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LINEAR DYNAMIC ANALYSIS OF HOLLOW CORE SLAB AND RCC SLAB OF MULTI-STOREY BUILDING

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Abstract - *The need of concrete structures is getting increasing by more construction of residential, commercial and institutional buildings and huge portion of construction budget and national capital is being spent on construction of concrete building structures. But nowadays due to demand of economy and fast construction Hollow Core Slabs (HCS) have proven to be more desirable as compared to RCC slab and precast and pre-stressed hollow core concrete slabs has been proposed as a viable alternative to reinforced cement concrete slabs. Using pre-stressed concrete with tubular voids along the slab's circumference, it is made as a precast slab and in multi-storey houses, hollow-core slabs are used since flooring as they are economical, have good acoustic properties and thermal insulation, and it is economically feasible to achieve long stretches. Due to the light weight of the overall structure, a hollow core plate was used to reduce core shear in the X and Y directions regardless of the area. In each region, the duration decreased by the same amount, and the displacement conserved in both directions increased in all regions. Ground drift decreases in Zone 3 and increases in the X direction in Zones 4 and 5. It decreases in all areas in the Y direction, and the apron acceleration decreases in all areas in direction X. Face acceleration increases in direction Y in all areas. The above results are satisfactory, but experimentation is required to prove this*.

***Key Words*: Hollow core slab, storey drift , story shear, lateral displacement**

1 INTRODUCTION

It is the structural engineer's responsibility to make sure that the built environment can withstand strong dynamic events like wind, earthquakes and traffic. All Builders need to know how their built environment reacts to these dynamic actions. A direct result of earthquakes is that many people die from the collapse of structures and rubble, and in the long run, thousands of people lose their homes due to the collapse of buildings and the uncertainty and reconstruction process and the engineering department plan the direct consequence of these program by better the seismic response of building structures and working continuously to improve the sesmic design.

When an earthquake occurs, a structure moves laterally and vertically caused by surface ground motion induced by seismic waves. The lateral motion is typically much greater than the vertical motion, with the ground moving at acceleration (ag). Inertial forces (F) are generated in the building as a result of this lateral motion, defined as the product of the mass of structure (m) multiplied by acceleration of structure .According to Newton's Second Law (Force = Mass xAccleartion). At a fundamental level, the mass, size and configuration of a building structure dictate how the structure will respond to an earthquake event.

1.1 HOLLOWCORE SLAB

This slab are precast concrete elements commonly used in the roof structure of high-rise residential, commercial, office and industrial buildings. Honeycomb panels can also be used as sound-absorbing walls or walls for vertical or horizontal installation and slabs are prefabricated concrete slabs with tubular cavities along the slab length, typically 2/3 to 3/4 in diameter hence the slab much lighter in weight than a solid concrete slab of same thickness or strength and good durability .It reduces both transportation and material (concrete) costs because othe reduction in weight. The slab width is usually 120cm, standard thickness is from 15cm to 50cm. Wire reinforcement provides resistance to the bending moment of the load. The thinner the attic, the more usable building space can be converted into additional floors in a high-rise building at inherent cost and less connectivity. This floor has a great work surface and is ready to be painted.

Hallow core slabs high load carrying capacity and high strength. Prefab honeycomb units are easy to install and provide a work-ready platform. This greatly reduces construction delays due to the rapid construction of high-rise projects. Currently, two general methods are used for the production of honeycomb sheets. One of them is a dry casting or extrusion system in which little concrete is pressed through the machine. The core is excavated or built through a pipe and concrete is poured all over the core. The second system using steep concrete and each sides are made of solid, solid or machined foam with sliding sides. Made from soft or bulk casting systems, core roller tubes consist of a rigid pneumatic tube or lightweight aggregate fed by long roller tubes projecting from the core. For concrete with low downtime, the amount of water is slightly higher than the amount needed to hydrate the cement.

