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Pushover Analysis of Steel Structures

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***Abstract*-In a decades ago Steel structure has assumed a significant job in development Industry. It is important to plan a structure to perform well under seismic burdens. The seismic presentation of a multi-story steel outline building is planned by the arrangements of the current Indian code (IS 800 - 2007). The shear limit of the structure can be expanded by presenting Steel bracings in the basic framework. Bracings can be utilized as retrofit also. There are „n" quantities of conceivable outcomes to organize Steel bracings, for example, D, K, and V type erratic bracings. A regular six-story steel outline building is intended for different kinds of offbeat bracings according to the IS 800-2007. D, K, and V are the various sorts of flighty bracings considered for the current examination. Execution of each edge is concentrated through Non-linear static analysis**

***Keywords*-atc-40 pushover, fema 440 pushover analysis, applied technology council (atc-20), atc-20.**

I.INTRODUCTION

Steel is by a long shot most helpful material for building development on the planet. Today steel industry is the fundamental or key industry in any nation. It quality of roughly multiple times that of solid, steel is the perfect material of present day development. It"s chiefly focal points are quality, speed of erection, construction, and demountability. Basic steel is utilized in load-bearing casings in structures, and as individuals in supports, scaffolds, and space outlines.

Steel, nonetheless, requires fire and consumption insurance. In steel structures, claddings and isolating dividers are made up of stone work or different materials, and regularly a solid establishment is given. Steel is likewise utilized related casing and shear divider development. Because of its enormous solidarity to weight proportion, steel structures will in general be more efficient than solid structures for tall structures and huge range structures and extensions. Steel structures can be developed exceptionally quick and this empowers the structure to be utilized early along these lines prompting generally speaking economy steel offers much preferable compressive and elasticity over cement and empowers lighter developments.

To get the most advantage out of steel, steel structures ought to be planned and secured to oppose consumption and fire. They ought to be planned and point by point for simple creation and erection. Great quality control is basic to guarantee legitimate fitting of the different auxiliary components. The impacts of temperature ought to be considered in plan. Steel structures are flexible and strong and can withstand serious loadings, for example, quakes. Steel structures can be effortlessly fixed and retrofitted to convey higher burdens. Steel is one of the most amiable ecological structure materials – steel is 100% recyclable. To get the most advantage out of steel, steel structures ought to be planned and ensured to oppose erosion and fire. They ought to be planned and itemized for simple manufacture and erection. Great quality control is basic to guarantee legitimate fitting of the different basic components. The impacts of temperature ought to be considered in plan. To forestall advancement of breaks under weariness and seismic tremor stacks the associations and specifically the welds ought to be structured and point by point appropriately. Exceptional prepares and defensive measures for consumption and fire are accessible and the originator ought to be acquainted with the alternatives accessible. Since steel is delivered in the processing plant under better quality control, steel structures have higher unwavering quality and wellbeing.

II. PUSHOVER ANALYSIS – AN OVERVIEW

A displacement-controlled pushover analysis is basically composed of the following steps:

- A two or three dimensional model that represents the overall structural behavior is created.
- Bilinear or tri-linear load-deformation diagramsof all important members that affect lateral response are defined.
- Gravity loads composed of dead loads and aspecified portion of live loads are applied to thestructural model initially.
- A pre -defined lateral load pattern which isdistributed along the building height is thenapplied.
- Lateral loads are increased until somemember(s) yield under the combined effects of gravity and lateral loads.

- Base shear and roof displacement are recorded at first yielding.
- The structural model is modified to account for the reduced stiffness of yielded member(s).
- Gravity loads are removed and a new lateral load increment is applied to the modified structural model such that additional member(s) yield. Note that a separate analysis with zero initial conditions is performed on modified structural model under each incremental lateral load. Thus, member forces at the end of an incremental lateral load analysis are obtained by adding the forces from the current analysis to the sum of those from the previous increments. In other words, the results of each incremental lateral load analysis are superimposed.
- Similarly, the lateral load increment and the roof displacement increment are added to the corresponding previous total values to obtain the accumulated values of the base shear and the roof displacement.
- Steps 7, 8 and 9 are repeated until the roof displacement reaches a certain level of deformation or the structure becomes unstable.
- The roof displacement is plotted with the base shear to get the global capacity(pushover) curve of the structure (Figure 3.1).

