"Comparative Study of Conventional Two Way Slab And Voided Two Way Slab By Using U-Boot Beton Based On Seismic Performance And Economy"

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Abstract – *One of the most common component in the modern building constructions is reinforced concrete slab. For the lighter self- weight of the structure reinforced concrete slab with voids are new and innovative type of structure of concrete slab system are developed while maintaining similar load carrying capacity of solid slab. U-Boot Beton material is used as a voids in the reinforced concrete flat slab. The method of U-Boot Technology is virtually eliminating all concrete from the middle of a floor slab, which is not performing any structural function. These voided slab are capable to reducing amount of concrete required for construction of building. Due to this, reduce load on column and foundation of the entire building which can be beneficial in the seismically active region as well as economic point of view. The present study discuss about analysis of multistorey flat slab building in comparison to voided slab lightened with U-Boot Beton building by Indian Standard code. To evaluate seismic response of the buildings, Analysis was performed by Response spectrum method as per IS 1893 Part-1 is compared by Indian Standard code using Sap-2000 software. Result of time Periods, Base shear, Dead weight, lateral displacement Inter-story drift and cost analysis of flat slab building is compared with voided slab lighten with U-boot Beton building.*

Key Words: Flat slab, voided slab, U-Boot Beton *Seismic performance, response spectrum analysis, Sap-2000*

1. INTRODUCTION

When designing a reinforced concrete structure the primary limitation is span of the slab between the column. Designing large span require use of support beam or very thick slab thereby increasing weight of structure means it require large amount of concrete and support beam can also contribute to larger floor to floor height which increase cost of finish material. Heavier structure are less desirable than lighter structure in seismically active region because the larger dead load for a building increase the magnitude of inertia force.

A new solution to reduce the weight of concrete structure and increase the span of two-way R/F concrete slab system was developed in the form of voided slab. Voided slab provide similar load carrying capacity to traditional slab but weight significantly less. Voided slab remove concrete from non-critical area and replace the removed concrete with hollow plastic voids formers while achieving same load capacity as solid slab. When we use U-boot beton material instead of concrete in the non-critical area of flat slab dead weight, seismic response and cost of multi-storey flat slab building in comparison to voided slab lighten with U-boot Beton by using Sap-2000 software.

2. Response Spectrum Method

This method is useful for those type of structures where modes except the primary one affect significantly the response of the structure, in this method the response of multi degree of freedom system is determined by the superposition of modal response, each of the modal response is being determined from spectral analysis of single degree of freedom system, which are then combined to find out the total response. This method is mostly usually used in industries. Response spectrum method is linear dynamic method in which estimates structural response for short, nondeterministic and transient dynamic events, earthquake and shocks are examples of such events. It can be obtained by CQC or SRSS method. If frequency is widely spaced SRSS method is applicable while if closely spaced frequency is there then CQC is preferred. It works in linear range to obtain the peak structural response of building. That linear range is used to find lateral forces evolved in structure due to ground motions and earthquake thus it make possible to earthquake resistant design of structures.