1.2 OBJECTIVES

- To model analysis at 10 storey symmetrical RCC building subjected to seismic load
- To model analysis at 10 storey symmetrical RCC building subjected to model with hallow core slab
- To compare the respond of RCC slab building and hallow core slab under the seismic load conditions.
- To Compute response of RCC slab frame building and hallow core slab building for different seismic zones

2. METHODOLOGY

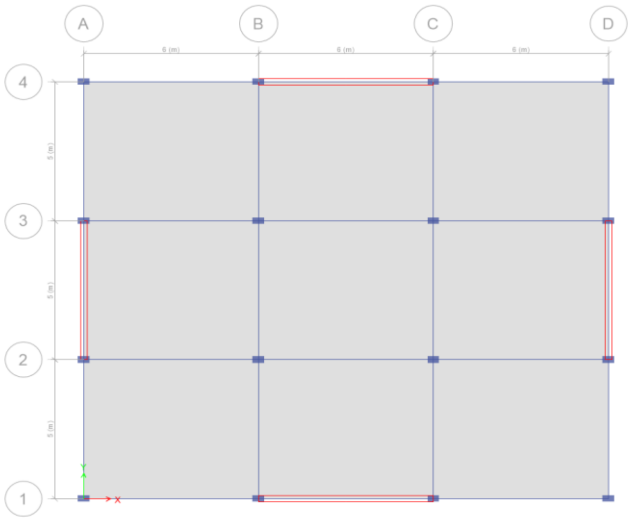
- Response of structure to earthquake motion
- Simplicity and symmetry
- Response spectrum analysis
- Seismic methods of analysis
- Factors in seismic analysis
- Shear walls
- Models prepared by using E-tabs and ANSYS

The study with ETABS included a multi-storey building (G + 9). For the analysis of the model in terms of seismic parameters, the linear dynamic analysis solution continuum approach was chosen. Seismic parameters such as base shear, time span, story drift, story acceleration and story displacement are listed between the models. In seismic zones 3, zone 4 and zone 5, plate models with support channels and channels are analyzed. They are modeled as secondary beams with the same dimensions as the channel slabs because hollow core slabs cannot be modeled in ETABS. The hollow core slab was modeled using ANSYS techniques and the secondary beam property modifiers were changed in such a way that the secondary beams in ETABS behaved and operated as a hollow core slab. In each space of 6 x 5 m, secondary beams with dimensions of 1.2 x 5 m and 200 mm and 5 numbers are connected. The shell loads on the secondary beams are used as concentrated comparable loads. RCC models were represented as R3, R4, and R5 in Zone 3, Zone 4, and Zone 5, respectively. In Zone 3, Zone 4, and Zone 5, the channel plate models were designated H3, H4, and H5, respectively

As hollow core slab cannot be directly modelled by ETABS, we have adopted Secondary Beams with the same dimensions as Hollow Core Slabs (Fig 4.6). The hollow core slab is modelled using ANSYS(Analysis of Systems software) (Fig 3.8) and the property modifiers were derived from it and is represented by Table 4.2. These modifiers of the hollow core slab have been inputted to the ETABS modelled secondary beams such that they behave and perform as a hollow core slab. The secondary beams of dimension 1.2 x 5m and 200mm thick and 5 numbers are placed in each bay of 6 x 5m. The shell loads are applied as equivalent concentrated loads on the secondary beam.

Table -1: Sample Table format

SL NO	DESCRIPTION	RCC MODEL	HCS MODEL
1	Building size	18*15 m	18*15m
2	Number of storeys	G+9	G+9
3	Height of Storeys	3m	3m
4	Grade of concrete	M25	M25
5	Density of concrete	25 KN/M³	25 KN/M³
6	Grade of concrete for slabs	M25	M40
7	Density of concrete for slabs	25 KN/M³	23.54KN/M³
10	Section Dimension		
	Beam	230*400	230*400
	Column	230*400	230*400
	Slab	6*5m 200 thick	1.2*5m 200 thick
11	Shear walls		
	Along X direction	200 thick	230 thick
	Along Y direction	230 thick	230 thick
	Loads		
12	Live load	3 KN/m²	3 KN/m²
	Finishes	1 KN/m²	1 KN/m²
	Masonry load on beams	12 KN/m²	12 KN/m²
	Storey 9		
13	Live load	1.5KN/m²	1.5 KN/m²
	Finishes	0.5KN/m²	0.5 KN/m²
	Masonary load on beam	12 KN/m²	12 KN/m²
14	Fix support	Fixed at base	Fixed at base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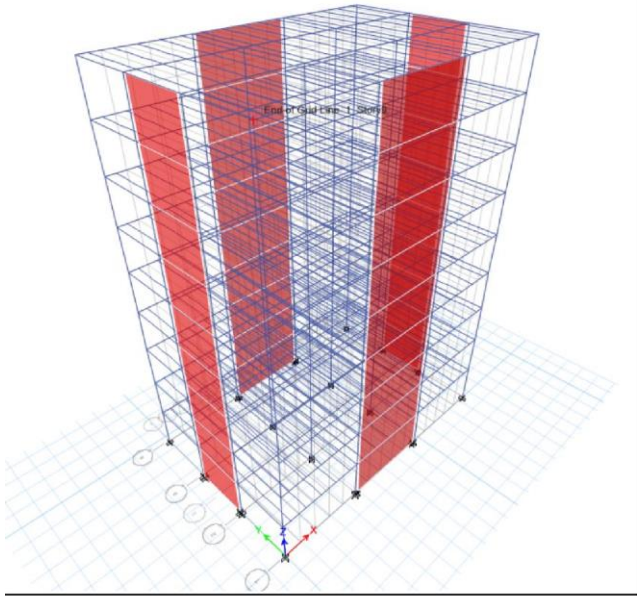

