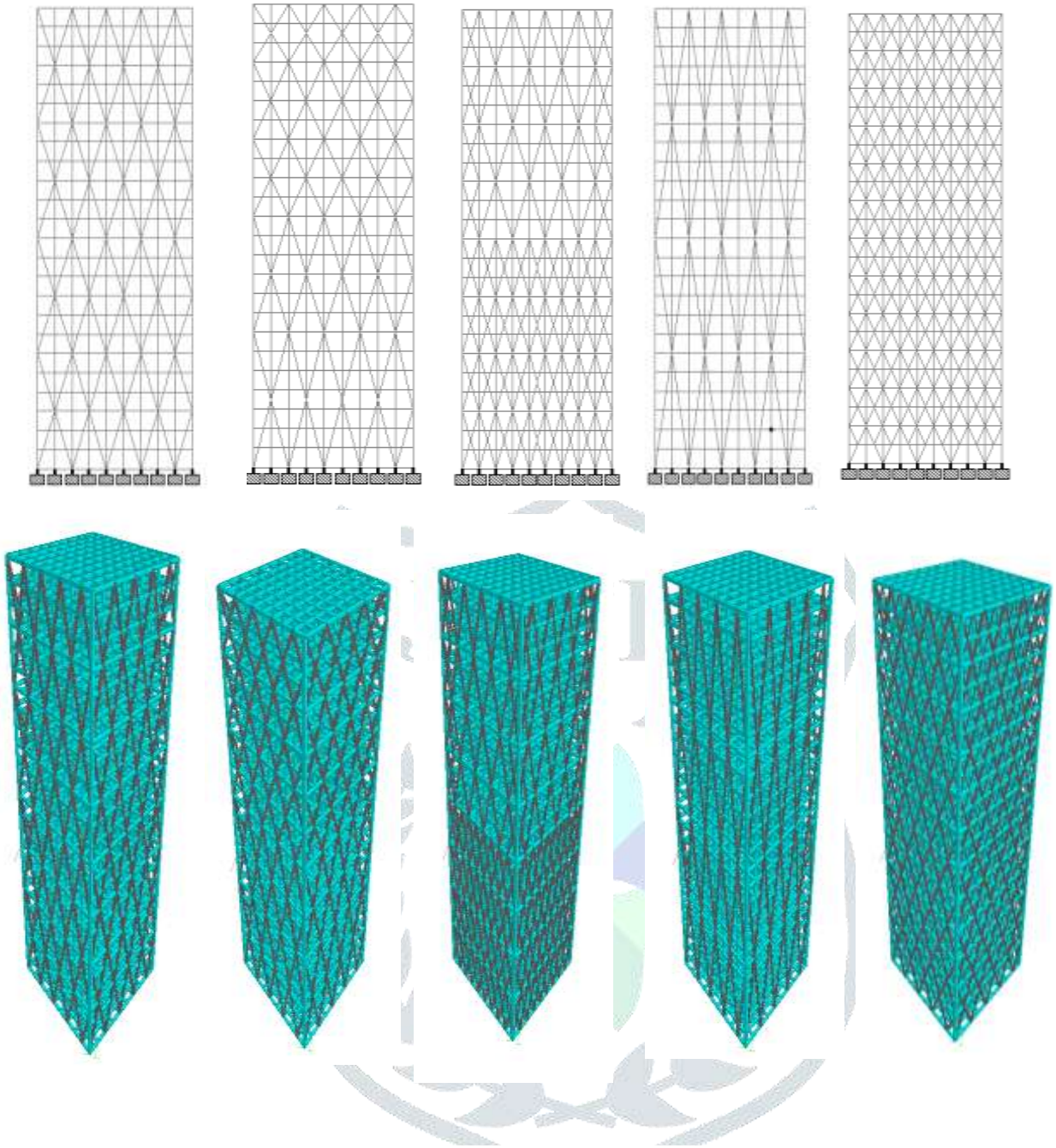


Figure 4. Different geometry design of diagrid structure

Here Comparative study of moment resisting frame structure under various parameter like base shear, model time period, lateral displacement, top story displacement and storey drift. So comparative of different diagrid patterns with that five parameters as per different storey. So comparison will done for 15 models under various parameters. Those parameters are given below,

1	Model time period	As per IS1893-2002, cl 7.6.1 for rc-frame building
2	Lateral displacement	In wind as per IS 456-2000, cl 20.5
		In seismic as per IS1893-2002, cl 7.11
3	Top story displacement	In wind as per IS 456-2000, cl 20.5
		In seismic as per IS1893-2002, cl 7.11
4	Story drift	In wind as per IS 456-2000, cl 20.5
		In seismic as per IS1893-2002, cl 7.11
5	Base shear	As per IS1893-2002, cl 7.5.3

III. IMPLEMENTATION WORK

For the purpose of study of behaviour of G+24, G+30 and G+36 storey building with different geometric patterns of diagrid structure under various parameters like base shear, model time period, top story displacement, story drift and lateral displacement. The building is analysed by under seismic load (response spectrum-liner dynamic analysis) IS-1893:1:2000 and wind load IS-875.3:1987 using Staad-pro software.

