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EVALUATING THE EFFECT OF STRENGHT HIERARCHY ON SEISMIC PERFORMAMCE OF BUILDING BY PUSHOVER ANALYSIS

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Abstract— **The moment frame building generally follows a predefined load path which starts from slab, goes along beam, beam column joint, columns and foundation to soil underneath. For this path strength hierarchy of the individual member plays an important role. In this paper the effect of strength hierarchy on the seismic performance of building are studied by nonlinear pushover analysis techniques. The building is modeled and analyzed by ETABS analysis package. Two models of the building, one having strong column and weak beam (SCWB) and other having weak columns and strong beam(WCSB) are considered for the study and their performance are evaluated by nonlinear pushover curve and performance point. The building having SCWB design performs better than WCSB design in terms of strength and ductility.**

Index Terms—**Component, formatting, style, styling, insert.**

I. INTRODUCTION

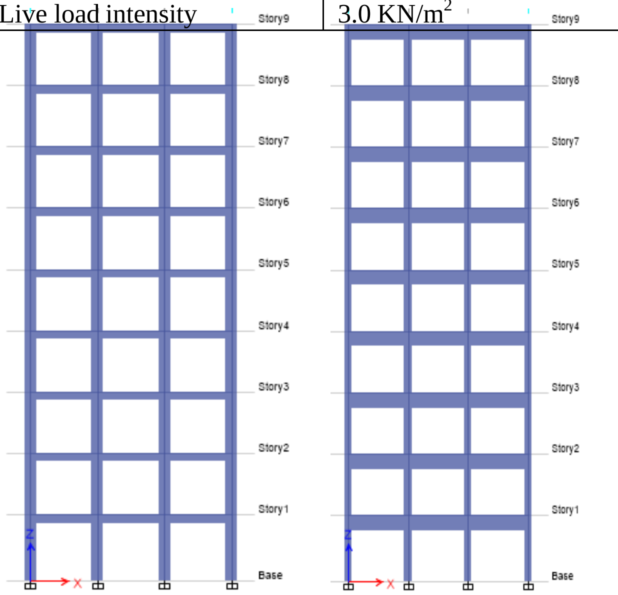
Structural planning of the building is one of the important aspects in seismic performance of buildings situated in high seismic zone. The building can be design having strong columns and weak beam or with weak columns and strong beam from the aspect of flexural strength. The behavior, strength and ductility of building is largely dependent on the strength hierarchy of individual structural members. Hence it is highly important to consider this aspect by a structural engineering while fixing sizes of various members specially beams and columns. In a moment resisting frame building columns are the main lateral load resisting elements and should be made stronger than the beams.

II. METHODOLOGY

Two models of the building are considered for the analysis as shown below. The elevations of two models are shown in figure 1 and data used for the analysis are shown in table 1
Model I (M1): Structural frame with strong column and weak beam (SCWB)
Model II (M2): Structural frame with weak column and strong beam (WCSB)

Table -1: DATA USED FOR ANALYSIS

Response reduction factor	5
Importance factor	1.5
Soil condition	Medium
Seismic Zone	IV
Type of frame	SMRF
Plan size	10.5m x10.5m
External wall	230mm
Interanl Wall	115mm
Thickness of slab	125mm
Floor to floor height	3.2m
Material	M25/Fe415
Floor finish	1.875KN/m^2
Live load intensity	3.0 KN/m^2



Model M1 (SCWB) Model M2 (WCSB)
Fig – 1: Mathematical models of building

III. Modeling And Analysis

The building is modeled using ETABS analysis package. Beams and columns are modeled as two nodded beam element with six degrees of freedom at each node. Since as a part of lateral load analysis slab is modeled as four nodded membrane element with only three degrees of freedom at each node. Rigid diaphragm is considered at each floor level. The equivalent static analysis is carried out on the building for the above seismic data. The building is the design for the load combinations specified in IS 456:2000 for strength and serviceability. The member optimization is done for the load combinations the sizes of columns beams for the two models are worked out. The sizes of beams and columns for the two models are shown in table 2.

Table -2: Design sizes of members

Sr. No.	Item	Model M1 (SCWB)	Model M1 (SCWB)
1	Sizes of column (mm)	600 x 600	425 x 425
2	Sizes of beams (mm)	300 x450	400 x 800

After design and determination of elastic strength of member a displacement controlled nonlinear pushover analysis is carried out on the above two models. The target displacement was kept equal to 4% of the height of the building.

