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Behavior of Coupling Beam and Ordinary Reinforced Concrete Beam with Different Size of Haunches

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ABSTRACT: The Beam is structural elements of the structure, beam with columns or shear wall are the important member of the structure. In some seismic regions beam fails due to its depth restriction. So special element coupling beam apply on the particular location to reduce the shear stresses, lateral forces of wind and earthquake. In past researches shows various method to improve the seismic behaviours of the structure, some researches apply damper on its to avoid failure while earthquake and failure during earthquake will directly moves to the embedded dampers rather than the framing system of the structure, some investigators use tapered beam to check the behaviours of the beam as per inclination of angles of the beam depth. In past Experimental review specimen of rectangular and octagonal opening into the shear wall was conducted under cyclic load and result shows the orthogonal opening has less cracks with high load as compare with rectangular openings, which says that the octagonal openings form due to haunches at the corners has more strength as compare with the rectangular openings without haunches at the corners. Now this paper use the haunches bars at the corners of the ordinary reinforced concrete beam and coupling beam with different sizes of haunches at the corners of the structural beam to get the different behaviours of shear stress, moments, forces, deflections of the beam with different sizes of haunches and improvement in the framing system of the structure, improvement in deformation of cracks, shear stress, durability and stiffness of the framing system.

KEYWORDS: coupling beam, haunches, regular framing system, displacement, storey drift, storey stiffness, Response spectrum.

I. INTRODUCTION

Ordinary reinforced concrete beam is a structural element made of concrete and steel rebar that used in the construction. RC beams are strong and durable, making them suitable for use in building, bridges, and other infrastructures[1]. Coupling beams are a very important member of a lateral force resisting system. This consequently decrease overturning effect and improve overall stiffness of a system. Therefore, the main function of coupling beam is dissipation of energy and improving stiffness and strength of the lateral load system of the structure. Coupling beam is a lateral force resistant component of a structure[2]. Coupling beam is used effectively when two shear wall or any other elements that are used for withstanding lateral loads. This consequently decrease overturning effect and improve overall stiffness of a system. And application of haunches on beam give much better performances in storey stiffness and displacement as shown in this research.

II. LITERATURE SURVEY

Abdul Marsono, 2014, shows the experimental results of reinforced concrete shear wall structure with rectangular and octagonal openings. Addition of haunches in rectangular corner opening to reduce the effective length of coupling beam and lead to shift the cracks locations and increase the strength of the coupling beams. Quasi static test were used for experiments. Rectangular opening are common shape of opening used in shear wall in order to provide door, windows, entrance to car parking area, elevators and staircases. This researches adding of haunches at the corners of the rectangular coupling beam and form octagonal openings to increase the strength of coupling beam. Research

experiment the specimen under cyclic load with shear wall with single band of rectangular and octagonal openings. given results shows the coupling beam in shear wall with octagonal openings are stronger then the coupling beam in shear wall with rectangular openings. in past decades some methods are suggested to increase the strength of shear walls in additional to high strength concrete. the model was constructed by ordinary Portland cement (OPC), sand, aggregates and target the value of 40 MPA compressive strength in cylindrical specimen. It is expected that adding of haunches to the corners of rectangular openings the effective length of coupling beam decrease that causes to increases the strength of coupling beam and shear wall system.

Taesang et al. 2011, Shown the failure of coupling beam with small length to depth ratio. So, to improve the ductility of coupling beam provides diagonal reinforcement in the beam. If the diagonal reinforcement increase causes problem due to congested reinforcement in some part of the beam. Recent research on the coupling beam has shown that the post tensioning is an effective method for seismic region because it resists the gravity forces, wind forces, and seismic forces. In this paper investigators made new types of coupling beam with energy dissipation device such as metallic damper and frictional damper which reduces framing system in the structures. In the couple shear wall system metallic damper or frictional damper is inserted into the beam. This gives better performance as compared to conventional reinforced concrete couple shear wall. Damage of these systems are concentrated only at the dampers rather than at the shear wall and beams. quasi-static test is conducted to verify the performance of the reinforced concrete couple shear wall.