Table 1.general data of dissertation

GENERAL DATA		
1	Plan area	36 X 36 m
2	no of story	24,30,36 m
3	storey height	4 m
4	Dead Load	3.75 kn/m2
5	Live Load	3 kn/m2
6	Zone factor	Zone:2 (0.16)
7	soil type	medium soil
8	response reduction R	5
9	importance factor I	1
10	wind speed (surat)	44 m/s
11	terrain category	4
12	slab thickness	150 mm
13	grade of concrete	M35
14	grade of Structural member steel	Fe415
15	No. of patterns	5

Here plan of structural frame is given below, there are 36x36 m plan area with 9-bays of 4 m in X and Y direction. So it is a simple moment resistance RC frame structure are there for analysis of different geometry patterns of diagrid structure. There are only interior columns and corner 4 columns are in frame structure and around the frame only diagrid(inclined columns) are provide with different patterns. So that structural system is moment resisting frame with diagonal column structural system.

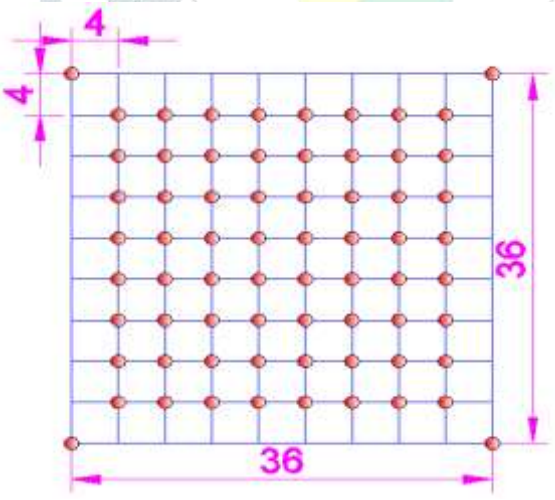
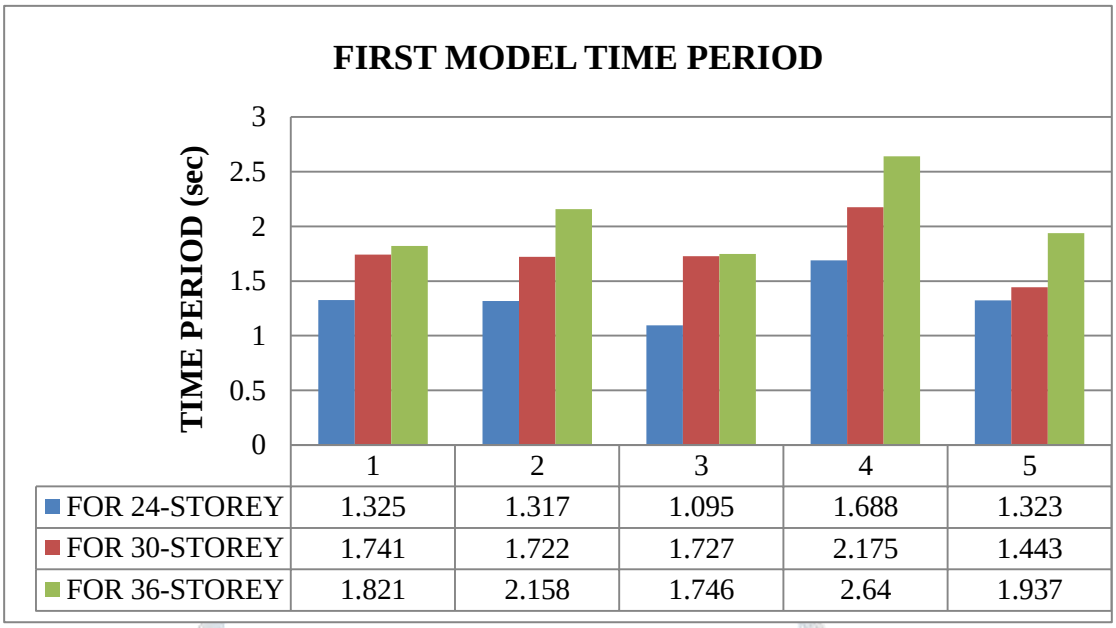


