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Study of Nonlinear Behaviour of a Braced Structure in all Seismic Zones

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ABSTRACT: Progressive collapse refers to a phenomenon in which local damage in a primary structural element leads to total or partial structural system failure. When investigating the progressive collapse of structures, nonlinear dynamic procedures lead to more accurate results than static procedures. However, nonlinear dynamic procedures are very complicated and the evaluation or validation of the results can become very time consuming. Therefore, it is better to use simpler methods. In this study, a simplified analysis procedure for the progressive collapse analysis of steel structures is presented using the load displacement and capacity curve for braced steel space framed structure using STAAD Pro.

I. INTRODUCTION

A simple computer-based push-over analysis is a technique for performance-based design of building frameworks is Push-over analysis attains much importance in the past decades due to its simplicity and the effectiveness of the results. The present study develops a push-over analysis for steel frame designed according to IS-800 (2007) and ductility behaviour of each frame.

Suitable capacity parameters and their acceptable values, as well as suitable methods for demands prediction will depend on the performance level to be evaluated. In light of these facts, it is imperative to seismically evaluate the existing building with the Present day knowledge to avoid the major destruction in the future earthquakes. The Buildings found to be seismically deficient should be retrofitted or strengthened.

Pushover Methodology:

A pushover analysis is performed by subjecting a structure to a monotonically increasing pattern of lateral loads, representing the inertial forces which would be experienced by the structure when subjected to ground shaking. Under incrementally increasing loads various structural elements may yield sequentially. Consequently, at each event, the structure experiences a loss in stiffness. Using a pushover analysis, a characteristic non-linear force displacement relationship can be determined.

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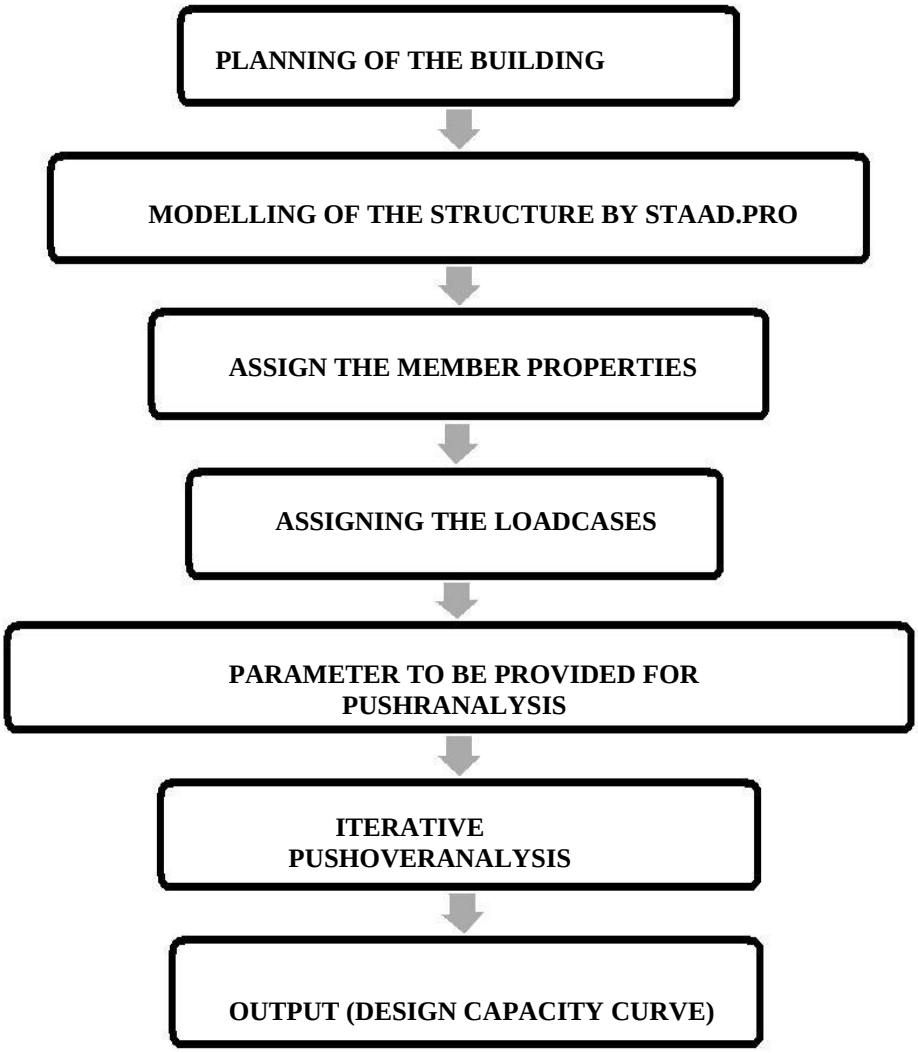