IV .Results And Discussion

The results obtained from nonlinear pushover analysis are show below. The target displacement is kept equal to 4% of the height of the structure and acceleration load is applied in steps until the target displacement is achieved.

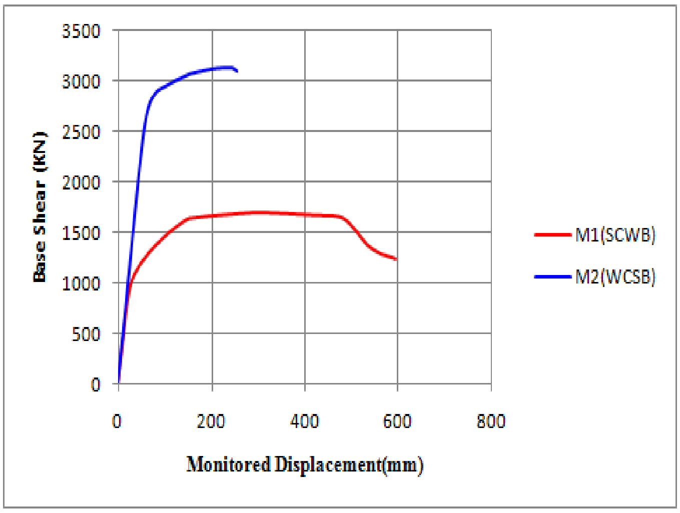


Chart -1: Pushover curve for model M1 and M2

The above lateral load deformation curve of two models shows that both strength and ductility of building with strong column and weak beam design is more than weak column and strong beam design. The sudden drop of strength was observed in model M2 (WCSB) after around 300mm of monitored displacement however yielding of the members are continued up to 450mm monitored displacement in model M1 (SCWB). Hence the strong column weak beam model may sustain more load than weak column and strong beam. The hinge formation mechanism, performance point and other parameters are presented below.

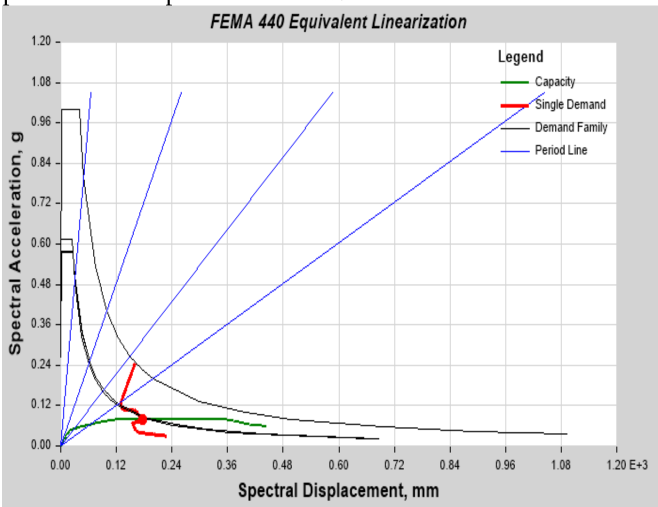


Chart -2: Performance point and capacity spectrum for model M1 (SCWB)

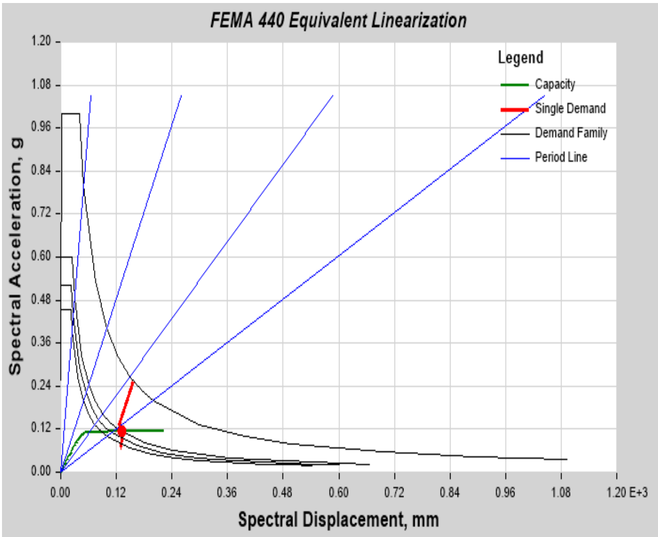


Chart -3: Performance pointand capacity spectrum for model M2 (WCSB)