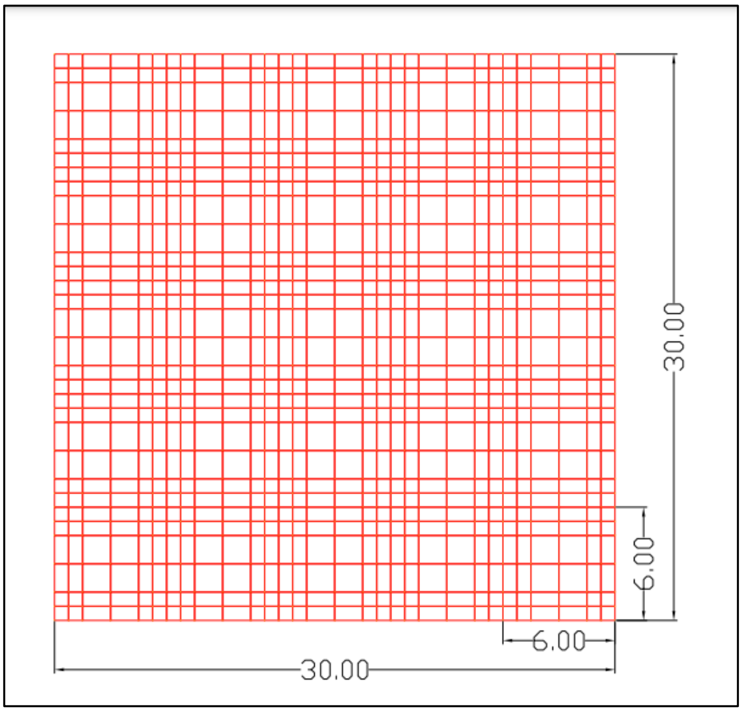
Storey	G+5, G+8,G+10

Storey height (m)	3.6
Plan Area (m2)	900
Plan Dimension (m)	30*30
Type of frame	OMRF
Thickness of slab (mm)	250
Plinth height (m)	1.8
Concrete grade	M20, M25
Steel grade	Fe 500
Seismic zone	V
Importance factor	1
Response reduction factor	5
Type of soil	III
Unit weight of Concrete (kN/m^3)	25
Live Load (kN)	3
Floor Finish (kN)	1
Roof Live (kN)	1.5
Roof Treatment (kN)	1

Fig-1 Plan of building (From sap-2000 window)

3. Structural Model Considered For Comparison

Table -1: Model Data



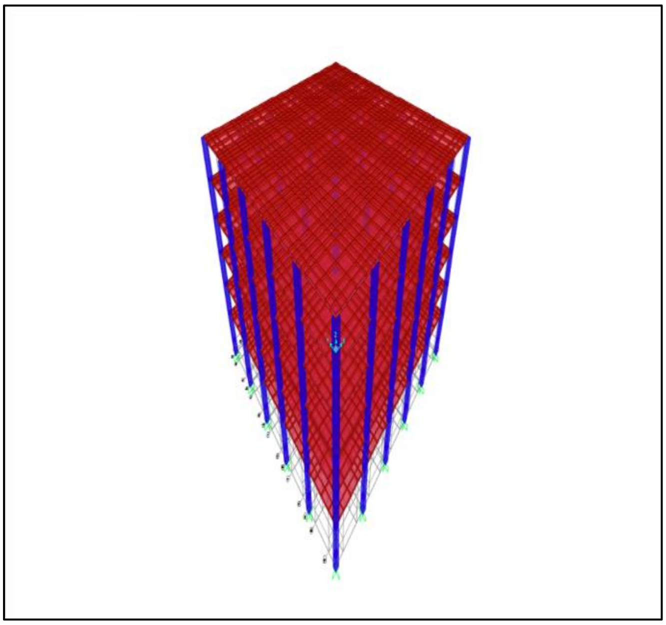


Fig - 2 3D Model of flat slab building
(From SAP 2000 window)

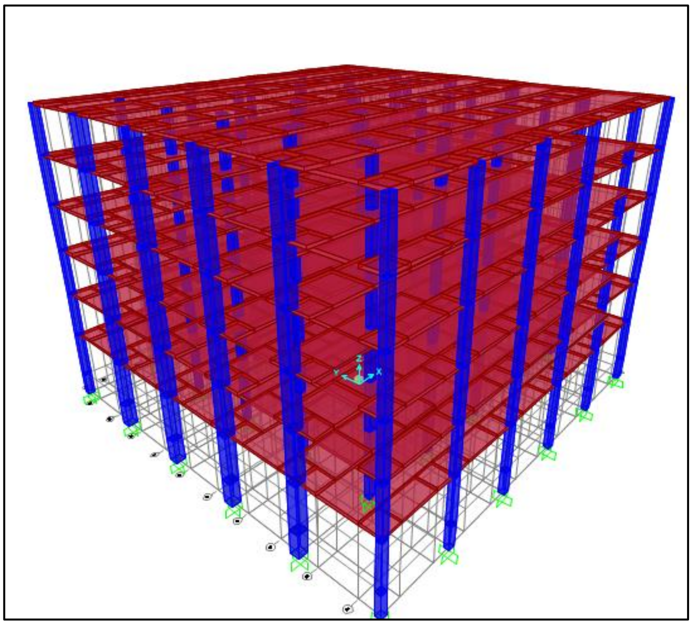


Fig-3 3D Model of Flat Slab Building using U-Boot Beton
(From SAP 2000 window)