Nursiah et al. 2014, Coupling beam is defined as the beam that connects with couple shear wall. And it usually required where provided excess stairwell or elevators. It is used to resist high shear and force of earthquake. There is a types of coupling beam. Concrete coupling beam. It consists of longitudinal reinforcement, concrete, shear stirrups. It has more stirrups than the ordinary beam. The behaviour of coupling beam is different than the ordinary beam. Concrete coupling beam is unsafe in cyclic load and almost brittle and exhibited shear failure. Hybrid coupling beam which is the combination of the ordinary reinforced concrete beam and steel truss with composite mortar. This system uses steel trusses which are easier to construct and presence of flange in steel trusses may improve flexural capacity of coupling beam. Indonesia is located at highly seismic region; therefore, it needs special notice for construct high risk buildings. So, in Indonesia coupling beams are mostly provided to resist high shear and forces of earthquake.

Suwada& T. Kabeyasawa . 2012, In the opening direction loading, all the specimens showed flexural failure of first-story column. 2) In the closing direction loading, the specimens in which the first-story column are extended toward inside show flexural failure of first-story column, whereas the specimens in which the first-story column are extended toward outside showed joint failure. 3) Haunch at the corner of the joint is effective on improving strength and stiffness. 4) The proposed equations of the flexural strength of the first-story column and the joint failure can estimate the strength obtained by experiments.

III. METHODOLOGY

1. In this study a comparative analysis between coupling beam and conventional reinforced concrete beam and combination of both is done by using ETABS. The result of this analysis will study various parameters such as base shear, story displacement and storey drift. Software used is ETABS.
2. The work has been carried out for the seismic analysis structure. The study has been carried out for the zone-III specified as per IS 1893-2016.

IV. STRUCTURAL ANALYSIS & RESULTS

In this study, structure will be model for the following cases with different types of coupling beams”-

1. **Model 01: G+25 stories building with Ordinary beams.**
2. **Model 03: G+25 stories building with coupling beams with haunches of 400x400mm at the corners.**
3. **Model 04: G+25 stories building with coupling beams with haunches of 500x500mm at the corners.**
4. **Model 05: G+25 stories building with coupling beams with haunches of 600x600mm at the corners.**
5. **Model 06: G+25 stories building with coupling beams with haunches of 700x700mm at the corners.**

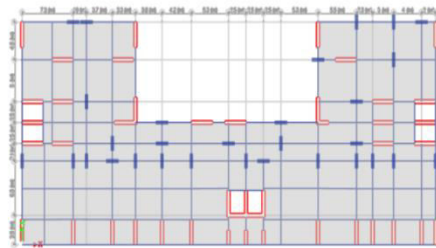


Fig 1.1 Plan view

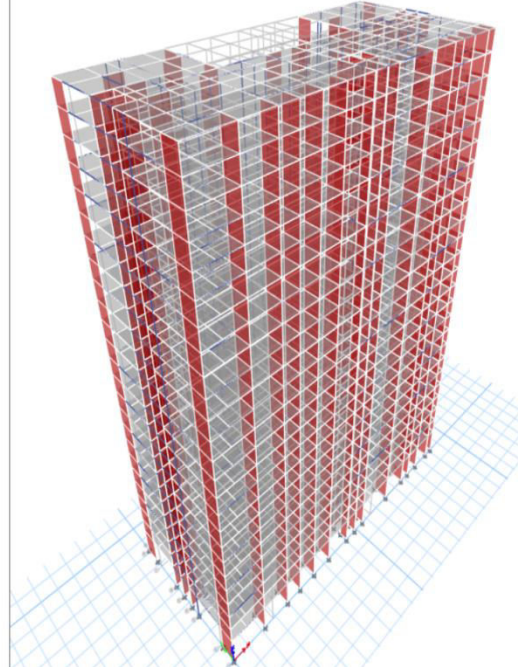
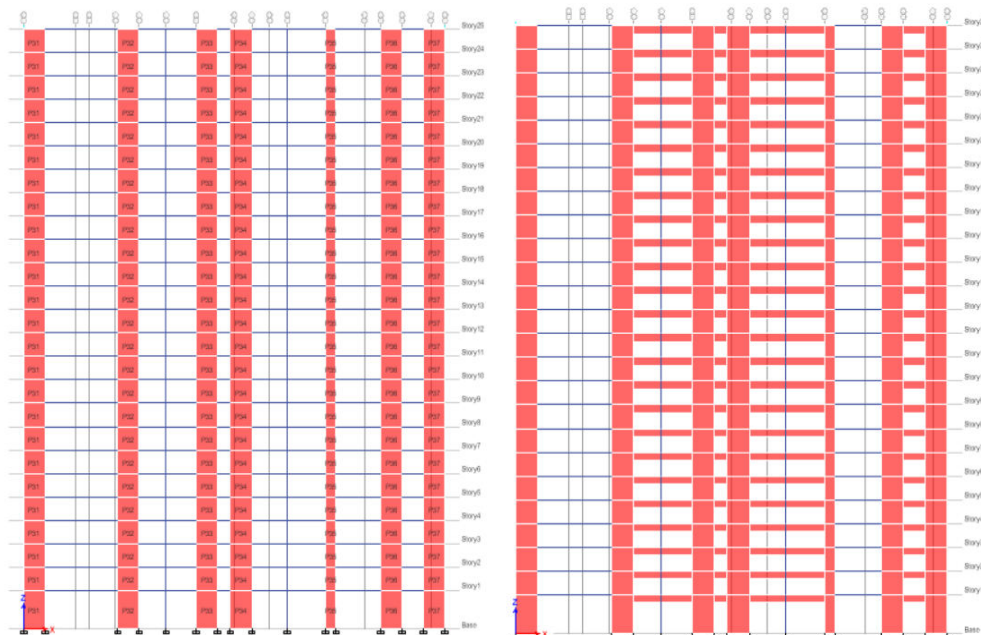


