COMPARATIVE STUDY ON DYNAMIC BEHAVIOUR OF MULTI-STOREY BUILDING WITH AND WITHOUT COUPLED SHEAR WALL SYSTEM

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Abstract - *In high and medium rise structures to resist lateral forces, coupled shear walls are one of the systems commonly used. In multistory building should not collapse or is induced severe damage during earthquake actions so, for this reason coupled shear walls are used. It should be having high strength, high ductility, high energy absorption capacity and high shear stiffness to limit lateral deformations. In the project, the building with without coupled shear wall is considered and the same building is with coupled by two shear wall with including flat slab with drop panel in Soft Soil Condition with different seismic zone condition is considered, then compare the behavior of these buildings are studied. Analysis is done by using ETABS software for static and dynamic case.*

Key Words: **Coupled Shear wall, Flat Slab with drop, Storey Displacement, Storey Drift, Base Shear, Time Period and ETABS.**

1 INTRODUCTION

Building is a structure in which, it consists of wall and roof. Where there are presents more or less permanently in level surface, as house or factory. Building having so many verities like shape, size and function. Has been consider throughout the history for a huge no of factor from building materials available, ground conditions, specific uses and aesthetic reasons

A multi-story building are supports two or more floors above ground. There is no formal restriction the height of such a building or the member of floors a multi story building may contain, through taller building do face more practical difficulties.

1.1 Seismic Load

In General Dynamic motions are occurred when the building is subject to earthquake. Inertia force acts to the building in opposite towards the acceleration of earthquake excitation there inertia force is called seismic loads, terms like time and space where seismic loads are not constant. Maximum storey shear force is consider, where it act as a most influential to the static loads give maximum storey shear force for each floor

1.2 Wind Load

Wind load is a one of the type of lateral load; the positive or negative force of the wind acting on a structure, wind applies a positive pressure on the windward side of building and a negative suction to the leeward side. Wind load can appear in any unexpected directions. Variations of wind speed will be directly proportional to the magnitude of the pressure that appears over the surface. Here wind may appear either positive or negative pressure where it will be influence by architectural plan or design

1.3 Lateral Earth Pressure

It is the type of lateral loads in which, it is the pressure that soil exerts in the horizontal direction. Its depends on Shear strength characteristics of soil, Lateral strain condition, Pore water pressure, State of equilibrium of soil and wall and ground surface shape. Lateral earth pressure say that below the ground there will be flow of water it may appears the lateral pressure over the building. Density of liquid is always directly proportional to the lateral pressure.

1.4 Shea Wall

Shear wall are the structure use to resist lateral forces like wind, seismic and lateral earth pressure. Shear wall are commonly placed between column links, stair walls, lift walls etc. It's transferring the earthquake and wind load to sub structure. During the earthquake happen there generate waves which will effects over the surface of the earth.

1.5 Coupled Shear Wall

It is a type of shear wall structure in which coupled by using beam, it is also called core wall. It helps to reduce the stress concentration from the structure where sometime architecture plan needs opening in the shear wall for doors and windows, so for stress concentration will be more at surrounding of the opening we needs to reduce this things by making solid shear wall system to coupled shear wall system. Key parameter like stiffness ratio in the coupling beam to wall piers, it makes the degree of coupling between wall piers which cause the system to acts as single unit.

1.6Flat Slab with Drop

It is a type of concrete slab in which this system where beams are not present only column and slab system but in outer edge there provide beam. Flat slab is noticed as one sided or two sided support system, where the shear load of the flat slab being concentrated over the supporting columns and a square slab called drop panel, drop panel acts as a major role in the flat slab system. Its helps to increase stiffness of the floor, it develop the economical span range. It helps to reduce cost of formwork. Flat slab makes larger head room or shorter storey height.

1.7Coupling Beam

It is a member use to resisting later force; it couples or combines two independent systems to make single unit. This consequently decrease overturning effect and improve overall stiffness of a system. The main function of coupling beam is dissipation of energy and improving stiffness and strength of the lateral load system of the structure.

