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PROGRESSIVE COLLAPSE STUDY ON REGULAR STEEL SPACE FRAMES SUBJECTED TO SEISMIC LOADING

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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 steel space framed structure using STAAD Pro.

KEYWORDS:PUSHOVER,PROGRESSIVECOLLAPSE,BASESHEAR,CAPACITYCURVE,ZONES,

DISPLACEMNT

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:

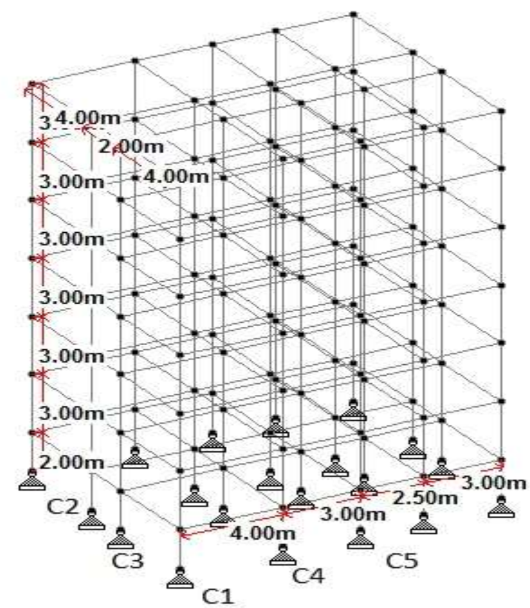
A pushover analysis is performed by subjecting a structure to a monotonically increasing pattern of lateral loads, representing the inertial forces which would be experienced by the structure when subjected to ground shaking. Under incrementally increasing loads various structural elements may yield 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.

Structural modelling:

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

REGULAR FRAMED 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, **case-(4)**: progressive collapse load case by removing a column (C3) at assumed 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 RF modelled in STAAD.Pro

Results and Discussions:

SEISMIC ZONE	**BASE SHEAR (KN)**					
	(RF)	**(RFC-1)**	**(RFC-2)**	**(RFC-3)**	**(RFC-4)**	**(RFC-5)**
Seismic zone	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR
	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)
SEISMIC ZONE II	1434.1	110.94	107.855	114.018	111.699	113.45
SEISMIC ZONEIII	1434	114.832	111.208	111.208	110.343	111.19
SEISMIC ZONE IV	1436	111.54	113.076	113.076	119.992	113.43
SEISMIC ZONE V	1436.8	121.337	116.705	116.705	117.13	117.65

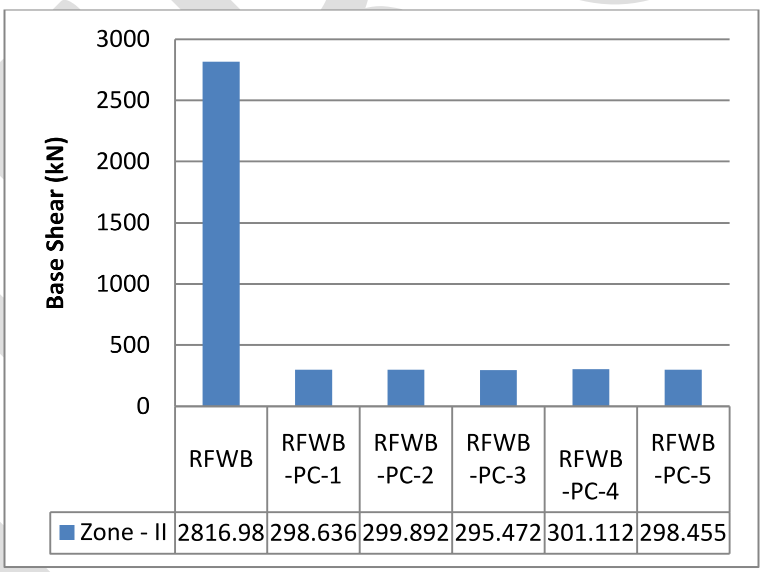
SEISMIC ZONE	**REGULAR FRAMED structure DISPALCEMENT (mm) FOR**					
	(RF)	**(RFC**	**(RFC**	**(RFC-**	**(RFC**	**(RFC**

		-1)	-2)	3)	-4)	-5)
Seismic zone	DISPLACEMENT (mm)	DISPLACEMENT (mm)	DISPLACEMENT (mm)	DISPLACEMENT (mm)	DISPLACEMENT (mm)	DISPLACEMENT (mm)
SEISMIC ZONE II	50.026	5.07	5.009	5.429	5.099	5.176
SEISMIC ZONEIII	50.024	5.249	5.165	5.12	5.037	5.073
SEISMIC ZONE IV	50.057	5.099	5.525	5.206	5.478	5.175
SEISMIC ZONEV	50.05	5.547	5.42	5.373	5.347	5.368

REGULAR FRAMED STRUCTURE:

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

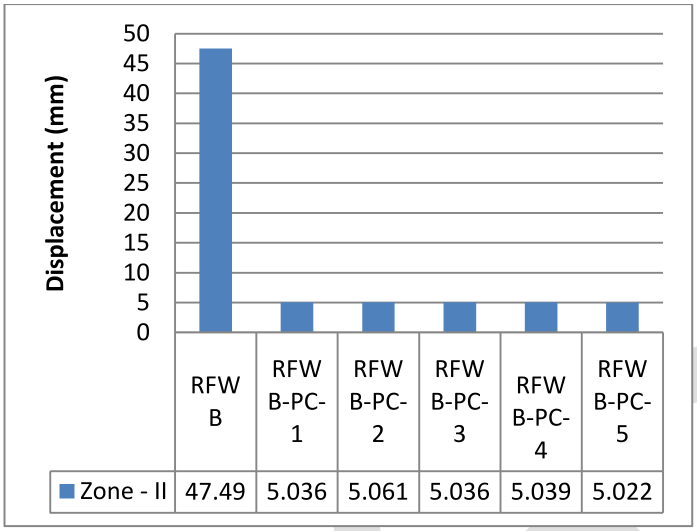
BASE SHEAR:



Comparison of Base shear at Seismic zone-II

It was observed that base shear capacity of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by 89%, 89.35%, 89.47%, 89.5% and 89.4 % when compared to RFWB.

DISPLACEMENT:

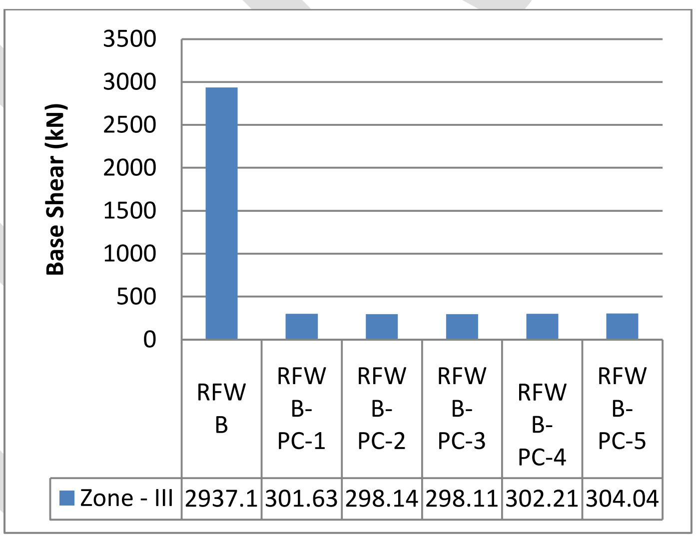


Comparison of displacements at Seismic zone-II

It was observed that displacement resistance of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by 89.3%, 89.3%, 89.39%, 89.38% and 89.38 % when compared to RFWB.

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

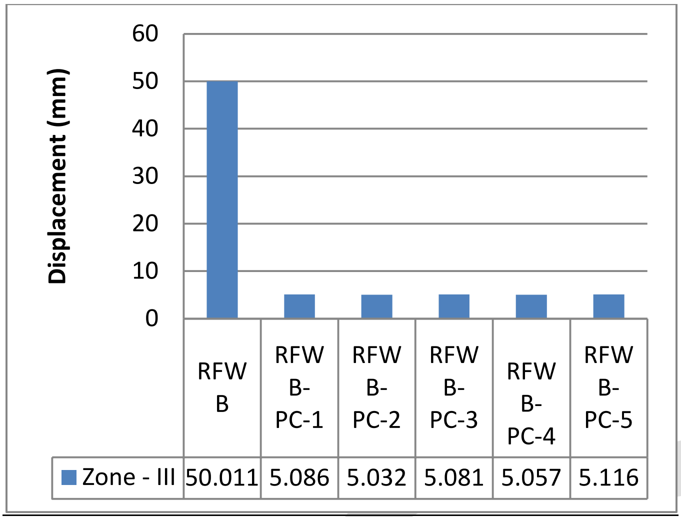
BASE SHEAR:



Comparison of Base shear at Seismic zone-III

It was observed that base shear capacity of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by89.7%, 89.8%, 89.8%, 89.7% and 89.6 % when compared to RFWB.

DISPLACEMENT:

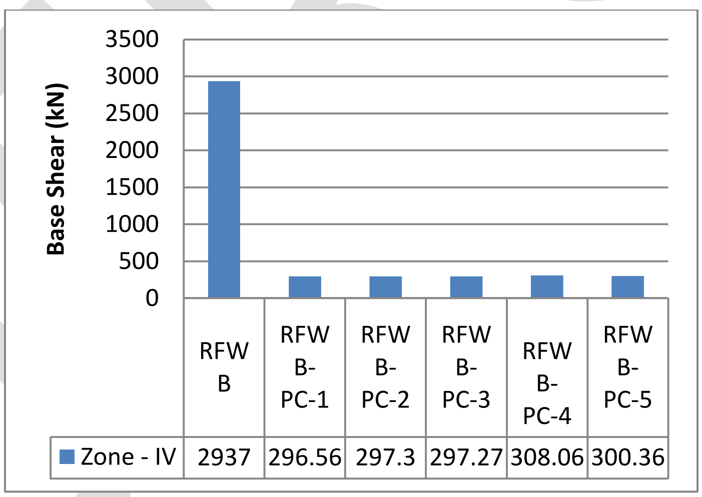


Comparison of displacements at Seismic zone-III

It was observed that displacement resistance of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by 89.8%, 89.9%, 89.8%, 89.88% and 89.7 % when compared to RFWB.