Fig 1.2 3D view



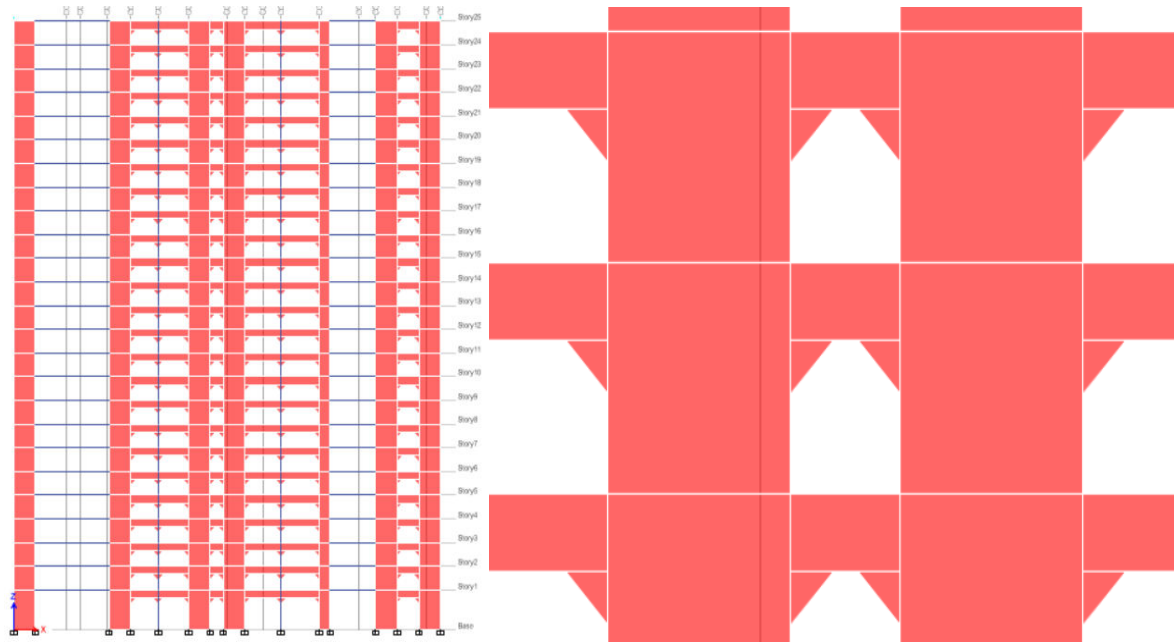


Fig 1.3 Elevation plan with and without haunches

PRELIMINARY DATA:

Following are some preliminary data assumed or defined for the work.