II. STRUCTURAL MODELLING

The study in this thesis is based on nonlinear analysis of steel frames on different configurations of frames are selected such as

Isometric View of RF modelled in STAAD.Pro

Braced structure:

Case-(1): Regular G+5 frame ,**Case-(2):** Progressive collapse load case by removing a column (C1) at assumed corner joint**, Case-(3):** Progressive collapse load case by removing a column (C2) at assumed exterior edge joint in Z direction, C**ase-(4):** Progressive collapse load case by removing a column (C3) at assumed

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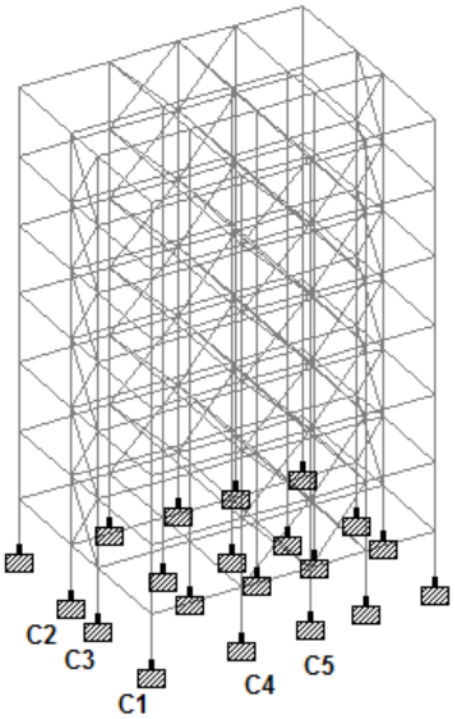
exterior edge joint in Z direction, **Case-(5):** Progressive collapse load case by removing a column (C4) at assumed exterior edge joint in X direction, **Case-(6):** Progressive collapse load case by removing a column (C5) at assumed exterior edge joint in X direction.



Isometric View of RFWB modelled in STAAD.Pro

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III. RESULTS AND DISCUSSIONS

BRACED STRUCTURE

SEISMIC ZONE	Braced structure BASE SHEAR (KN) FOR					
	RFWB	RFWB-PC-1	RFWB-PC-2	RFWB-PC-3	RFWB-PC-4	RFWB-PC-5
ZONE-II	2816.983	298.636	299.892	295.472	301.112	298.455
ZONE-III	2937.114	301.632	298.139	298.105	302.205	304.044
ZONE-IV	2937.043	296.564	297.299	297.265	308.059	300.356
ZONE – V	2938.112	311.984	308.284	308.249	309.575	311.061

SEISMIC ZONE	Braced structure DISPALCEMENT (mm) FOR					
	RFWB	RFWB-PC-1	RFWB-PC-2	RFWB-PC-3	RFWB-PC-4	RFWB-PC-5
ZONE-II	47.49	5.036	5.061	5.036	5.039	5.022
ZONE-III	50.011	5.086	5.032	5.081	5.057	5.116
ZONE-IV	50.01	5.001	5.017	5.067	5.155	5.054
ZONE – V	50.03	5.261	5.203	5.254	5.18	5.234