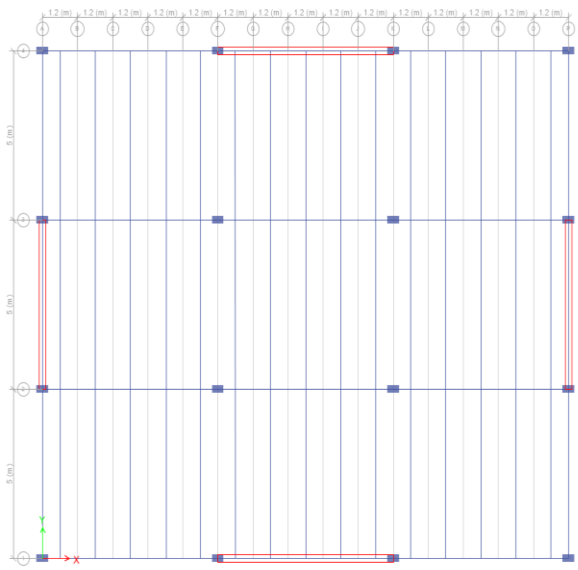

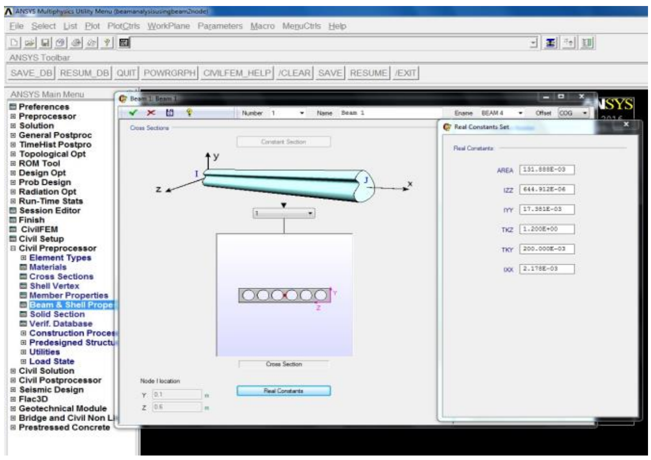
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CivilFEM
Civil Setup
Civil Preprocessor
Element Types
Materials
Cross Sections
Shell Vertex
Member Properties
Solid Section
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Utilities
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Civil Postprocessor
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Flac3D
Geotechnical Module
Prestressed Concrete
Real Constants Set
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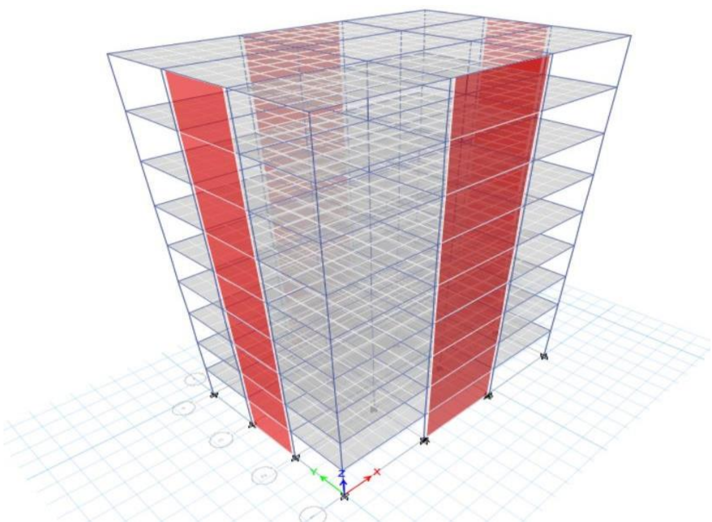
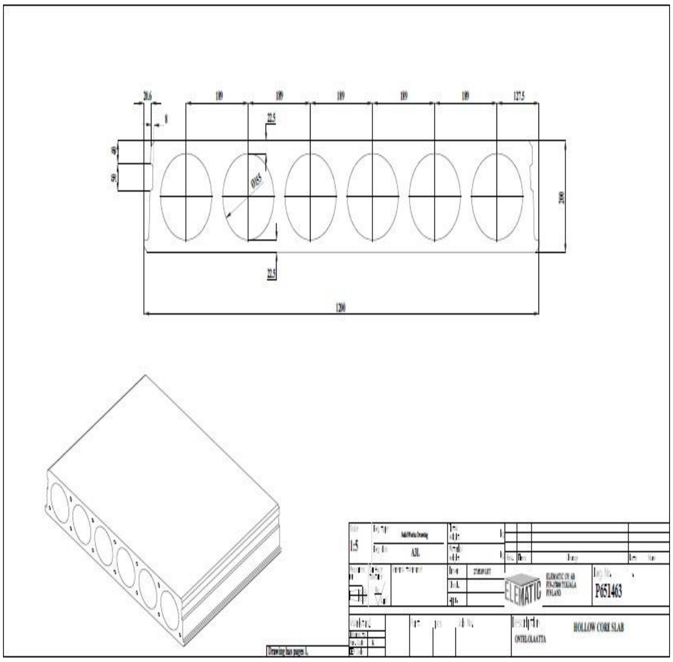