The capacity spectrum for model M1 and M2 are shown in chart 2 and 3 above. The parameters of the performance point is shown in table 3 below

Table -3: PARAMETERS OF PERFORMANCE POINT

Sr. No	Parameter	Model M1 (SCWB)	Model M2 (WCSB)
1	Displacement	220.2 mm	154.1mm
2	Spectral displacement	176.31	131.9
3	Spectral acceleration	0.0077414	0.1141

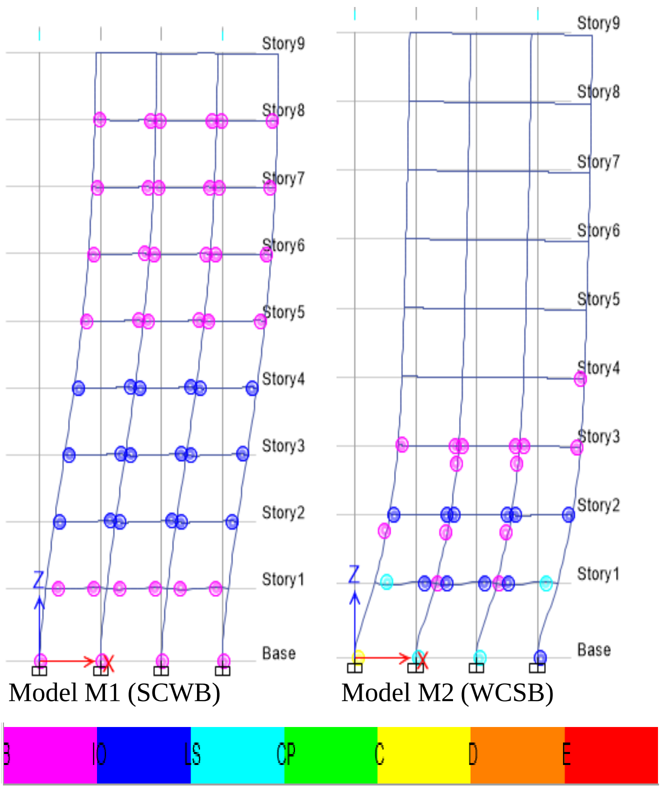


Fig – 2: Hinge formation at step no 175 of pushover

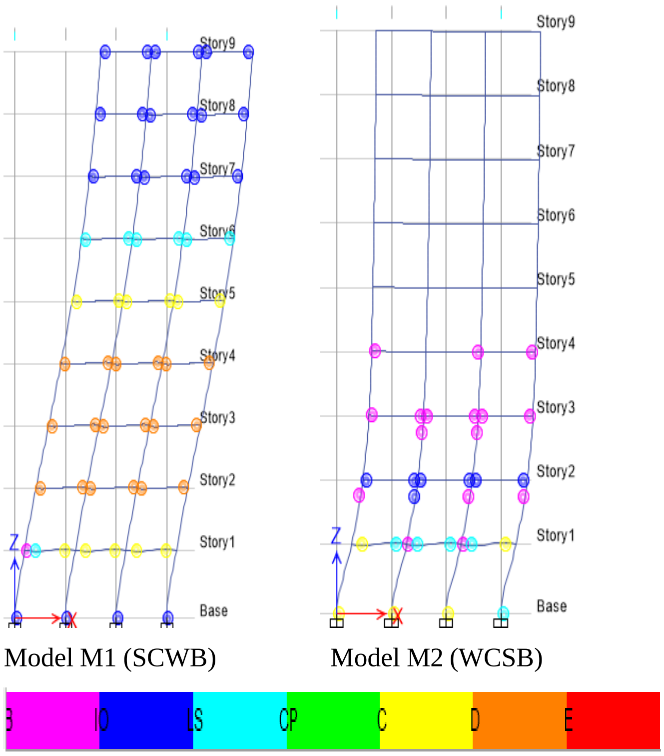


Fig – 3: Hinge formation at last step of pushover

V. CONCLUSIONS

The lateral displacement curve shows that both strength and ductility is more in building design by strong column and weak beam concept. The collapse mechanism of weak column and strong beam (WCSB) is not acceptable since columns sustain large inelastic action and inelasticity is largely concentrated in columns. The hinge formation in model M1 (SCWB) occurs mostly in beams and distributed evenly along the height of the building where as in weak column design plastic hinges mainly formed in columns and concentrated at lower level of building. It is strongly recommended to follow strong column and weak beam design for building in high seismic zone.

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