II. LITERATURE REVIEW

K.G. Patwari, et al, (2016) this paper highlights clearly about, shear wall with flat slab gives stability to structure as well as it improves lateral load resistance. Here considered two models like conventional type building and shear wall with flat slab building. Here G+9 and G+11 RC buildings are consider for analysis using ETABS software with different parameters consider like, Base shear, displacement, Time period. Time period is more for conventional structure than flat slab structure because of monolithic, displacement increase in case of flat slab structure than conventional structure. As a result structure with flat slab and shear wall sustain additional and maximum load as redistribution reduces as the number of member reduces in selected lateral load resisting system.

B.Sowmya, et al, (2014) in this paper, author focus about structural behavior affected by the size of the openings and stress concentration around the openings and size of the opening is directly relation with the depth of the coupling beam. So, here consider G+9 storied building using FES like ETABS. Consider the different size of openings in shear wall and check there stress concentration around the openings. Here, when the size of the opening is increase simultaneously stress will be increase, so openings are directly related with stress concentration.

Reshma Chandran, et al, (2014) in this paper, author going to say about comparative study over solid and coupled shear wall system. Analysis was done by using ETABS software with using different parameters like storey shear, axial force in column, seismic base shear, maximum deflection at roof level, lateral displacement at each floor levels and time period, with different storey levels like G+9, G+19, and G+ 39. Coupled shear wall is more efficient in case of G+ 19 storeys; coupling beam exhibits the maximum shear at the second floor.

Gummadi Amar, et al, (2014) in this paper, author focus about RCC coupled shear wall using FEM, consider 10 storey's for verifying and analyzing the same model by using ANSYS-12 software. Here consider design parameters like storey shear, storey displacement, lateral force and von mises stress in steel also refer from IS 1893-2002, In the FEA of coupled shear wall under structural loading, the max deformation were observed for the top surface of shear wall and its gradually reduced towards the bottom, max stress are located at bottom of the shear wall. Max lateral displacement at the top storey due to lateral loads was in control and in limitations the check calculated is safe. Dedicated element employed a creak model to allow for concrete creaking with the option of modeling the reinforcement in a distributed or discrete manner. Shear wall is very effective to resist horizontal forces coming from earthquake and wind forces etc.

Mohammad Hassan, et al, (2004) this paper focus on seismic behavior of hybrid coupled wall system, where steel beams used as coupling the reinforced concrete shear walls analysis by pushover method, was defined in FEMA-356(2000) using parameters like base shear, storey drifts, wall rotations, shear distortion. Hybrid coupled wall are well suited in high seismic risk, where compare with normal one. Absorbing above lower roof drifts, inter story drifts and wall rotations. The inter story drift ratio from the pushover analysis (1%) is about 30% of less than the median values from the dynamic runs (1.43%).

III. DESCRIPTION OF SAMPLE BUILDING

In the study building models has been taken for all the cases.

- Model having without coupled shear wall with flat slab with drop
- Model having with coupled shear wall with flat slab with drop

A 3D RC frames with 7 bay by 4 bay for 14 (G+13) stories of dimension 77mx44m has been taken for seismic analysis effect of without and with Coupled shear wall using hard soil condition and seismic zones like II, III, IV, V as per IS 1893 (part 1):2002.

IV. DESIGN DATA

Table 1 Geometric Property

Parameter	Values
Number of storeys	G+13
No. of bays in X direction	7
No. of bays in Y direction	4
Bay width in X direction	11m
Bay width in Y direction	11m
Storey height	4m
Slab thickness	0.25m
Drop thickness	0.45m
Main Beam size	1.1x1.3m
Coupling Beam size	0.3x1.5m
Column size	1.1x1.4m
Coupled shear wall size	1.25x0.3m & 1.5x0.3m

Table 2: Material Properties of concrete

Property	Values
Grade of concrete	M25, M30
Modulus of elasticity	Ec = 5000√fck
Poisson's ratio of concrete	0.2
Density of concrete	25kN/m³