3. RESULTS AND DISCUSSION

The seismic study was conducted of the 3-D framed structure of 6 RCC and hollow slab building structure models in sesmic zone 3,4,5

The RCC models in zone 3,4,5 were represented as R3, R4 and R5 respectively.

The hollow core slab models have been represented as H3, H4 and H5 in zone 3, zone 4 and zone 5 respectively.

Table 3.1 Base Shear

BASE SHEAR (kN)							
Sl.No		ZONE 3		ZONE 4		ZONE 5	
		R3	H3	R4	H4	R5	H5
1	RSx	770.61	587.350	1155.76	881.87	1745.49	1351.585
2	RSy	389.45	351.2	583.0	540.47	875.58	815.125

Table 3.2 Time period

TIME PERIOD (s)							
Sl.No.		ZONE 3		ZONE 4		ZONE 5	
		R3	H3	R4	H4	R5	H5
1	MODE 1	1.69	1.519	1.695	1.519	1.695	1.585

Table 3. 3 Storey Drift in X direction

STOREY DRIFT IN X DIRECTION						
STOREY	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
STOREY 1	.0015	0.0005	0.0015	0.0089	0.0015	0.0013
STOREY 2	.0004	0.0007	0.0004	0.0014	0.0005	0.0030
STOREY 3	.0005	0.0009	0.0006	0.0014	0.0011	0.0020
STOREY 4	.0006	0.0008	0.0009	0.0013	0.0014	0.0020
STOREY 5	.0007	0.0009	0.0011	0.0012	0.0016	0.0021
STOREY 6	.0005	0.0009	0.0012	0.0014	0.0017	0.0021
STOREY 7	.0008	0.0009	0.0012	0.0013	0.0018	0.0020
STOREY 8	.0004	0.0008	0.0012	0.0010	0.0016	0.0015
STOREY 9	.0008	0.0007	0.0012	0.0008	0.0017	0.0013

Table 3.4 Storey Drift in Y Direction

STOREY DRIFT- Y DIRECTION						
STOREY	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
STOREY 1	.0025	0.0015	0.0038	0.0021	0.0055	.0040
STOREY 2	.0006	0.0014	0.0010	0.0022	0.0014	0.0031
STOREY 3	.0008	0.0012	0.0012	0.0020	0.0017	0.0030
STOREY 4	.0008	0.0013	0.0015	0.0018	0.0020	0.0029
STOREY 5	.0009	0.0013	0.0014	0.0019	0.0021	0.0028
STOREY 6	.0014	0.0012	0.0017	0.0019	0.0022	0.0030
STOREY 7	.0010	0.0011	0.0015	0.0017	0.0022	0.0025
STOREY 8	.0010	0.0007	0.0014	0.0013	0.0022	0.0019
STOREY 9	.0009	0.0007	0.0014	0.0010	0.0021	0.0016