Figure 5. plan layout of diagrid structure

IV. RESULTS AND DISCUSSION

A comparative study and analysis of different geometry patterns of diagrid structure as per various height under seismic and wind load. Here linear dynamic analysis (response spectrum) is carried out for seismic load for G+24, G+30 and G+36 storey frame structure under various parameters like base shear, model time period, top storey displacement, storey drift and lateral displacement. As per the below chart, for G+24 Storey frame structure 5 patterns are compared with each other under various parameters. Same way for G+30 and G+36 Storey frame structure parameters are compared. Then also compared various parameters with various height of structure. So total 15 models comparison are carried out for result and comparison.

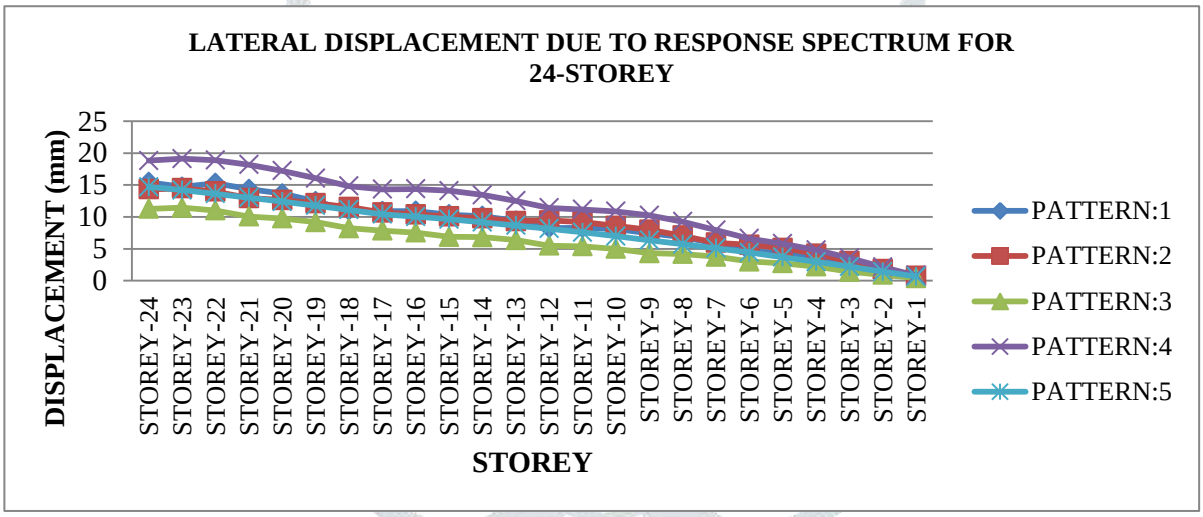
a) Model Time Period

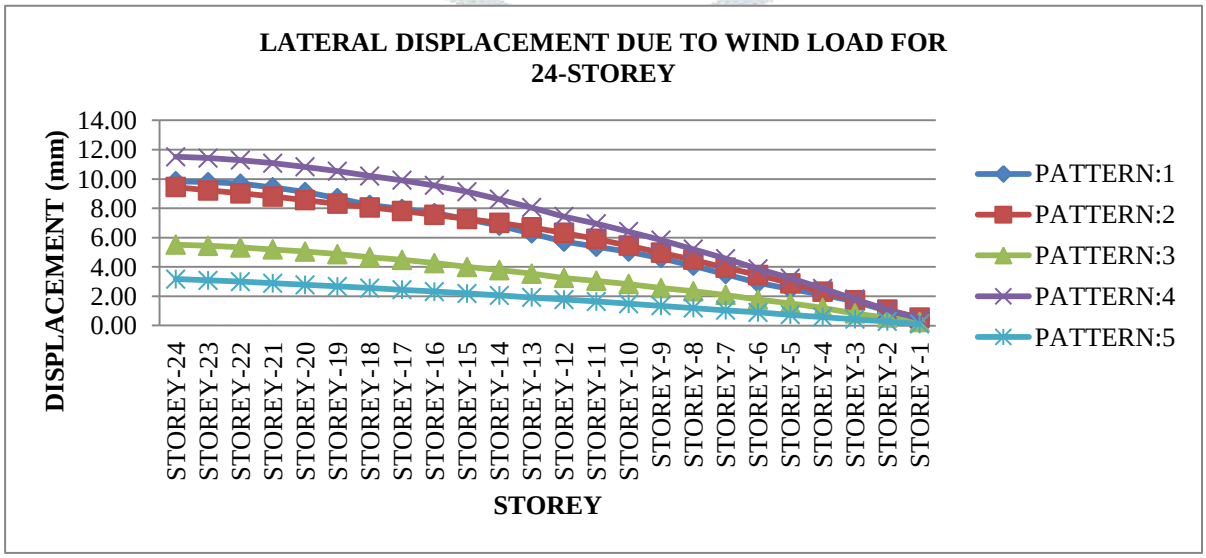


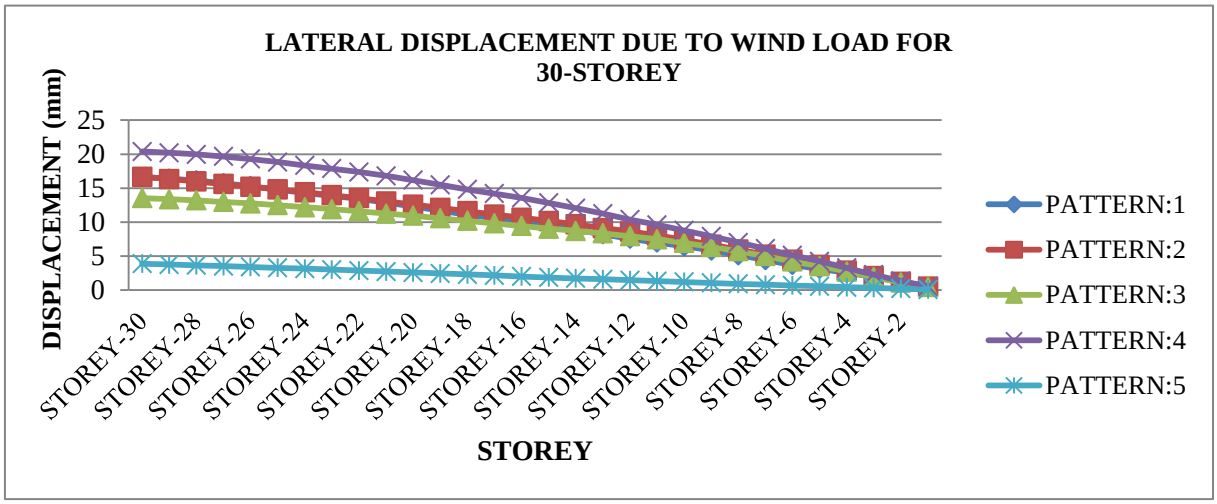
	1	2	3	4	5
FOR 24-STOREY	1.325	1.317	1.095	1.688	1.323
FOR 30-STOREY	1.741	1.722	1.727	2.175	1.443
FOR 36-STOREY	1.821	2.158	1.746	2.64	1.937

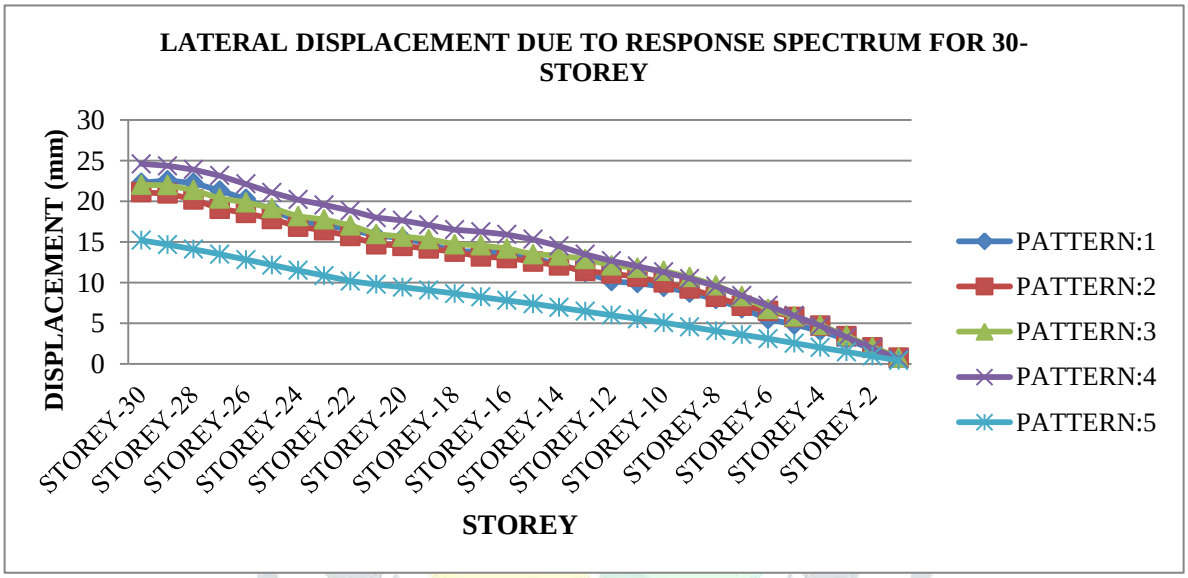
Chart 1. time period of all storey with all patterns