1. Length in X direction=59.1m, 2. Length in Y direction= 26.6m, 3. Typical storey height=3m, 4. Ground storey height=5m, 5. No. of storey =25, 6. Height of bldg. =60-80m, 7. Bay spacing in X direction= vary, 8. Bay spacing in Y direction= vary, 9. Beam sizes: a. 230x600mm, b. 300x600mm, c. 300x750mm, d. 300x1000mm, 10. Columns sizes: 1800x500mm, 11. Shear wall sizes: 3000x450mm, 12. Slab Thickness: 200mm, 13. Spandrels size: 300x1000mm, 14. Haunches size: 400x400mm, 500x500mm, 600x600mm, 700x700mm.

LOAD CONSIDERATION:

Load calculations:

1. SELF WEIGHT OF THE MEMBER , 2. SUPER IMPOSED DEAD LOAD- 1.5kN/m² , 3. LIVE LOAD- 3kN/m²
SEISMIC LOADING, 4. Z=0.16(for zone III IS1893 (part 1):2016, Clause: 6.4.2, Table no: 03), I=1.2 (importance factor) (IS1893 (part 1):2016, Clause: 7.2.3, Table no: 08), Soil Type 1 , R=5 (RC building with Special moment resisting frame (SMRF)(Response Reduction Factor) (IS1893 (part 1):2016, Clause: 7.2.6, Table no: 09), WIND LOADING: Wind Speed=44m/s

RESULTS:

Max displacement in (m) :	Normal beam frame system	400x400mm haunches	500x500mm haunches	600x600mm haunches	700x700mm haunches
Ex	30.67	20.21	20.17	20.1	20.02
Ey	36.91	26.06	26.06	26.04	26.06
RSx	23.299	15.56	15.5	15.451	15.373
Rsy	29.776	18.43	18.38	18.323	18.204

Table: 1.1.Comparison of all models in Displacement in Ex, Ey, Rsx&Rsy.

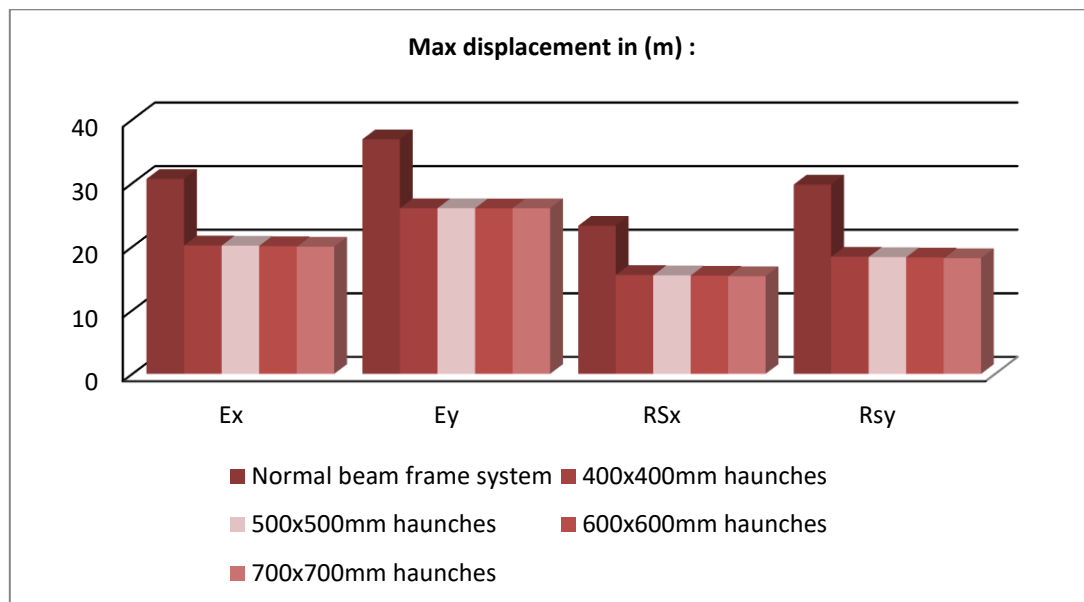


Fig: 1.4 Graphical details of maximum displacements in Ex, Ey&Rsx, Rsy

Displacement is minimum for coupling beam with 700x700mm haunch. and it simultaneously decrease when sizes of haunch increase.