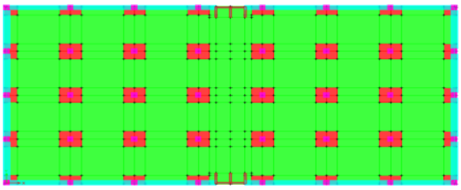

Fig 1: Building plan for without coupled shear wall system

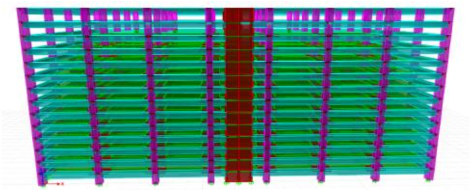

Fig 2: 3D View of without coupled shear wall system

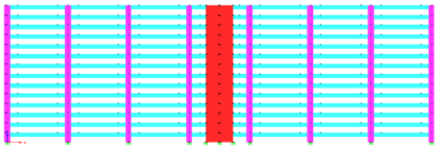

Fig 3: Model elevation of without coupled shear wall system

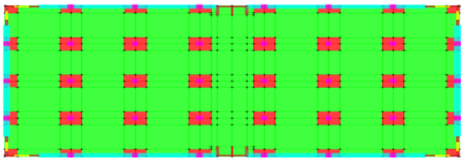

Fig 4: Building plan for with coupled shear wall system

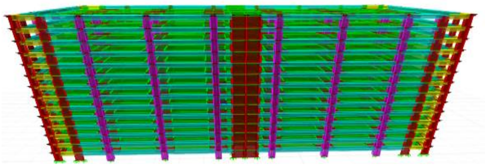

Fig 5: 3D View of with coupled shear wall system

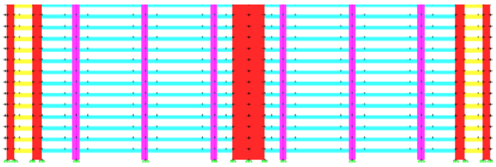

Fig 6: Model elevation of with coupled shear wall system

V. RESULT AND DISCUSSION

After completion of Analysis and modeling, the following results are obtained Storey displacement, Storey drift, Storey shear, Base shear and Modal time period.

STOREY DISPLACEMENT In Structure, lateral load effect is studying by considering RC frame regular building with and without coupled shear wall system, considering different soil condition with different seismic zone

Table 3: Comparison on without and with shear wall models with different soil strata and different seismic zones

SOIL STRATA	MODEL	SEISMIC ZONES	MAX DISPLACEMENT @ X-AXIS(mm)	MAX DISPLACEMENT @ Y-AXIS(mm)
	WITH OUT COUPLED SHEAR	Zone II	28.60	54.40
		Zone III	45.70	87.10

Hard Soil	WALL	Zone IV	41.10	78.40
		Zone V	61.70	117.6
	WITH COUPLED SHEAR WALL	Zone II	22.70	36.90
		Zone III	36.30	59.10
		Zone IV	32.70	53.10
		Zone V	49.20	80.10