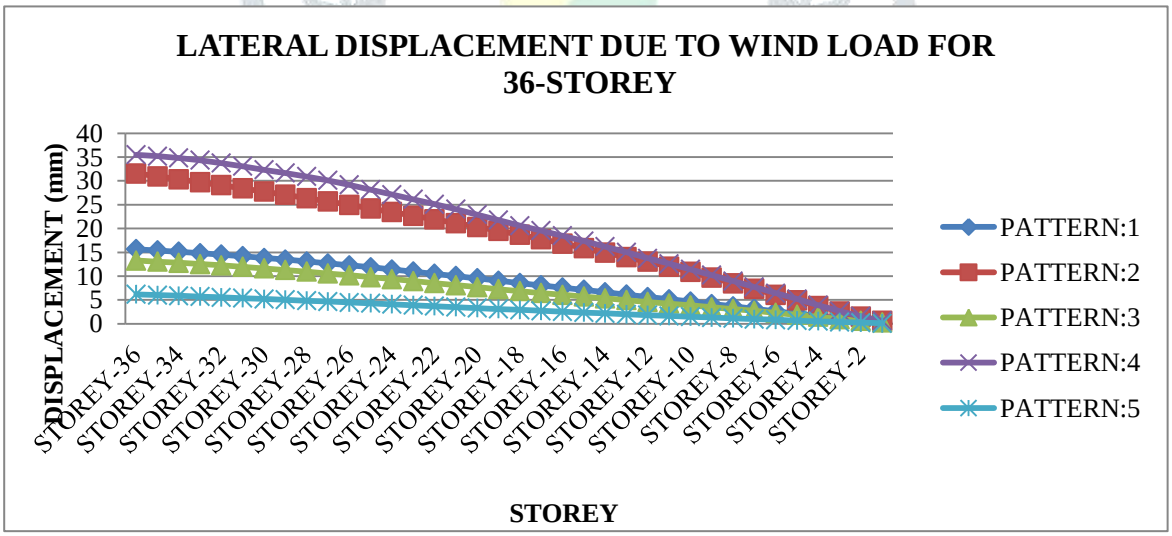
b) Storey Lateral Displacement






LATERAL DISPLACEMENT DUE TO WIND LOAD FOR 30-STOREY
DISPLACEMENT (mm)
25
20
15
10
5
0
STOREY-30
STOREY-28
STOREY-26
STOREY-24
STOREY-22
STOREY-20
STOREY-18
STOREY-16
STOREY-14
STOREY-12
STOREY-10
STOREY-8
STOREY-6
STOREY-4
STOREY-2
STOREY
PATTERN:1
PATTERN:2
PATTERN:3
PATTERN:4
PATTERN:5


LATERAL DISPLACEMENT DUE TO RESPONSE SPECTRUM FOR 30-STOREY
DISPLACEMENT (mm)
30
25
20
15
10
5
0
STOREY-30
STOREY-28
STOREY-26
STOREY-24
STOREY-22
STOREY-20
STOREY-18
STOREY-16
STOREY-14
STOREY-12
STOREY-10
STOREY-8
STOREY-6
STOREY-4
STOREY-2
STOREY
PATTERN:1
PATTERN:2
PATTERN:3
PATTERN:4
PATTERN:5


LATERAL DISPLACEMENT DUE TO WIND LOAD FOR 36-STOREY
DISPLACEMENT (mm)
40
35
30
25
20
15
10
5
0
STOREY-36
STOREY-34
STOREY-32
STOREY-30
STOREY-28
STOREY-26
STOREY-24
STOREY-22
STOREY-20
STOREY-18
STOREY-16
STOREY-14
STOREY-12
STOREY-10
STOREY-8
STOREY-6
STOREY-4
STOREY-2
STOREY
PATTERN:1
PATTERN:2
PATTERN:3
PATTERN:4
PATTERN:5