Table3.5 Storey Displacement in X direction

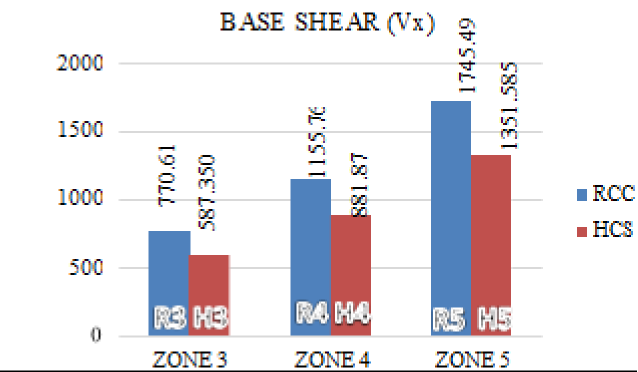
STOREY DISPLACEMENT IN X DIRECTION (mm)							
Sl.No	STOREY	ZONE 3		ZONE 4		ZONE 5	
		R3	H3	R4	H4	R5	H5
1	STOREY 1	0.48	1.65	0.70	1.35	1.10	2.00
2	STOREY 2	1.50	4.00	2.25	3.8	3.3	5.56
3	STOREY 3	3.10	6.15	4.80	6.9	6.71	10.5
4	STOREY 4	4.83	8.08	7.85	10.70	10.87	15.67
5	STOREY 5	6.45	9.96	10.40	14.49	15.59	21.73
6	STOREY 6	9.19	12.48	13.79	18.72	20.52	28.75
7	STOREY 7	11.53	15.45	17.30	22.68	25.95	34.00
8	STOREY 8	13.89	17.20	20.15	25.77	31.25	38.61
9	STOREY 9	16.22	18.56	24.33	27.25	36.25	41.45

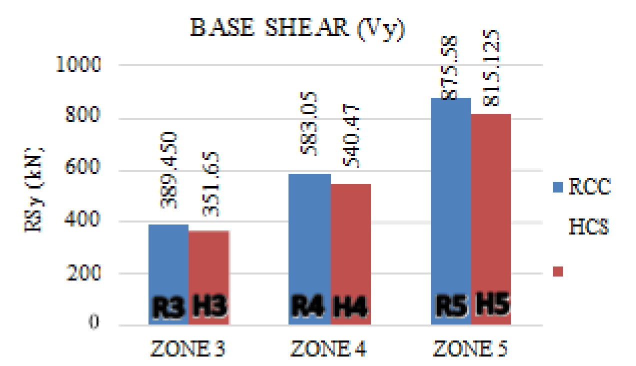
Table3.6 Storey Displacement in Y direction

STOREY DISPLACEMENT IN Y DIRECTION							
Sl.No	STOREY	ZONE 3		ZONE 4		ZONE 5	
		R3	H3	R4	H4	R5	H5
1	STOREY 1	7.58	4.52	10.66	6.42	15.52	9.82
2	STOREY 2	8.52	8.55	13.19	12.32	19.78	19.15
3	STOREY 3	10.84	12.46	16.26	18.52	24.39	27.74
4	STOREY 4	14.22	15.38	19.68	23.72	29.52	32.35
5	STOREY 5	15.72	19.00	23.57	28.49	35.22	37.33
6	STOREY 6	18.75	22.77	27.21	32.65	41.52	45.82
7	STOREY 7	21.55	23.58	31.41	35.93	47.91	53.35
8	STOREY 8	24.20	26.22	36.30	39.25	54.44	59.00
9	STOREY 9	27.04	27.25	40.56	41.86	60.52	62.79

1)BASE SHEAR

BASE SHEAR (kN)							
Sl.No		ZONE 3		ZONE 4		ZONE 5	
		R3	H3	R4	H4	R5	H5
1	RSx	770.61	587.35	1155.7	881.8	1745.49	1351.58
2	RSy	389.45	351.65	583.05	540.4	875.58	815.125