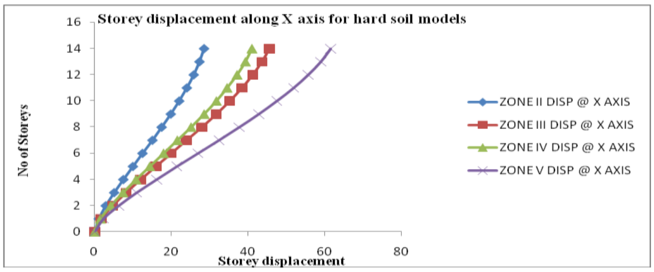

Chart 1: Graph Showing No. of Storey's V/S Displacement for along X- Direction

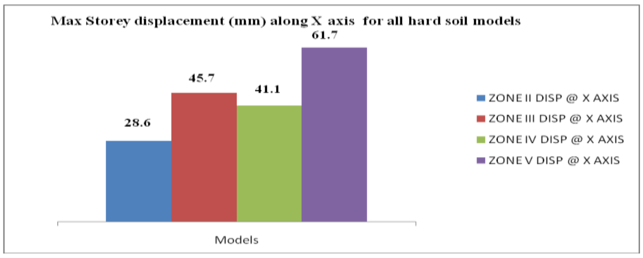

Chart 2: Graph Showing Max Storey Displacement along X - Direction

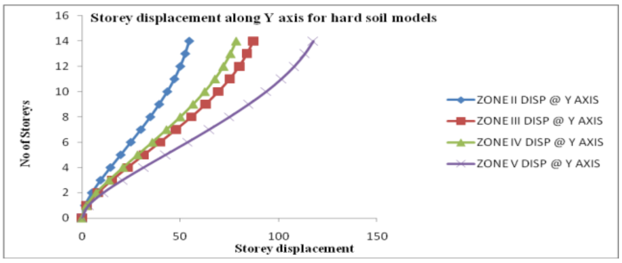

Chart 3: Graph Showing No. of Storey's V/S Displacement for along Y-Direction

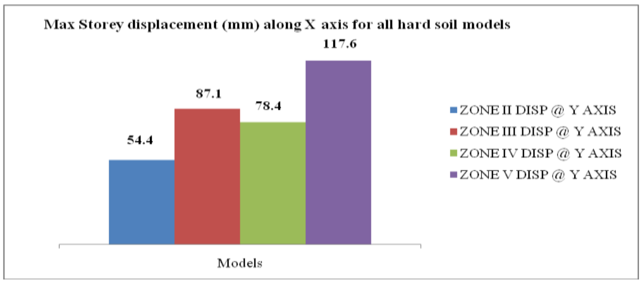

Chart 4: Graph Showing Max Storey Displacement along Y-Direction

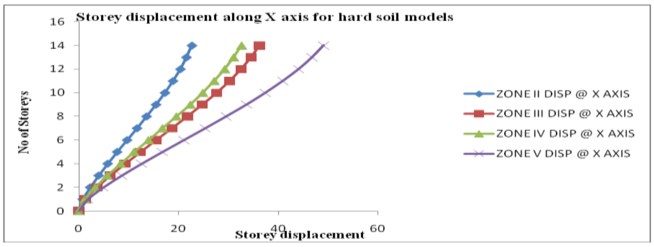

Chart 5: Graph Showing No. of Storey's V/S Displacement for along X –Direction

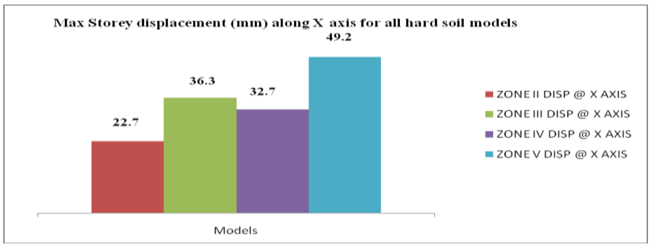

Chart 6: Graph Showing Max Storey Displacement along X – Direction

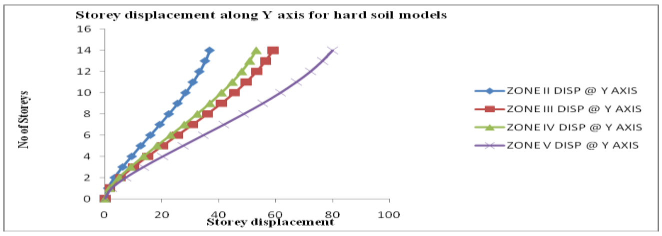

Chart 7: Graph Showing No. of Storey's V/S Displacement for along Y-Direction

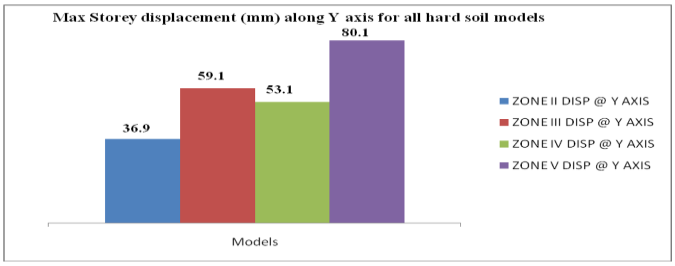

Chart 8: Graph Showing Max Storey Displacement along Y-Direction

Charts plotted from 1, 2, 3, & 4for (without shear wall) X & Y axis and 5, 6, 7 & 8 for (with shear wall)X & Y – axis for displacement v/s storey's for in fill frame models for hard soil strata with different seismic zones. Zone II and Zone III for Elastic Static Analysis and zone IV and zone V for Dynamic consider as per code IS 1983 2002 for 14 floors. As per the condition, displacement will be gradually increase from Zone II to Zone V, But here Zone IV will be decreases from Zone III, so Zone IV will be more stiffness then other Seismic Zones.