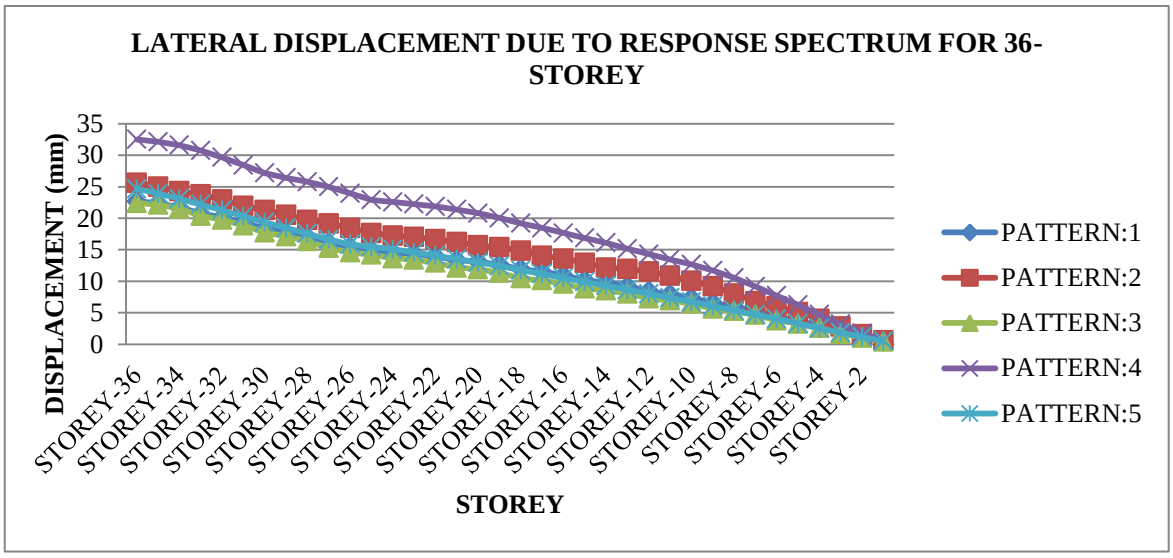
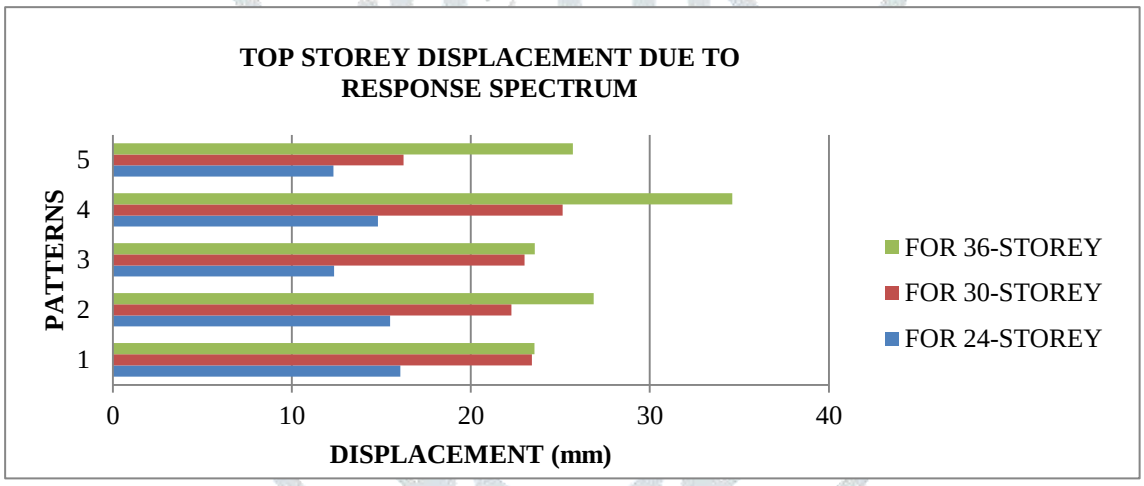


Chart2. lateral displacement of all storey due to RS and WL

c) Top Storey Lateral Displacement

Top storey displacements of as per different storey of diagrid structure are given in below table. Storey displacement limit as per IS-456(2000) for wind load is H/500 and as per IS-1893-(2002) for earthquake is H/250.