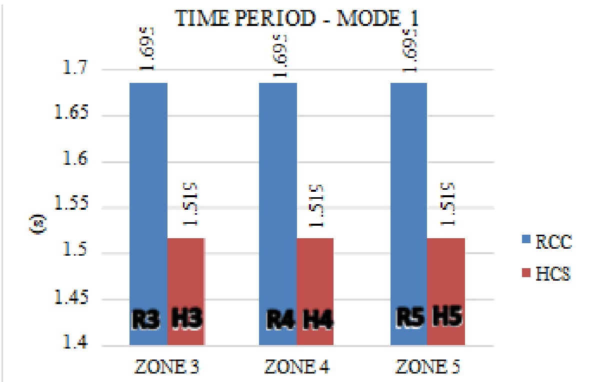




BASE SHEAR IN Vx and Vy DIRECTION

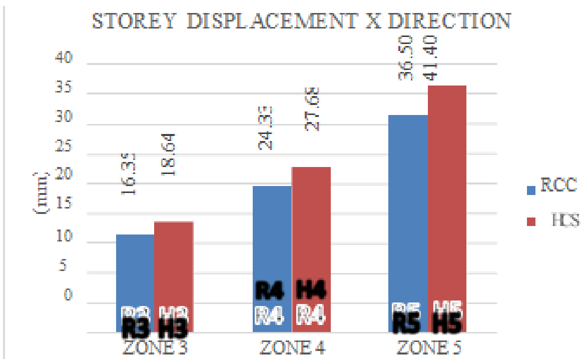
2)TIME PERIOD

TIME PERIOD - MODE 1 (s)			
	ZONE 3	ZONE 4	ZONE 5
RCC	1.695	1.695	1.695
HCS	1.519	1.519	1.519

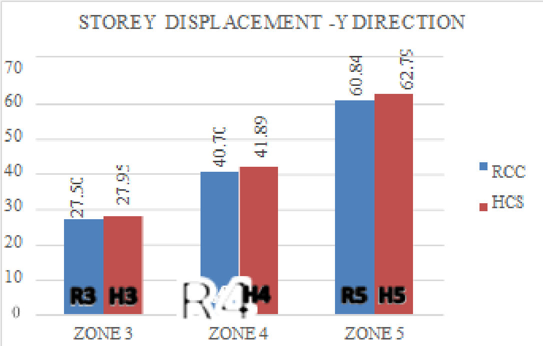


3) STOREY DISPLACEMENT

STOREY DISPLACEMENT IN X DIRECTION (MM)						
Sl.No	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
1	16.35	18.64	24.33	27.68	36.50	41.40

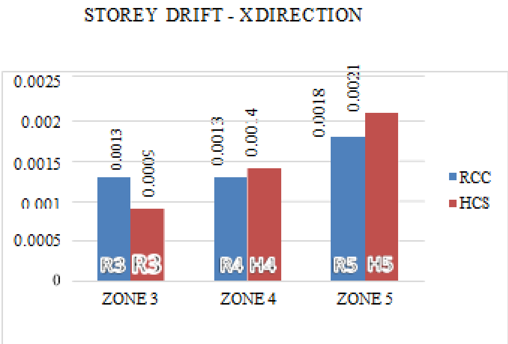


STOREY DISPLACEMENT IN Y DIRECTION(mm)						
Sl.No	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
1	27.50	27.95	40.70	41.89	60.84	62.79

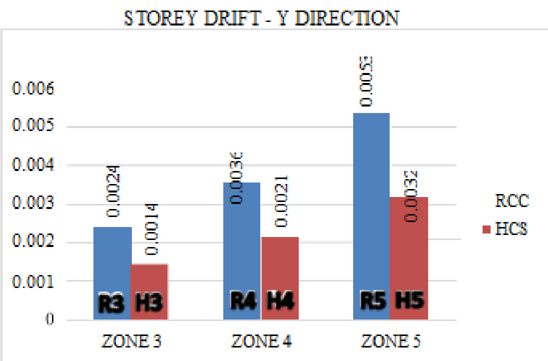


4)STOREY DRIFT

STOREY DRIFT - X DIRECTION						
Sl.No	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
1	0.0013	0.0009	0.0013	0.0014	0.0018	0.0021

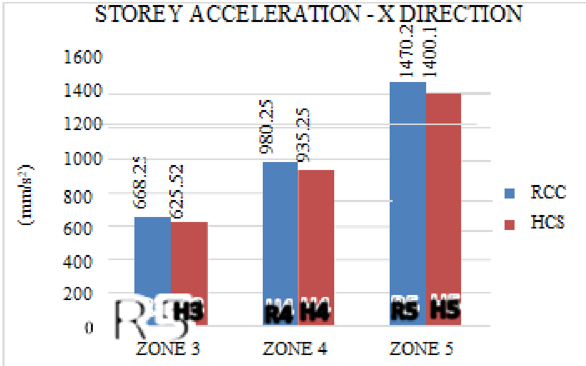


STOREY DRIFT – Y DIRECTION						
Sl.No	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
1	0.0024	0.0014	0.0036	0.0021	0.0053	0.0032