Storey Drift

To study the response of lateral load effect on structure we used RC frame regular building with and without coupled shear wall, considering different soil strata and seismic zones.

SOIL STRATA	MODEL	SEISMIC ZONES	MAX STOREY DRIFT @ X-AXIS (m)	MAX STOREY DRIFT @ Y-AXIS (m)
Hard Soil	WITH OUT COUPLED SHEAR WALL	Zone II	0.0006	0.0012
		Zone III	0.0010	0.0020
		Zone IV	0.0009	0.0018
		Zone V	0.0013	0.0027
	WITH COUPLED SHEAR WALL	Zone II	0.0004	0.0008
		Zone III	0.0007	0.0013
		Zone IV	0.0007	0.0011
		Zone V	0.0010	0.0018

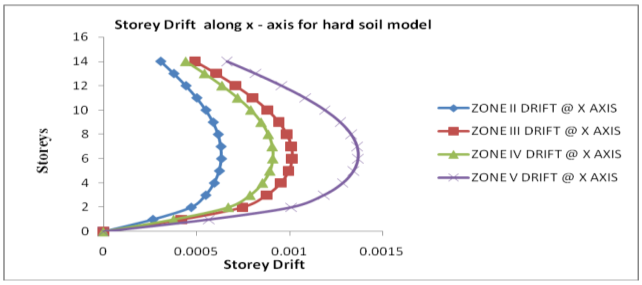

Chart 9: Graph Showing No. of Storey's V/S Drift for along X –Direction

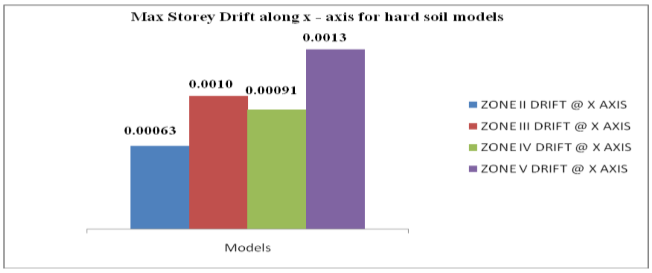

Chart 10: Graph Showing Max Storey Drift along x –Direction

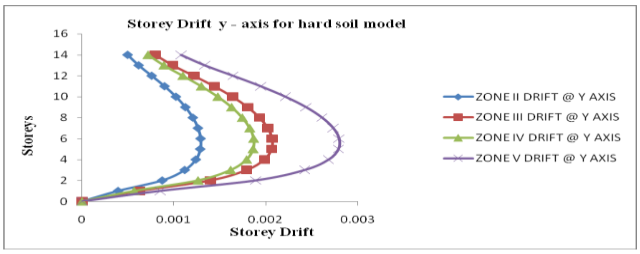

Chart 11: Graph Showing No. of Storey's V/S Drift for along Y- Direction

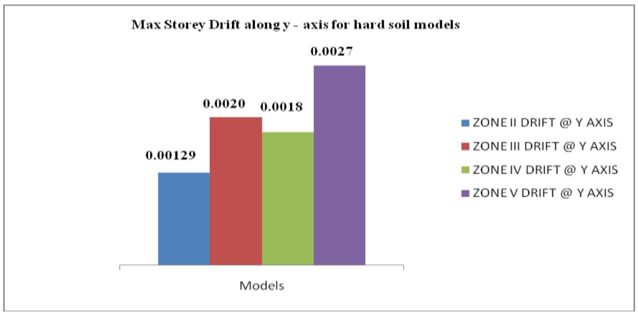

Chart 12: Graph Showing Max Storey Drift along Y - Direction

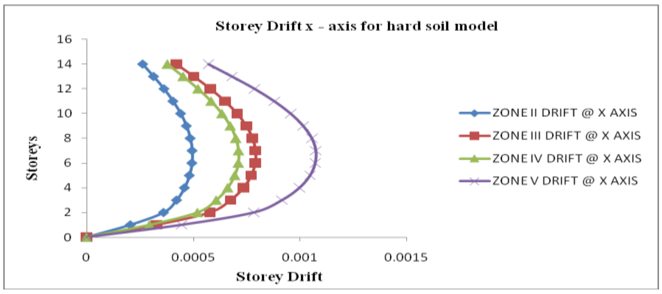

Chart 13: Graph Showing No. of Storey's V/S Drift for along X –Direction

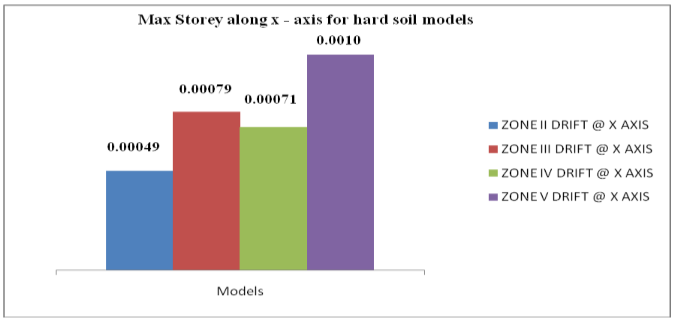

Chart 14: Graph Showing Max Storey Drift along x - Direction

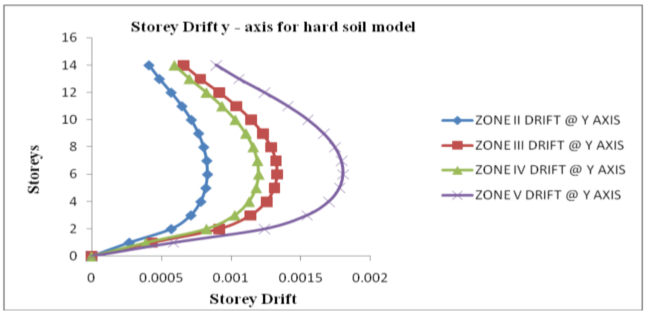