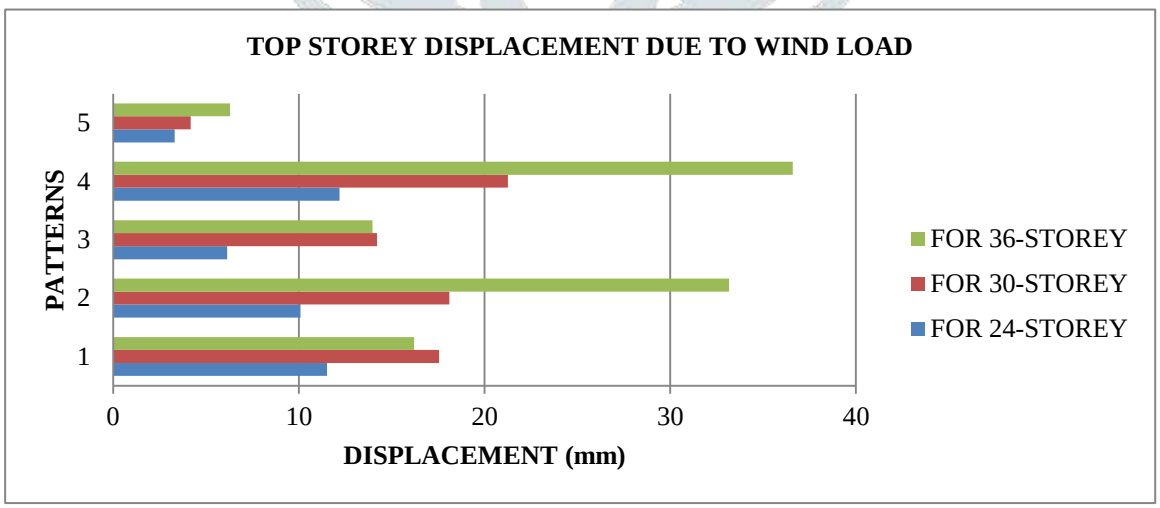


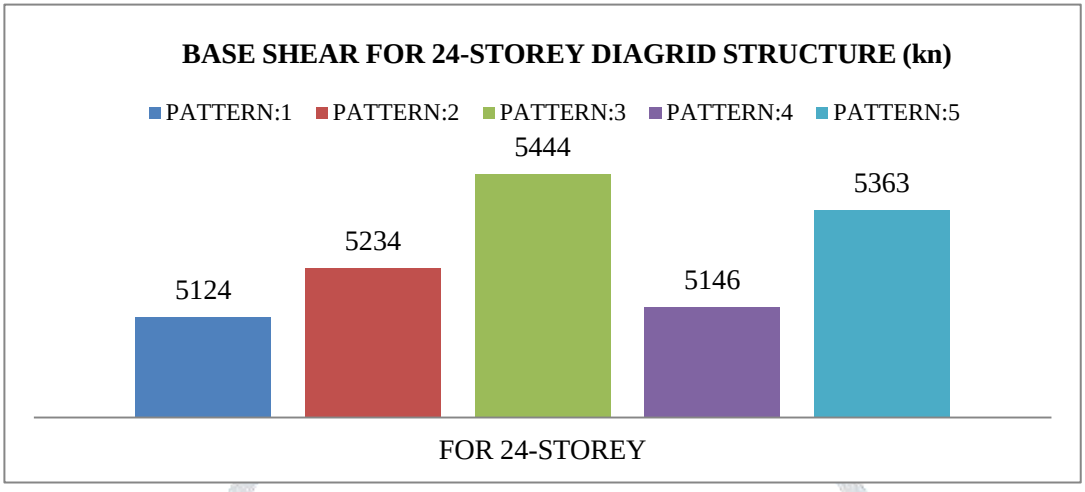
Chart 3. Top storey displacement of all patterns in RS and WL

