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Analysis of 3-Dimensional Building Frame Considering Outrigger and Hexagrid Technology using ETABs

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ABSTRACT

The advancement of high strength underlying materials just as the presentation of dominating improvement strategies gave a lift in the advancement of tall constructions. As the tallness of the design builds, they become logically defenseless against wind load and seismic force. The resistance of tall designs to lateral loads is the central determinant in the detailing of new fundamental underlying systems that create by the steady undertakings of primary specialists to continue expanding the structure tallness while keeping the diversion inside commendable places of imprisonment and restricting the proportion of materials. In this proposed work a logical review will be consider on such frameworks like outrigger framework with center shear divider and hex lattice frameworks, to decide their primary productivity in moving the horizontal loads securely to the ground.

A correlation of outrigger framework with center shear divider and a hex matrix framework was made on a 15-story building built up substantial structure by utilizing standard bundle ETABS by looking at changed boundaries like Maximum Story Displacement, Maximum Story Drift, Forces, Moment and Story Shear.

KEYWORDS: *Structural analysis, ETABS, displacement, seismic load, lateral load resisting member, soft story, outriggered structure, hexagrid structure*

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I. INTRODUCTION

In the history of structures, efforts have been aggressive towards the human goal to make progressively tall structures. Different social and financial factors, for example, migration of people from country side to urban areas looking for better way of life and openings for work, the increment in land values in urban regions and higher population density, have prompted an incredible increase in the number of tall structures all over the world. As the tall structure is best to land use strategy in present time it can spare a ton of land, hence the horizons of the world's urban areas are ceaselessly being punctured by particular and recognizable tall structures as great as mountain ranges, and achieving more height keeps on being the challenge and goal. However, there are some incredible challenges which are to be looked by the designer every day to make these structures a reality. Out of many challenges, one is that of lateral loads i.e., seismic load and wind load. So, there is a need to stabilize the tall buildings against these lateral loads and to provide comfort to the occupants.

In numerous regards, concrete is an ideal structure material, joining economy, the flexibility of structure and work, and imperative protection from fire and the attacks of time. The crude materials are accessible in essentially every nation, and the assembling of concrete is generally straightforward. Even in this century, it has become a general structure material. Tall structures are the most unpredictable assembled structures since there are many clashing necessities and complex structure frameworks to incorporate. The present tall structures are turning out to be increasingly thin, prompting the chance of more influence in examination with prior tall structures. From the main elevated structures built in the late 19thcentury until the cutting-edge high rises, the structure has assumed a significant function in the general plan.

II. LITRATURE REVIEW:

In this chapter we are presenting review of literatures related to analysis and design of structures considering lateral load resisting techniques, considering analysis tools. This review will show the present state of condition of structures and technique to resist displacement and heavy cost.

Daliya et al. (2019) The research paper introduced an investigation of hexagrid framework directed by utilizing examination and structure programming, ETABS. A standard floor plan 36m x 36m and sporadic floor plans moulded as C, L and T were considered, every basic part was structured according to IS 456:2000. G+30, G+40 and G+50 stories models are considered to look at the exhibition by tallness. Seismic parameters were considered from 1893-2002. Dead and live loads were considered according to Indian Standards. Results expressed that as the stature of the structure expands relocation additionally increments. The exhibition purpose of the T shape and L shape plan inconsistency was closer to one another. Timespan increments with increment in stature of the structure. Base shear was least except the C formed model.

Manzoor and Singh (2019) the research paper introduced a logical investigation made on the structural system, for example, the outrigger framework with centre shear divider and hexagrid frameworks, to decide their basic effectiveness in moving the sidelong loads securely to the ground. An examination of outrigger framework with centre shear divider and a hexagrid framework was made on a 38-story building strengthened solid structure by utilizing standard bundle ETABS 2016 by looking at changed parameters, for example, Maximum Story Displacement, Maximum Story Drift and Story Shears. The conclusion expressed that the hexagrid framework is best as it has least sidelong removal and it gives a superior engineering appearance to the structure.

Kachchhi et al. (2019) The research paper considers a parametric comparison of a symmetric building, modelling a 10-storey structure and the analysis of the model was done using ETABS V2017 for structural systems namely Shear walls, Belt Truss, Outrigger, Diagrid, Staggered Truss and a conventional Frame. Structure analysis was done considered Dead load, Live load, Seismic load and Wind load. Static and Response spectrum analysis was done for performing earthquake loads where the model was considered on seismic zone V. The results exhibited that Displacements on every story and story float was less in Diagrid frameworks in X-Direction in contrast with other parallel loads opposing framework. Storey Displacement on every story and story float were less in Staggered Truss frameworks in Y-Direction when contrasted with other parallel burden opposing framework.

Sindhu et al. (2021) In this paper author studied the utilization of two different lateral load resisting technique considering hexa-grid and diagrid technique to determine the most prominent technique to resist lateral forces. Adopted a regular square floor plan of 48×48 m and irregular floor plan like C and L type base plan of diagrid and hexa-grid are studied. All structural steel members are designed as per IS 800:2007. The design earthquake load is computed based on the zone factor and their soil types, importance factor and response reduction factor as per IS:1893-2016. All models considered have same 40 storey height and author comparison is based on the parameters like displacement, maximum storey drift, storey shear, maximum base shear and steel consumed are considered in this study. Author concluded that diagrid and hexagrid structural systems shows less lateral displacement and drift compared with conventional frame structural system.