Max Storeydrift :	Normal beam frame system	400x400mm haunches	500x500mm haunches	600x600mm haunches	700x700mm haunches
Ex	0.000503	0.000321	0.000320	0.000319	0.000318
Ey	0.000614	0.000413	0.000413	0.000413	0.000414
RSx	0.000389	0.000251	0.00025	0.000249	0.000247
Rsy	0.000509	0.000297	0.000296	0.000295	0.000293

Table: 1.2 Comparison of all models in story drift in Ex, Ey, Rsx&Rsy.

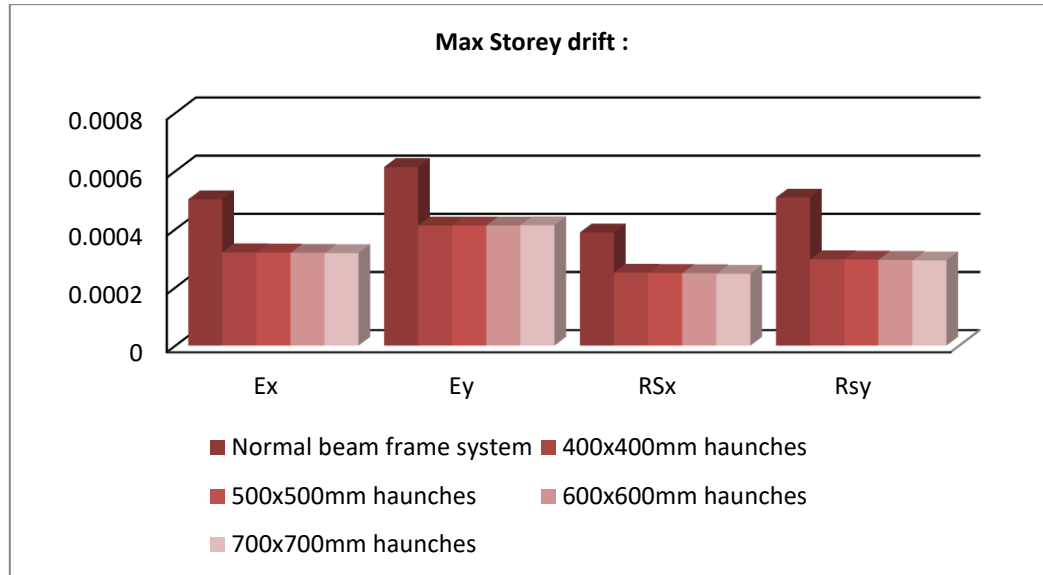


Fig: 1.5 Graphical details of maximum storey drift in Ex, Ey&RSx, Rsy

Max Storey shear in (KN) :	Normal beam frame system	400x400mm haunches	500x500mm haunches	600x600mm haunches	700x700mm haunches
Ex	-5567.46	-9097.086	-9129.013	-9175.292	-9232.86
Ey	-4610.356	-6402.97	-6411.331	-6423.5	-6435.788
RSx	5567.45	9097.086	9129.013	9175.292	9232.86
Rsy	4610.356	6402.97	6411.331	6423.5	6435.788

Table: 1.3 Comparison of all models in story shear in Ex, Ey, RSx&Rsy.