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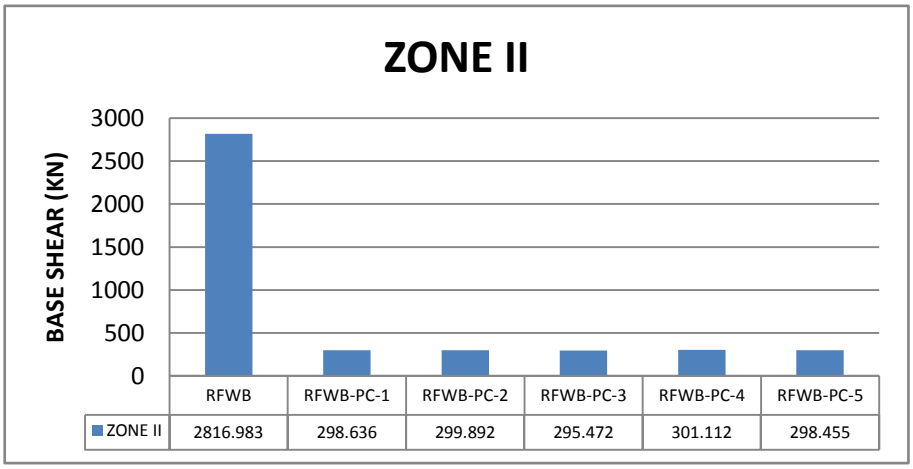
Graphical representation:

Braced structure:

Comparison between base shears and displacements from the capacity curves obtained from the pushover analysis at Seismic zone II:

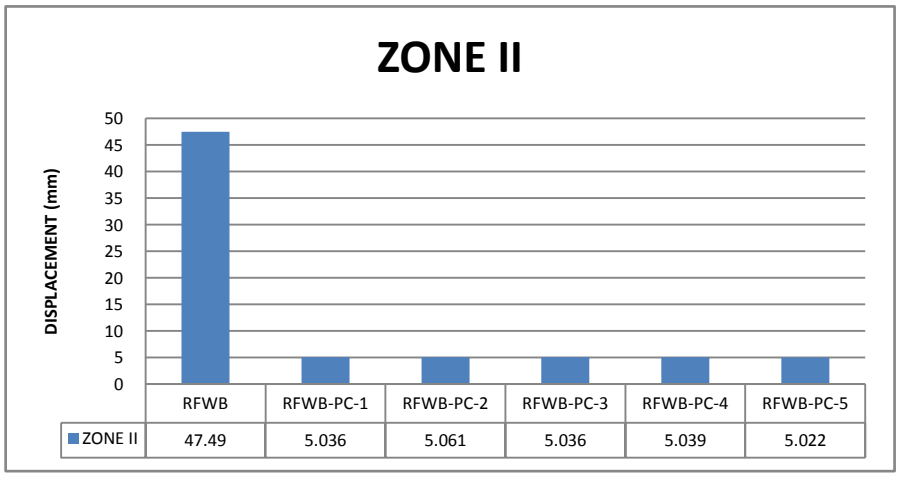
BASE SHEAR:



Comparison of base shear for seismic zone II

It is observed that the base shear capacity of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, and RFWBC-5 is reduced by by 89%, 89.35%, 89.47%, 89.5% and 89.4% when compared to Regular space frame RFWB.