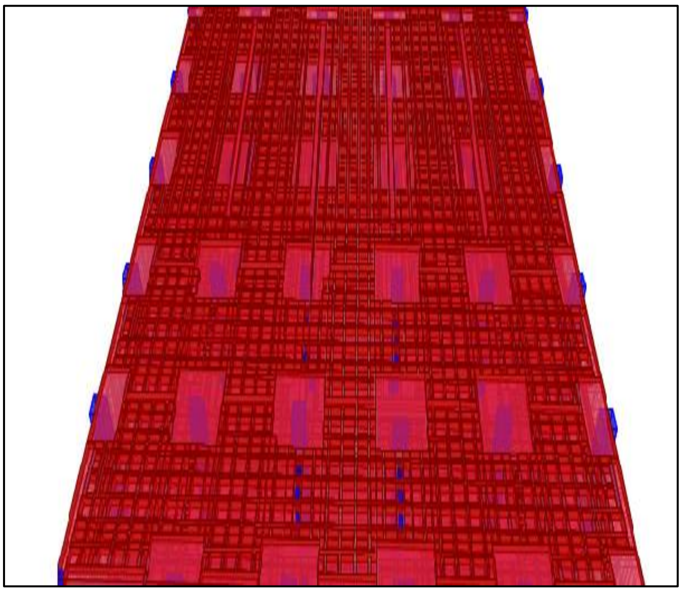
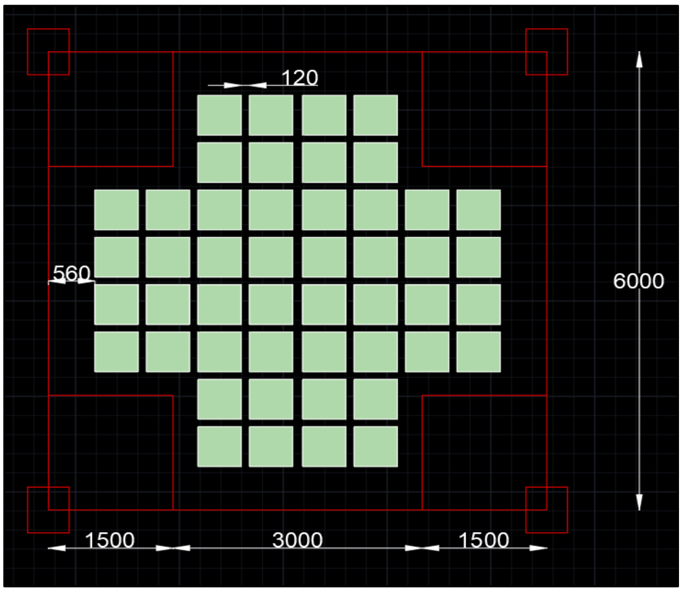


Fig – 4 a) Betoning Position view of Finite Element Model
(From SAP 2000windo)



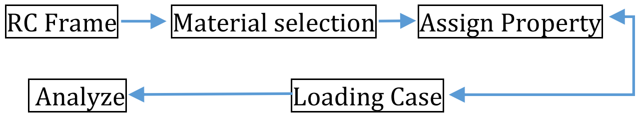
b) Betoning position view of cad

4. Methodology

In the present study Response spectrum method is used which is a linear dynamic analysis method which measures the contribution from each natural mode of vibration to indicate the maximum seismic response of a structure. Here base shear is calculated by,

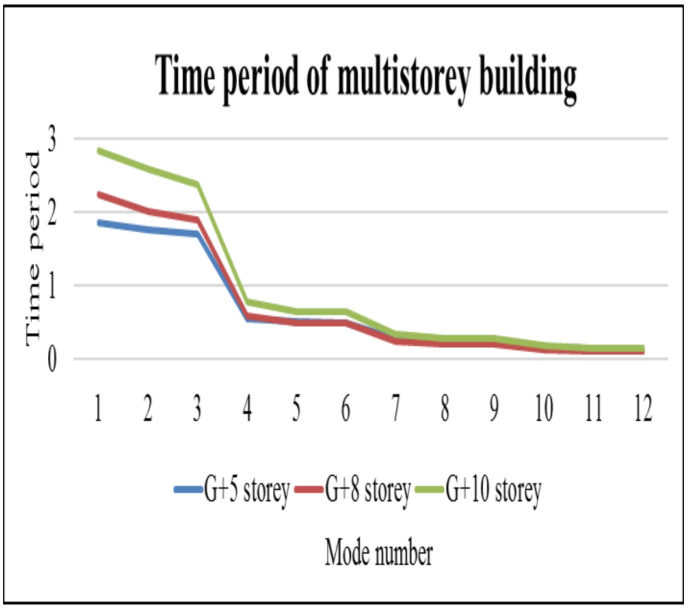
$$\boxed{V_b = A_h * W}$$

Analysis in Software: Response spectrum method is used for analysis, the property of material assigned to models is steel & concrete, the loading conditions of multi-storey structure are LSM and load assigned is self-weight of structure.