Chart 15: Graph Showing No. of Storey's V/S Drift for along Y- Direction

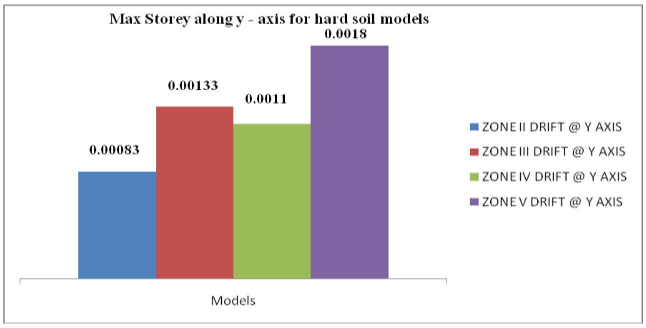

Chart 16: Graph Showing Max Storey Drift along Y - Direction

Charts plotted from 9,10,11,12 for (without shear wall) X & Y axis and 13, 14, 15 & 16 for (with shear wall)X & Y axis for Storey drift v/s storey's for in fill frame models for hard soil strata with different seismic zones. Zone II and Zone III for Elastic Static Analysis and zone IV and zone V for Dynamic consider as per code IS 1983 2002 for 14 floors. As per the condition, displacement will be gradually increase from Zone II to Zone V. But here Zone IV will be decreases from Zone III, so Zone IV will be more stiffness then other Seismic Zones.

Base Shear

SOIL STRATA	MODEL	SEISMIC ZONES	MAX Base Shear @ X – Direction (mm)	MAX Base Shear @ Y – Direction (mm)
Hard Soil	WITH OUT COUPLED SHEAR WALL	Zone II	15672	15672
		Zone III	25098	25098
		Zone IV	22584	22584
		Zone V	33877	33877
	WITH COUPLED SHEAR WALL	Zone II	15203	15203
		Zone III	24325	24325
		Zone IV	21893	21893
		Zone V	32989	32989

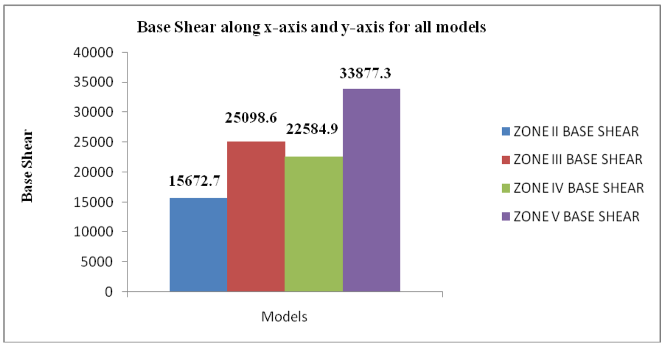

Chart 17: Graph Showing Maximum Base Shear @ X and Y- direction (without coupled shear wall)