DISPLACEMENT



Comparison of displacements for seismic zone II

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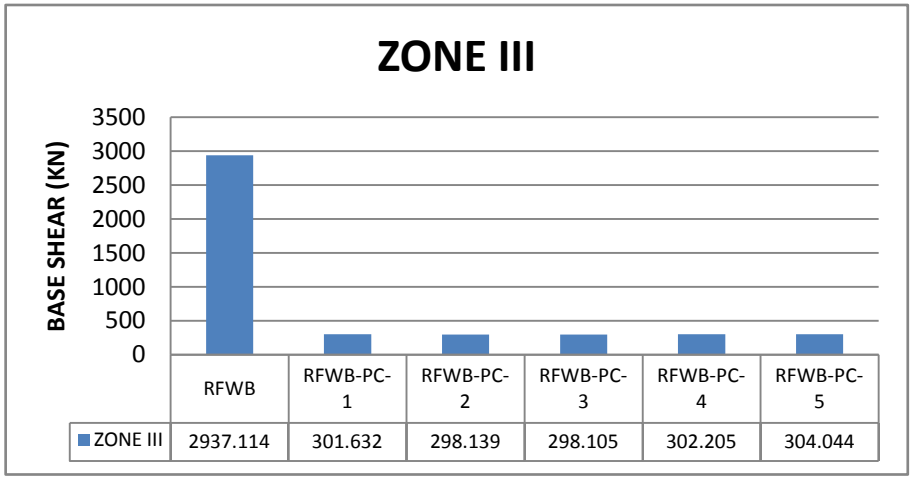
It is observed that the displacements of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, RFWBC-5 is reduced by 89.3%, 89.3%, 89.39%, 89.38% and 89.38% when compared to Regular space frame RFWB.

Comparison between base shears and displacements from the capacity curves obtained from the pushover analysis at Seismic zone III:

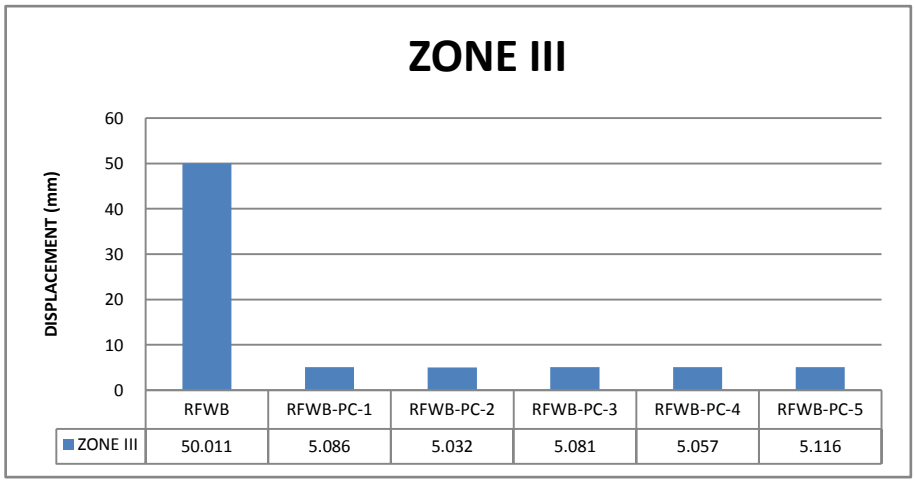
BASE SHEAR:



Comparison of base shear for seismic zone III

It is observed that the base shear capacity of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, and RFWBC-5 is reduced by 89.7%, 89.8%, 89.8%, 89.7% and 89.6 % when compared to Regular space frame RFWB.

DISPLACEMENT:



Comparison of displacements for seismic zone III

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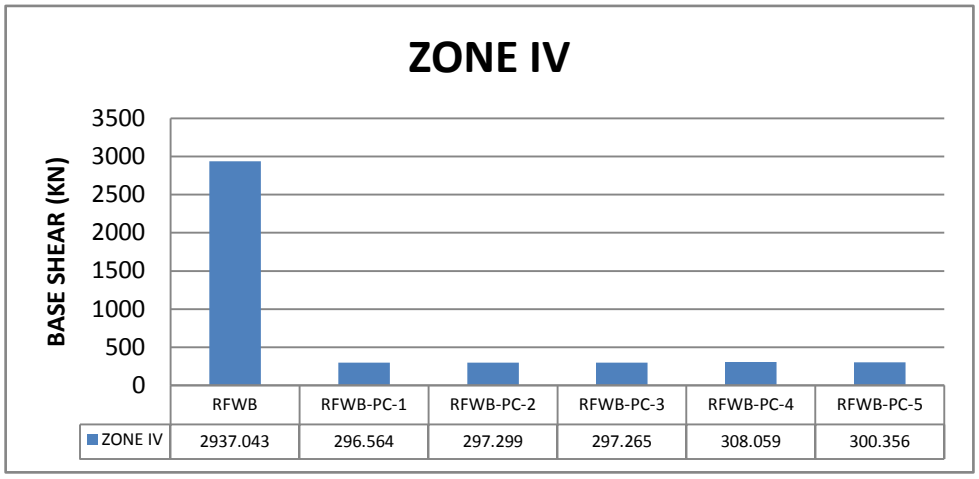
It is observed that the displacements of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, RFWBC-5 is reduced by 89.8%, 89.9%, 89.8%, 89.88% and 89.7 % when compared to Regular space frame RFWB.

Comparison between base shears and displacements from the capacity curves obtained from the pushover analysis at Seismic zone IV:

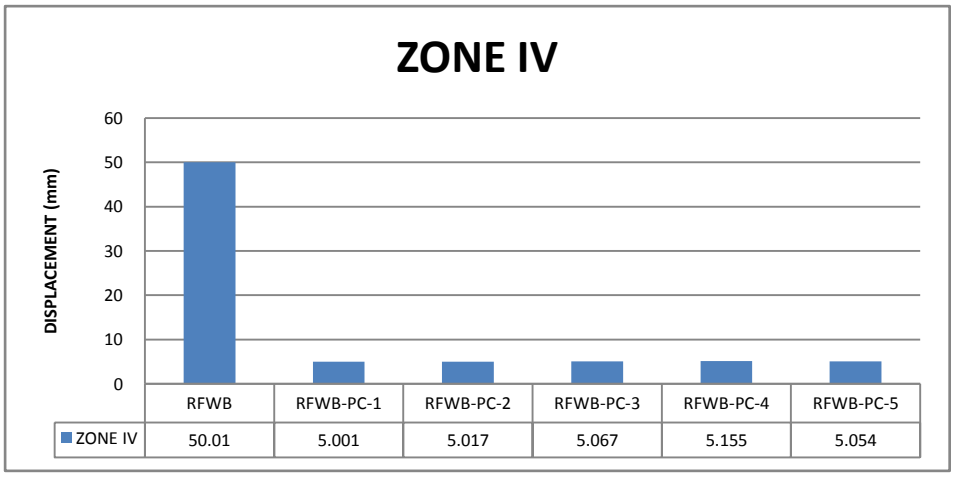
BASE SHEAR:



Comparison of base shear for seismic zone IV

It is observed that the base shear capacity of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, and RFWBC-5 is reduced by 89.9%, 89.9%, 89.8%, 89.5% and 89.7 % when compared to Regular space frame RFWB.

DISPLACEMENT:



Comparison of displacement for seismic zone IV

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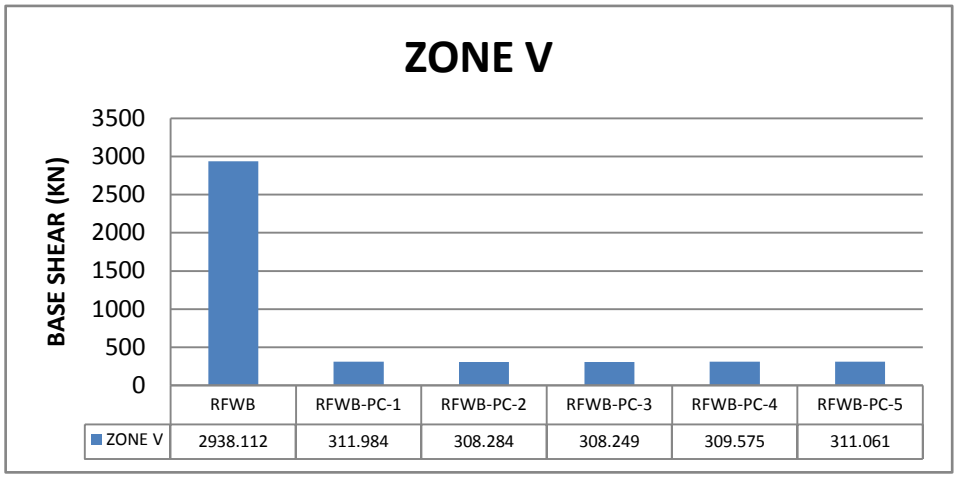
It is observed that the displacements of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, RFWBC-5 is reduced by 90%, 90%, 89.8%, 89.69% and 89.89 % when compared to Regular space frame RFWB.