5. Results

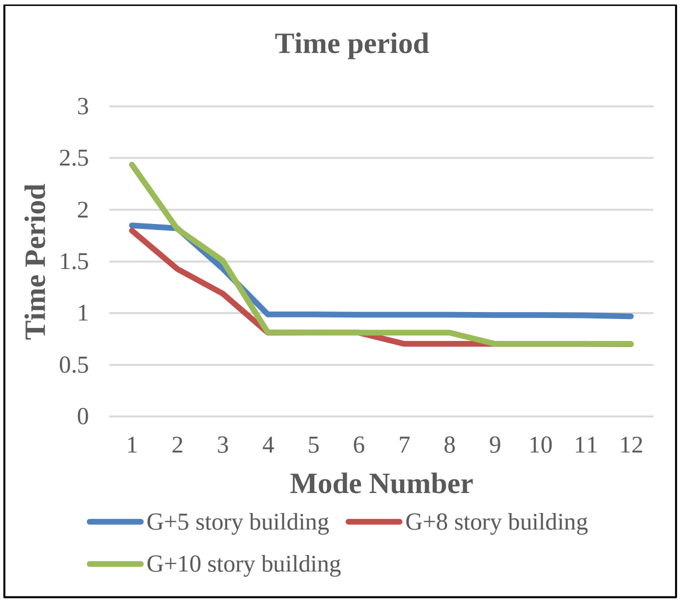
5.1 Modal Analysis of Multistorey Flatslab building

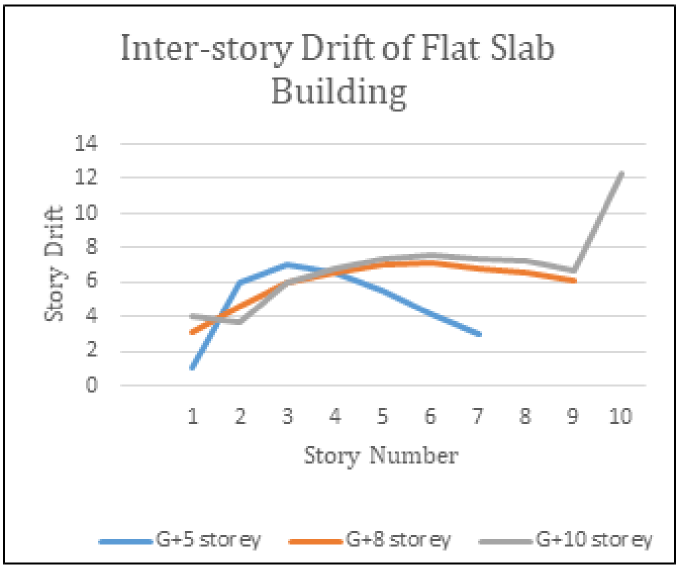


5. Objective

- *Formulation of problem statement, development of methodology and possible validation with high quality research article.*
- *Analysis of multistory flat slab building and evaluation of seismic response of the building.*
- *Analysis of multistory voided two way slab building using u-boot beton and evaluation of seismic response of the building.*
- *To find the cost of conventional two way slab building and voided two way slab using u-boot beton*

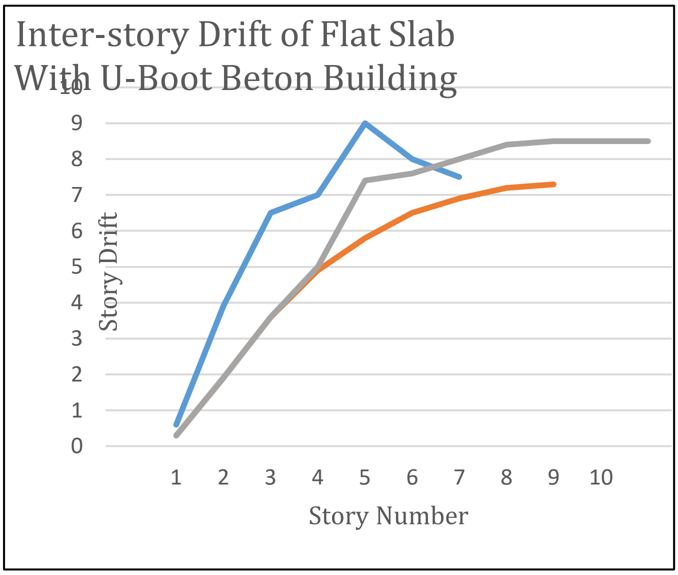
5.2 Modal Analysis of Multistorey Flatslab building With U-Boot Beton