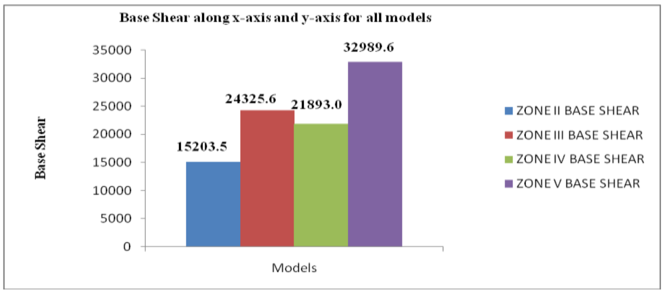

Chart 18: Graph Showing Maximum Base Shear @ X and Y- direction(with coupled shear wall)

Chart from 17 and 18, indicates the comparison of base shear values for models in **X and Y-Direction (Without and With Coupled Shear wall).** The maximum shear will be acting at the top storey. From the figure base shear will be more at Zone V. In generally base shear will be gradually increased, but here Zone IV will be decrease from Zone III. In Zone III with hard Soil Condition it will be more Stiffness than other Zone. Here we consider that regular shape models so base shear value will be same in both X and Y direction.

Model Time Period

MODE	WITHOUT COUPLED SHEAR WALLPERIOD (Sec)	WITH COUPLED SHEAR WALL PERIOD (Sec)
1	2.47	2.00
2	1.77	1.56
3	1.56	1.16
4	0.76	0.61
5	0.54	0.48
6	0.49	0.37
7	0.40	0.32
8	0.29	0.25
9	0.27	0.20
10	0.25	0.20
11	0.19	0.17
12	0.18	0.14

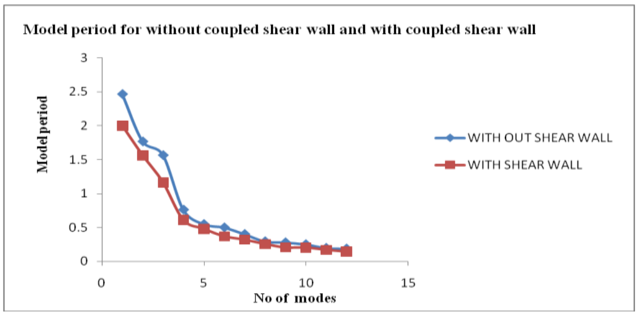

Chart 19: Graph showing time periods v/s No of modes for Hard Soil Strata for 14 floors

VI. CONCLUSION

In the present study an attempt has been to check the performance of high rise infill frame building for without coupled and with coupled shear wall with Hard soil condition and also different seismic zones. Here we consider that 14 storey's model for zone II, zone III condition we consider elastic static analysis and zone IV and zone V for dynamic analysis (by Response spectrum method) are carried out to compare the results.

- In with coupled shear wall model, there is a considerable reduction in storey displacement, storey drift, base shear and also time period compare with without coupled shear wall model
- As per IS code, there will be increasing value from zone II to zone V, but here zone IV will be decrease from zone III. In zone IV will be more stiffness than other zone models.
- Maximum lateral storey displacement occur at terrace floor level for all types of structure (without coupled and with coupled shear wall)
- Average displacement of with coupled shear wall building along x-direction is 79.72% less compared to without coupled shear wall building and along Y-direction is 67.89% less compared to without coupled shear wall building.
- Maximum Storey drift usually occurs at mid height level and goes on decreasing from mid height towards roof level
- Storey drift, with coupled shear wall system along x-direction is 21.37% less then without coupled shear wall system
- Storey drift, with coupled shear wall system along Y-direction is 35.35% less then without coupled shear wall system
- Maximum Base Shear occurs at base level due to direct ground contact of the structure
- There is an increase in base shear of 2.63% for with coupled shear wall structure with without coupled shear wall structure
- For without coupled shear wall and with coupled shear wall from hard soil to soft soil the % in base shear is 59.80%.

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