Comparison between base shears and displacements from the capacity curves obtained from the pushover analysis at Seismic zone V:

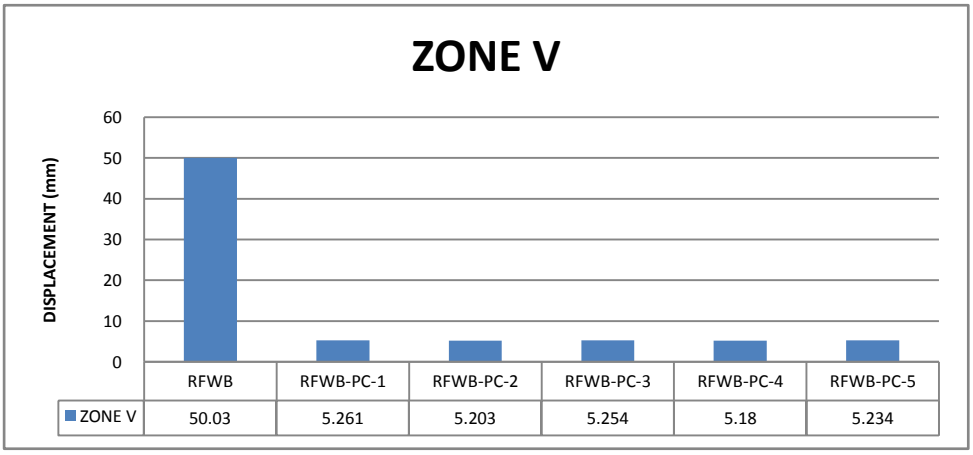
BASE SHEAR:



Comparison of base shear for seismic zone V

It is observed that the base shear capacity of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, and RFWBC-5 is reduced by 89.4%, 89.5%, 89.5%, 89.4% and 89.41% when compared to Regular space frame RFWB.

DISPLACEMENT:



Comparison of displacement for seismic zone V

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It is observed that the displacements of the Space frames RFWBC-1, RFWBC-2, RFWBC-3, RFWBC-4, RFWBC-5 is reduced by 89.48%, 89.48%, 89.49%, 89.64% and 89.53% when compared to Regular space frame RFWB.

IV. CONCLUSION

Braced structure:

1. Base shear and displacement capacity of the braced steel space frame with considering progressive collapse case is decreased by 89.47% and 89.38% when compared to Regular space frame without considering progressive collapse case at Seismic zone II.
2. Base shear and displacement capacity of the braced steel space frame with considering progressive collapse case is decreased by 89.7% and 89.7% when compared to Regular space frame without considering progressive collapse case at Seismic zone III.
3. Base shear and displacement capacity of the braced steel space frame with considering progressive collapse case is decreased by 89.9% and 90.0% when compared to Regular space frame without considering progressive collapse case at Seismic zone IV.
4. Base shear and displacement capacity of the braced steel space frame with considering progressive collapse case is decreased by 89.5% and 89.48% when compared to Regular space frame without considering progressive collapse case at Seismic zone V.
5. In all the progressive collapse load cases the percentage change in reduction of base shear and displacements is very minute in the same zone.

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