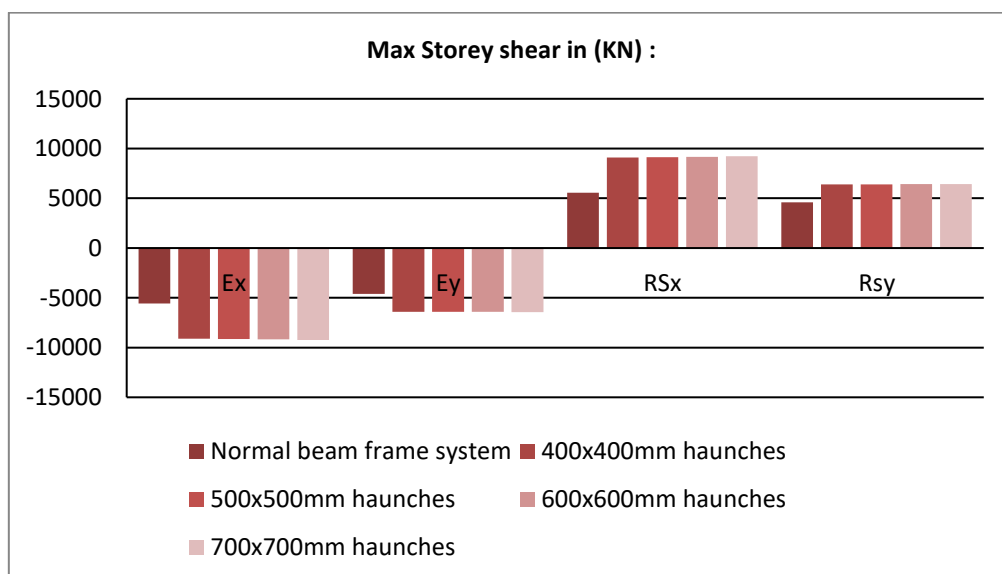


Fig: 1.6 Graphical details of maximum storey shear in Ex, Ey&RSx, Rsy

Storey shear of all models were compared and matched with static and dynamic as shown in storey shear table and above graphs.

Max stiffness (KN/m) : Storey in	Normal beam frame system	400x400mm haunches	500x500mm haunches	600x600mm haunches	700x700mm haunches
Ex	8659087	19981317	20223355	20634889	21116763
Ey	6741995	12947402	13004453	13079176	13160646
RSx	9401260	21485169	21710048	22137494	22696198
Rsy	6996803	14197925	14284161	14398332	14840411

Table: 1.4 Comparison of all models in story stiffness in Ex, Ey, Rsx&Rsy.

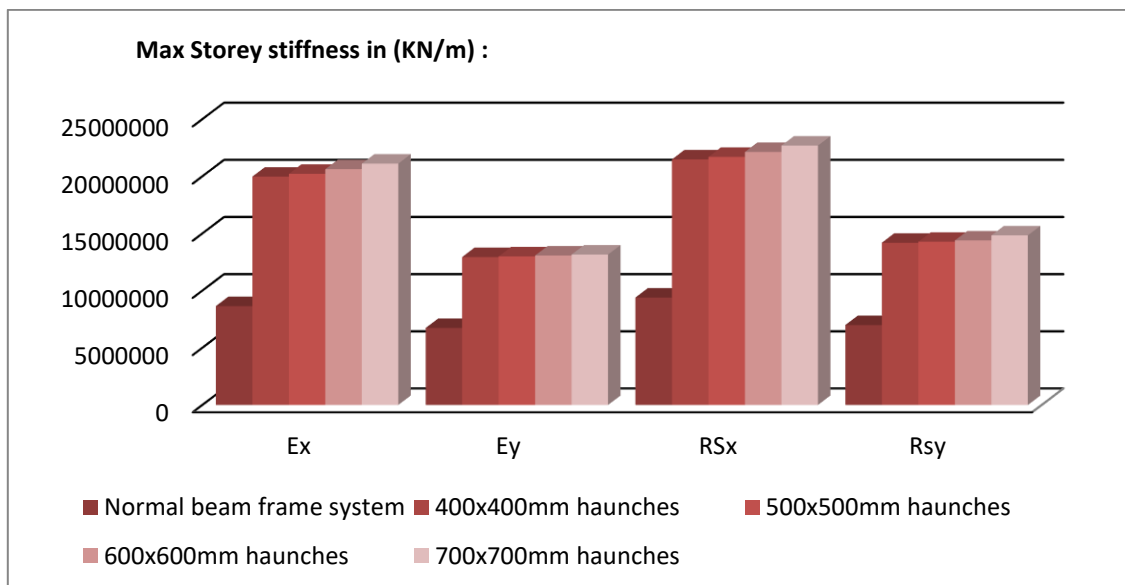


Fig: 1.7 Graphical details of maximum stiffness shear in Ex, Ey&Rsx, Rsy

From Fig. 7it is clear that storey stiffness is higher in building with 70x700mm haunch. Lower value in small sizes of haunches.