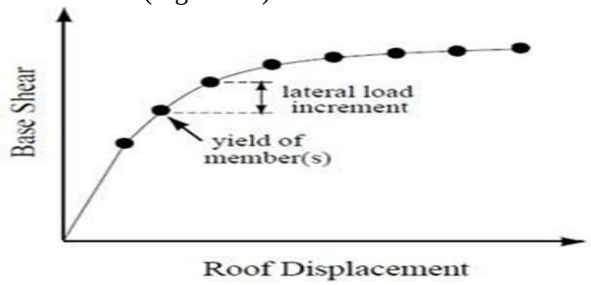

Figure-1 Global Capacity (Pushover) Curve of Structure.

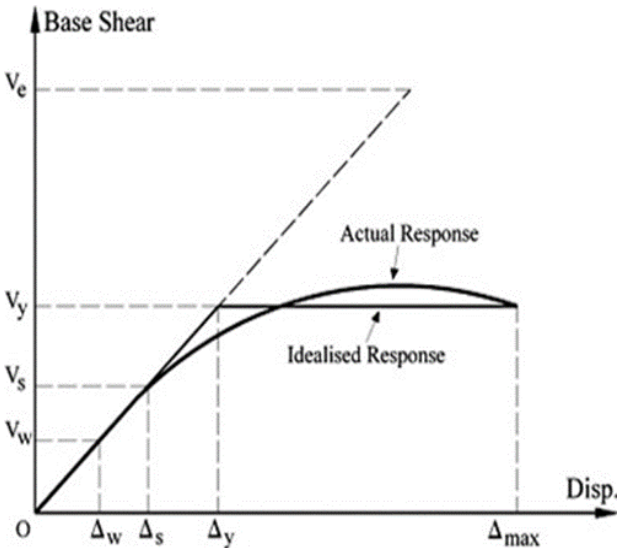

Figure -2 Typical Pushover response curve for evaluation of behavior factor, R.

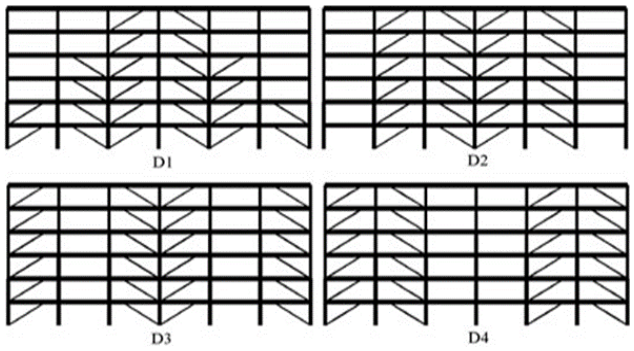

Fig -3 D-frames.

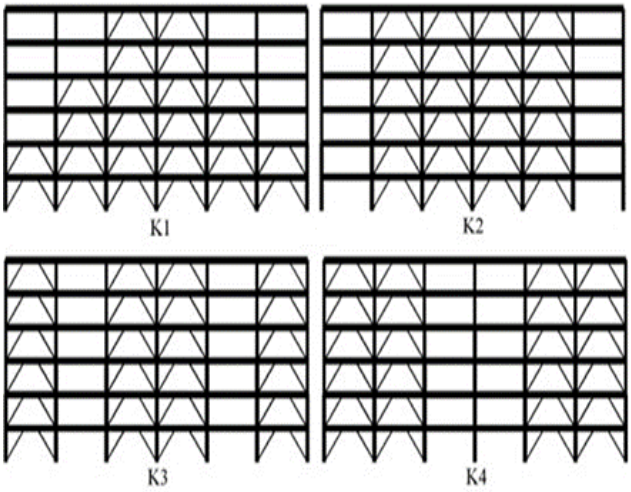

Fig-4 K-Frames.