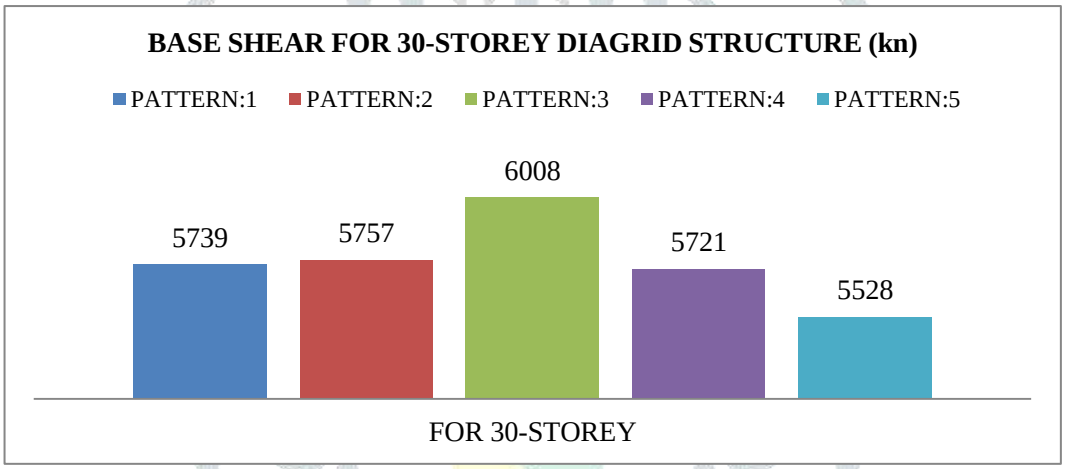
d) Storey Drift

As per **IS 1893-1: 2002, Clause no. 7.11.1** permissible storey drift in any storey is not exceed 0.004 times the storey height. So that permissible inter storey drift is **16** of building having 4.0 m storey height. Most efficient behaviour against storey drift of 24-storey and 30-storey structure is in **pattern 5**. minimum storey drift against wind load and seismic load are **0.168** and **0.788 for G+24**, 0**.149** and **0.684 for G+30** respectively. For **G+36** storey structure minimum storey drift is in **pattern 5** is **0.086** in wind load and **pattern 3** is **0.267** in seismic.

e) Base Shear

Base shear is the maximum expected lateral force that will occur due to seismic ground motion at the base of structure. According to IS: 1893 (Part-1): 2002, clause 7.8.2 response values have been modified and considered for comparison. The total design force or design base shear along any principal direction shall be determined by the following expression: Vb = Ah * W





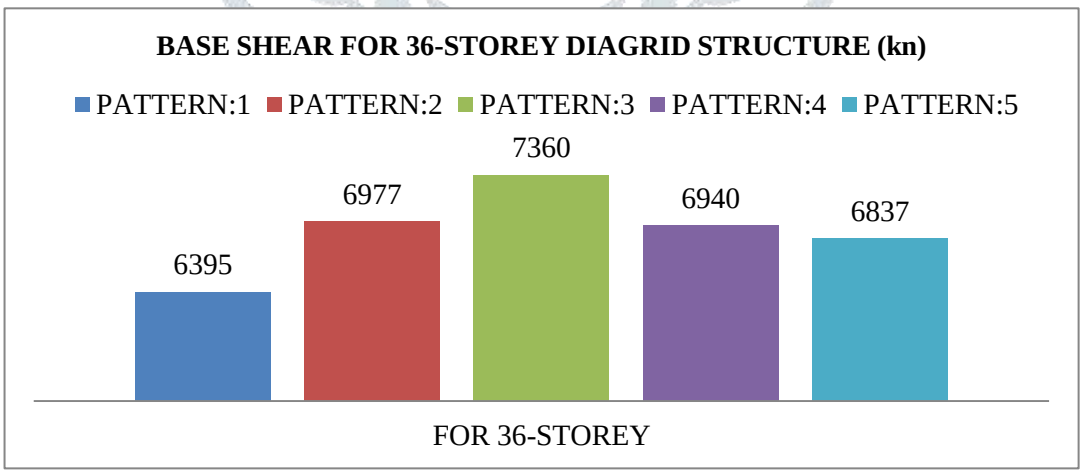


Chart 4. Base reaction of different patterns

V. CONCLUSION

- **model time period** is less For G+24 and G+36 storey in Pattern 3 and For G+30 storey in Pattern 5. So that patterns have stiffer and capacity to resist seismic load is more with compared to others patterns.
- All patterns are in permissible limit for **lateral displacement,** but pattern-5 is more sufficient against wind load and pattern-3 is sufficient against seismic load. for all G+24, G+30 and G+36 storey diagrid structure.
- Most efficient pattern against **storey drift** in wind load for all different storey is pattren-5 and for seismic load pattern-5 is efficient in G+24 and G+30 and for G+36 pattren-3 is more efficient.
- **Base shear** is less in pattern:1 in G+24 and G+36 storey. But as per increasing height base shear is less in pattern-5. so that's most efficient pattern with compared to other patterns.

- From the above result and discussion it's observed that all patterns are behaved different in different parameters.
- After all result comparison **pattren-5 (secondary bracing in diagrid pattern)** is most efficient in different parameters.

VI. REFERENCE

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