III. EXPERIMENTAL PROGRAM:

Materials Used: The various material used in the preparation of concrete are cement, sand, cement coarse aggregates, rice husk ash (RHA) and water.

Rice husk ash:- Rice husk ash is a pozzalanic material which is obtained from paddy of local area in district- Bhopal. It can be burnt into ash that fulfills the physical characteristics and chemical composition of mineral admixtures. Pozzolanic activity of rice husk ash (RHA) depends on (i) silica content, (ii) silica crystallization phase, and (iii) size and surface area of ash particles. In addition, ash must contain only a small amount of carbon. RHA that has amorphous silica content and large surface area can be produced by combustion of rice husk at controlled temperature. The physical and chemical properties are listed in table 1 and table2 respectively.

Fig 1 Rice Husk

Table 1 .Typical physical properties of RHA.

Property	Value
Appearance	Very fine powder
Colour	Grey
Mineralogy	Non-crystalline
Odour	Odourless
Specific gravity	2.3

Table 2. Typical chemical composition of RHA

Compound	Percentage composition
Calcium oxide (CaO)	2.2
Silicon oxides (SiO2)	86.94
Aluminum oxide (Al2O3)	0.2
Iron oxide (Fe2O3)	0.1
Magnesium oxide (MgO)	0.6
Sodium oxide (Na2O)	0.8
Potassium oxide (K2O)	2.3
Loss on ignition (LOI)	4.4

Cement: Plain Portland Cement (43 Grades) which is available in market is used.

Fine Aggregate: The natural river sand available in local market which passes through 4.75mm sieve with specific gravity of 2.62.Conforming to Zone II.

Coarse Aggregate: Crushed granite conforming to IS 383 - 1970 is used in this study. Coarse aggregate passing through 20mmand retained on 16 mm sieve and specific gravity 2.82 was used.

Water: Water is an important ingredient of concrete as it actively participated in chemical reaction with cement, clean portablewater which is available in our college campus is used.

Mix Proportion: The mixture proportion for the controlled concrete of M-10 to M25 grade was arrived from the trial mix as per IS 10262-2009.

Table 3. Mix proportions

S.no.	Mix	Cement (Kg/m^3)	Rice husk ash (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	Water (Kg/m^3)	w/c ratio
1.	M0	372	0	692	1216	186	0.5
2.	M5	353.4	18.6	692	1216	186	0.5
3.	M10	334.8	37.2	692	1216	186	0.5
4.	M15	316.2	55.8	692	1216	186	0.5
5.	M20	297.6	74.4	692	1216	186	0.5

IV. METHODOLOGY:

Replacement levels of PPC by RHA of 0, 5%, 10%, and 15% were chosen for this research work. Batching was carried out by weighing as per calculated amount of each concrete constituent according to the mix ratio of 1:1.86:3.26 and M-25 grade of concrete was adopted. The constituents were then mixed thoroughly until a uniform mix was obtained. Water was then added and the mix was repeated. The fresh concrete mix was then placed in a mold of size 150 mm, compacted, and left for 24 hr. before testing Compressive specimens were tested at the ages of 7 and 28 days.

V. RESULT AND DISCUSSION

Workability of Concrete

Table 4 Workability test for M-25 Grade

S. No	Grade of concrete	Slump Values			
		0	5	10	15
1	M-25	19	18	16	5

Splitting tensile Strength of Concrete

The results of Splitting tensile strength test presented in Table 5. The test was carried out obtain Splitting tensile strength of concrete at the age of 28 days.

Table 5 Splitting tensile strength test result of RHA concrete at 28 Days

S. No	Grade of concrete	Percentage Replacement (%)			
		0	5	10	15
1	M-10	2.98	3.04	2.52	2.22
2	M-15	3.12	3.11	2.64	2.17
3	M-20	3.26	3.04	2.76	2.12
4	M-25	3.40	3.11	2.88	2.07

Compressive Strength:-

The results of compressive strength presented in Table 6. The test was carried out obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using Compression Testing Machine (CTM) of capacity 2000KN available in structureslab. The maximum compressive strength is observed at 10% replacement of rice husk ash. If higher percentages of ash were used, then compressive strengths decreased. There is a significant impurities present in RHA like alumina , free lime and others.

Table 6 Compressive strength test result of RHA concrete at 7 Days

S. No	Grade of concrete	Percentage Replacement (%)			
		0	5	10	15
1	M-10	7.1	7.15	7.4	7.75
2	M-15	12	12.05	12.3	12.65
3	M-20	17.1	17.15	17.4	17.75
4	M-25	22.2	22.25	22.5	22.85

Table 7 Compressive strength test result of RHA concrete at 28 Days

S. No	Grade of concrete	Percentage Replacement (%)			
		0	5	10	15
1	M-10	15.92	16.65	17.73	16.85
2	M-15	21.02	21.75	22.83	21.95
3	M-20	26.22	26.95	28.03	27.15
4	M-25	31.12	31.85	32.93	32.05

VI. CONCLUSION:

1. From test results, it is found that the higher compressive strength is attained compared to conventional concrete.
2. There is strength reduction with the addition of RHA due to the impurities present in RHA like free lime, alumina andother raw minerals.
3. However, strength achieved is highest when 15% RHA is replaced with cement at 7 days of age.
4. The strength is greater when 10% of RHA is replaced with cement at 28 days of age.
5. When the RHA addition is greater than 10% for 28 days old concrete cubes, the strength produced by the concrete getsreduced than the target strength.
6. If RHA replacement is more than 15% for 7 days old cubes, compressive strength gets reduced.

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