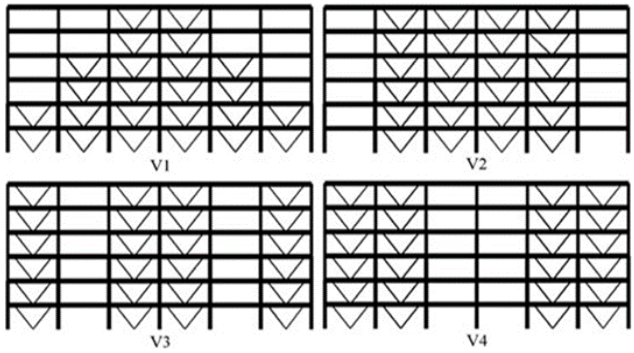

Fig-5 V-Frames.

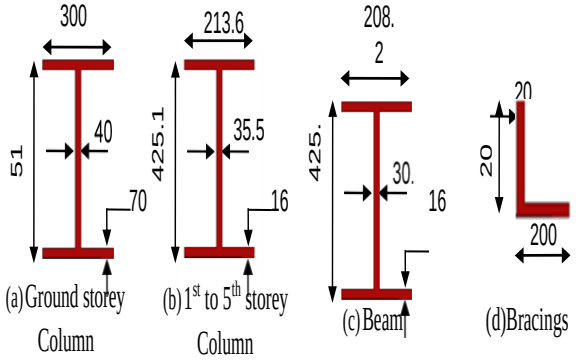

Fig-6 Cross sectional details of the frames.

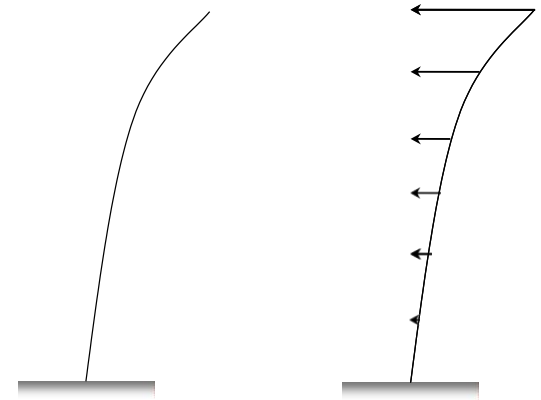

Fig-7 Ist mode shape and Lateral Load profile.

Table-1Fundamental period of vibration.

Frame	IS Code Time Period (T) sec	Computational Time Period (T) sec
V1	0.742	0.367
V2	0.742	0.355
V3	0.742	0.368
V4	0.742	0.362
D1	0.742	0.328
D2	0.742	0.339
D3	0.742	0.359
D4	0.742	0.346
K1	0.742	0.484
K2	0.742	0.485
K3	0.742	0.487
K4	0.742	0.489

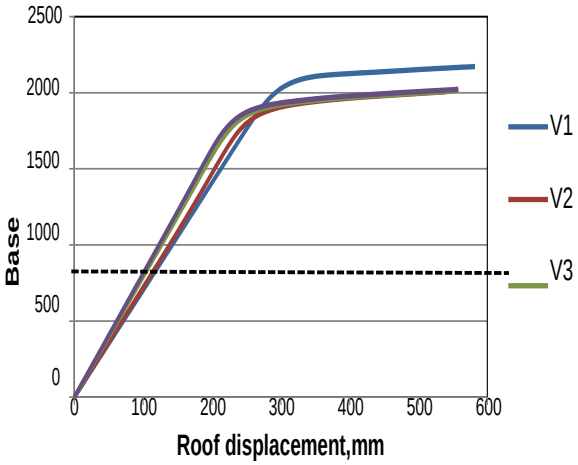

Figure-8 Comparison of Push over analysis of V Type Frames.