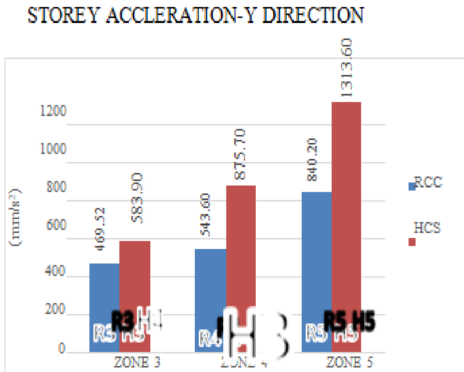


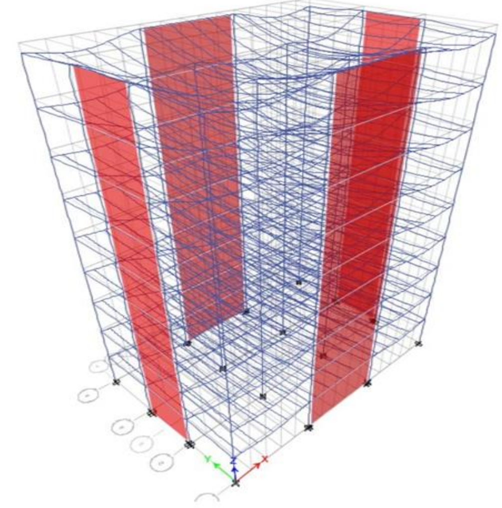
5)STOREY ACCLERATION

STOREY ACCELERATION - X DIRECTION (mm/s²)						
Sl.No	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
1	668.25	625.52	980.25	935.25	1470.25	1400.10

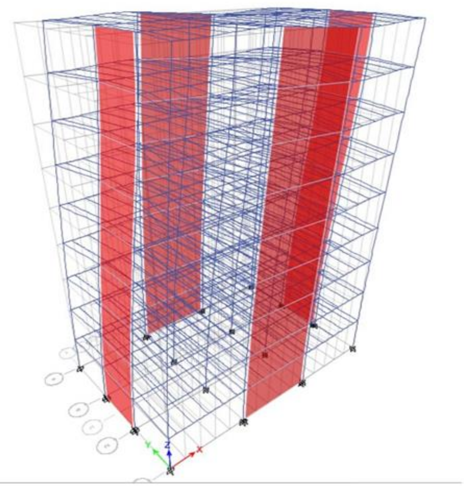


STOREY ACCELERATION - Y DIRECTION (mm/s²)						
Sl.No	ZONE 3		ZONE 4		ZONE 5	
	R3	H3	R4	H4	R5	H5
1	469.52	583.90	543.60	875.70	840.20	1313.6





Deformed shape of structure due to Gravity loads



Deformed shape of structure due to Lateral loads

4 CONCLUSIONS

The purpose of this project is to study the function of multi-storey hollow roofs and their relationship to buildings with multi-storey RCC roofs. Three models were evaluated for each RCC building in Zones 3, 4, and 5 and for each common ceiling structure.:

[1] Storey displacement has increased for hollow core slab compared to RCC structure
[2] Hollow core slab building acceleration in Storey is lower relative to the RCC building in the X direction, while it is higher in the Y direction.
[3] The time span of hollow core slab is less compared to RCC construction, storey drift has decreased for hollow core slab construction.
[4] It can be said that the amount of concrete in hollow ceilings is less than in reinforced concrete ceilings. In addition, significant savings can be achieved in terms of construction time and project costs. The use of thin double-walled prefabricated sheet metal reduces the height of the building and immediately provides a platform for further construction work..
[5] The thermal insulation and hearing properties of the channel plate are better than RCC plates, which has been demonstrated by various experiments carried out.
[6] The base shear of hollow core slab construction is less due to the reduction in building weight compared to RCC building.
[7] Although the results are satisfactory in the higher zones, experiments must be carried out to prove the same. Due to the limitations of not being able to model the channel slab directly in ETABS, further analysis is required in other software packages where more accurate results can be obtained

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