Time periods in (sec) :	Normal beam frame system	400x400mm haunches	500x500mm haunches	600x600mm haunches	700x700mm haunches
A	3.154	2.162	2.16	2.157	2.154

Table: 1.5Comparison of models

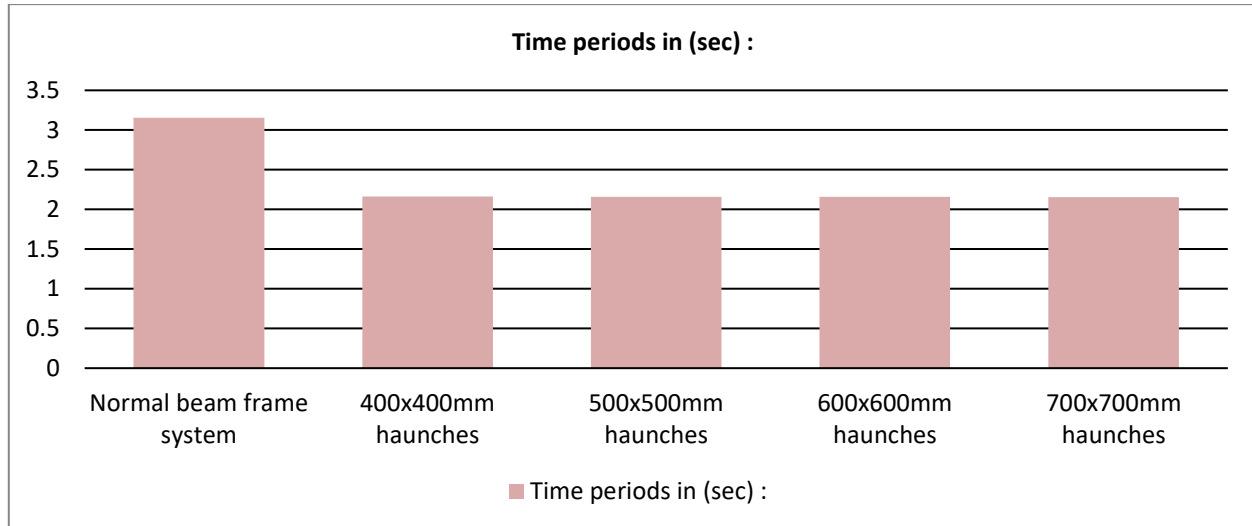


Fig: 1.8 Graphical details of maximum time period of models

First fundamental time period for the modal analysis result maximum for Normal beam frame system.

V. CONCLUSION

Analytical study has been conducted to understand the behaviour of different sizes of haunches member with coupling beam. ETABS software is used to carry out the analysis. In this research 700mmx700mm size of haunch with coupling beam has most effective as comparing the values of time period, stiffness, storey drift and lateral displacement. Following are the conclusion we have obtained from above analysis results are: -

1. Time period- In case of modal Time period the values were obtained for structure of regular frame beam system, regular frame with coupling beam system, coupling beam with 400mmx400mm haunches, coupling beam with 500mmx500mm haunches, coupling beam with 600mmx600mm haunches, coupling beam with 700mmx700mm haunches. This means that while using without haunch beam for the Earthquake analysis the building will take more time to oscillate for all six modes when comparing with haunch beam structure. If haunches size increase then the time period decreases simultaneously. We got the better result on the model of 700x700mm haunches as compared to all other models.
2. Base shear: Base shear values in Static and dynamic direction are less in regular frame beam system of the structure as compared to all other models. We got the higher values on the model of 700x700mm haunches as compared to all other models.
3. Displacement: The displacement values for EX, EY, Dx, Dy in regular frame beam system of the structure are higher than all other models. We got the lower values on the model of 700x700mm haunches as compared to all other models. Which improves the stability of the structure and improves the overall stiffness of the structure.
4. Drift Storey: Drift values for EX, EY, Dx, Dy in regular frame beam system of the structure are higher than all other models. We got the lower values on the model of 700x700mm haunches as compared to all other models.
5. Storey stiffness: The storey stiffness values for EX, EY, Dx, Dy in regular frame beam system of the structure are lower than all other models. We got the higher values on the model of 700x700mm haunches as compared to all other models. The maximum sizes of haunches give higher strength and stiffness of the structure.

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