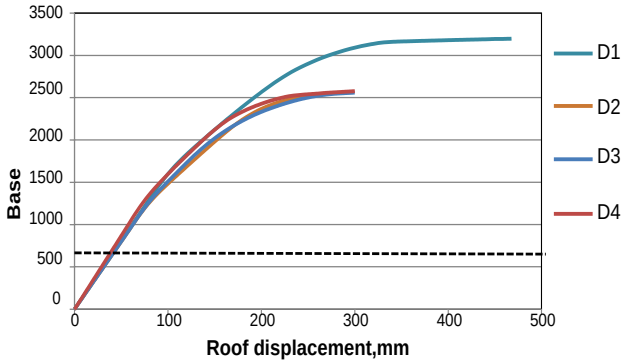

Figure-9 Comparison of push over analysis of D-Type Frames.

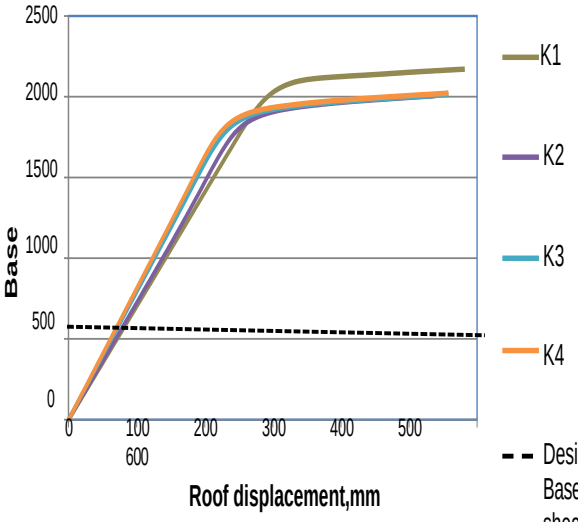

Figure-10 Comparison of push over analysis of K-Type Frames.

Table-2 R factors parameters of the frames.

Frame	*Design R value*	*Ductility μ*	*Rμ*	*Rs*	*Y*	*Over strength*	*R*	*Total weight ton-force*
V1	4	1.94	1.73	1.59	3.57	5.67	9.83	884
V2	4	2.20	1.80	2.58	2.06	5.31	9.56	884
V3	4	2.33	1.88	1.65	3.30	5.44	10.29	884
V4	4	2.43	1.92	2.67	2.04	5.44	10.50	884
D1	4	2.42	2.02	2.84	2.85	8.09	16.41	884
D2	4	1.90	1.69	2.35	2.68	6.29	10.69	884
D3	4	1.92	1.75	1.60	4.00	6.40	11.31	884
D4	4	2	1.78	2.09	3.07	6.41	11.47	884
K1	4	2.03	1.72	1.34	4.38	5.86	10.14	884
K2	4	2.11	1.81	1.40	3.68	5.15	9.38	884
K3	4	2.42	1.91	1.14	4.65	5.30	10.21	884
K4	4	2.43	1.95	1.34	3.96	5.30	10.36	884

III. SUMMARY AND CONCLUSIONS

1. Summary

The selected frame models are analyzed using pushover analysis. The seismic performance of a multi-story steel frame building is designed according to the provisions of the current Indian code (IS 800 -2007). Shear capacity of the structure can be increased by introducing Steel bracings in the structural system. Bracings can be used as retrofit as well. There are „n" numbers of possibilities to arrange Steel bracings such as D, K, and V type eccentric bracings. A typical six-story steel frame building is designed for various types of eccentric bracings as per the IS 800- 2007. D, K, and V are the different types of eccentric bracings considered for the present study. Performance of each frame is studied through nonlinear static analysis. Fundamental period of the Building frames and corresponding mode shapes are calculated. Pushover curves and behavior factors for the different eccentric steel frames are compared to find the relative performances of various frames considered.

2. Conclusions

- Modal analysis of a 2D steel frame models reveals that, there is huge difference between Computational Time periods and IS code Time period.
- Ductility of a moment-resisting steel frame is to some extent affected by its height. When bracing systems are included, the height dependency of ductility is greatly magnified
- Steel-braced dual systems exhibit higher ductility and therefore higher R factors.
- Considering the range of ductility capacities shown by different systems discussed, it is found that the bracing arrangement in D and K family, D1 & K4 respectively are found to be performing better compared to that of others.

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