5.3 Response Spectrum Analysis Results of Flat Slab Building

Parameter studied	Software Results of (G+5) story Building	Software Results of (G+8) Story Building	Software Results of (G+10) Story Building
Base shear	1479KN	2635KN	2613KN
Maximum Displacement	33.3mm	53.8mm	58.8KN
Time Period	1.856 s	2.23 s	2.83
Mass Participation Ratio	83.60% for UX and 85.15% for UY direction	71.14% for UX and	71.38 for UX and
		73.26 for UY direction	73.58 for UY
Dead weight	40056 KN	83842KN	102085KN



5.4 Response Spectrum Analysis Results of Flat slab with voids using U-boot beton material

Parameter studied	Software Results of G+5 building	Software Results of G+8 building	Software Results of G+10 building
Base shear	237.6 KN	395KN	371KN
Maximum Displacement	44.7mm	51.7mm	57.3 mm
Time Period	1.84 s	1.798 s	2.43 s
Mass Participation Ratio	75.10% for UX and 81.15% for UY direction.	66.78% for UX and 71.94% for UY direction	65% for UX and 70% for UY direction
Dead weight	23009 KN	67293KN	81708KN

6. Comparison of Results

6.1 Comparison of (G+5) Story Flat Slab Building and Flat Slab with Voided Slab Building

Parameter	Flat slab building (G+5)	Flat slab building with Voided Slab (G+5)	Remark
Time Period	1.856 s	1.84 s	Approximately same time period
Base shear	1479 KN	237.6 KN	83.93% Decrease
Displacement	33.30mm	44.7mm	16.23% Increase
Dead Weight	40056 KN	23009 KN	42% Decrease
Slab Thickness	250mm	200mm	50mm Reduce
Column size	500mm×600 mm	400mm×500 mm	100mm×100 mm Reduce

6.3. Comparison of (G+10) Story Flat Slab Building And Flat Slab with Voided Slab Building

Description	G+5			G+8			G+10		
	Flat Slab	U-Boot Beton	Cost Reduction (%)	Flat Slab	U-Boot Beton	Cost Reduction (%)	Flat Slab	U-Boot Beton	Cost Reduction (%)
Slab	10496026	9949827	5.2	16015577	14924741	6.81	2E+07	17519475	10.5
Column	9720166	10076566	-3.67	46073698	46073698	0	6E+07	56312298	0
Total	20216193	20026393	0.94	62089275	60998439	1.76	8E+07	73831772	2.71

6.2 Comparison of (G+8) Story Flat Slab Building And Flat Slab with Voided Slab Building

Parameter	Flat slab building	Flat slab building with Voided Slab	Remark
	(G+8)	(G+8)	
Time Period	2.23 s	1.798 s	19.37% Decrease
Base shear	2635 KN	395 KN	85% Decrease
Displacement	53.8mm	51.7mm	3.90% Decrease
Dead Weight	83842 KN	67293 KN	19.73% Decrease
Slab Thickness	250mm	200mm	50mm Reduce
Column size	900mm×1200 mm	900mm×1200 mm	Same

6.3 Comparison of cost of Flat Slab Building And Flat Slab with Voided Slab Building

7. Conclusion

- From the response spectrum analysis of all the models, we found out that the base shear was reduced up to ***83.93%, 85%*** and ***85.8%*** for ***G+5, G+8*** and ***G+10*** respectively. Hence, we can practise this technology in seismically active regions to reduce base shear.
- The reason behind the reduction in base shear is that U-boot Beton slab has less dead weight compared to conventional flat slabs.
- Dead weight of U-boot Beton slab structure is ***42%, 19.7%*** and ***20%*** less for ***G+5, G+8*** and ***G+10*** respectively compared to that of conventional flat slab structure.
- Reduction in the overall weight of structure also lead to reduction in the slab thickness compared to conventional flat slab structures.
- The time period decreased by ***19%*** and ***14%*** for ***G+8*** and ***G+10*** models and was same for ***G+5*** model, it means we can maintain less time period and less base shear as well.
- The displacement was greater in case of ***G+5*** storey model by ***16%*** and decreased by ***4%*** and ***2.5%*** for ***G+8*** and ***G+10*** storey models.
- From structures cost perspective, we find out that we can save up to ***5%, 7%*** and ***10%*** for ***G+5, G+8*** and ***G+10*** model and can thus say that as the number of storey increases the cost of slab per floor decreases.

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