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

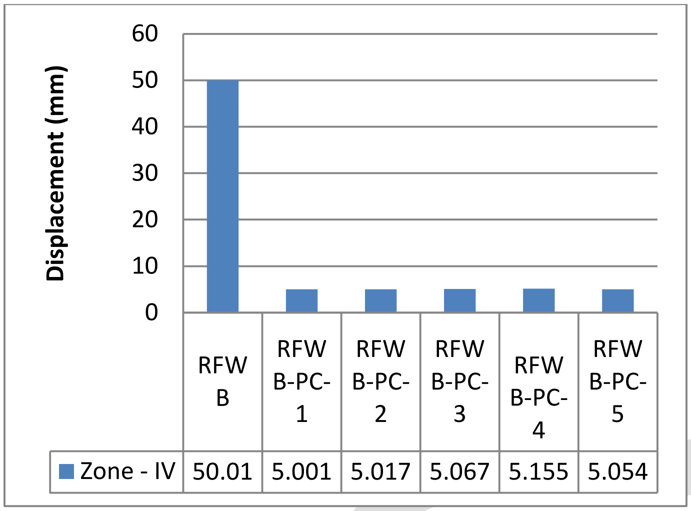
BASE SHEAR:



Comparison of Base shear at Seismic zone-IV

It was observed that base shear capacity of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by89.9%, 89.9%, 89.8%, 89.5% and 89.7 % when compared to RFWB.

DISPLACEMENT:

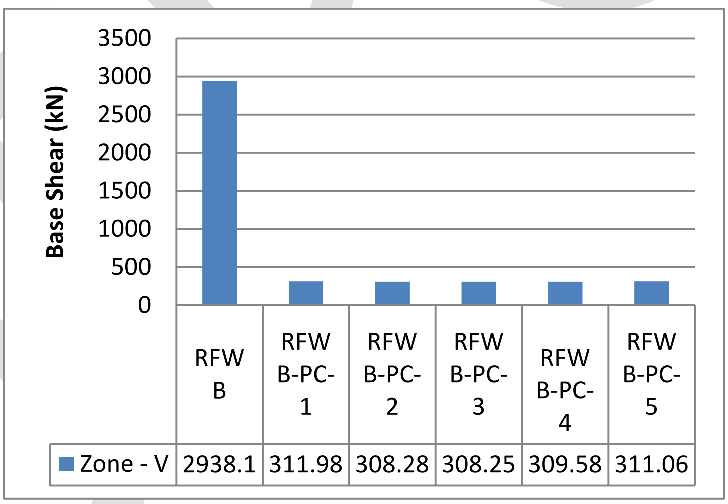


Comparison of displacement at Seismic zone-IV

It was observed that displacement resistance of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by 90%, 90%, 89.8%, 89.69% and 89.89 % when compared to RFWB.

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

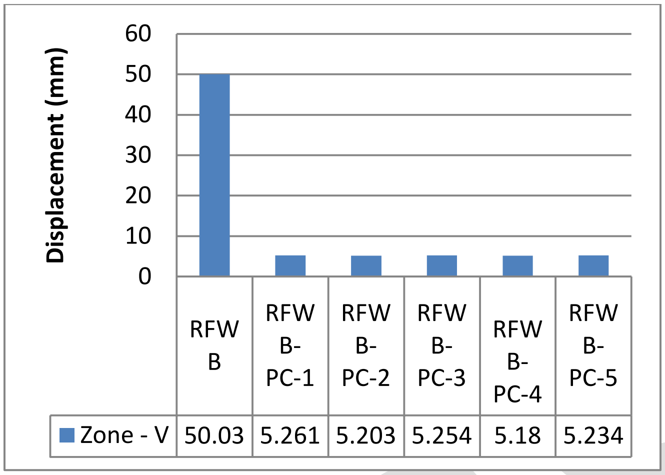
BASE SHEAR:



Comparison of base shear at Seismic zone-V

From the fig. 4.31, it was observed that base shear capacity of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by89.4%, 89.5%, 89.5%, 89.4% and 89.41 % when compared to RFWB.

DISPLACEMENT:



Comparison of displacement at Seismic zone-V

It was observed that displacement resistance of RFWB-PC-1, RFWB-PC-2, RFWB-PC-3, RFWB-PC-4, and RFWB-PC-5 was decreased by 89.48%, 89.48%, 89.49%, 89.64% and 89.53 % when compared to RFWB.

Conclusion:

1. The maximum base shear and maximum displacement capacity of the Space frame with considering progressive collapse case is reduced by92.4% and 90.093% when compared toRegularspace frame in Seismic zone II
2. The maximum base shear and maximum displacement capacity of the Space frame with considering progressive collapse case is reduced by 92.3% and 89.9% when compared to Regular space frame in Seismic zone III
3. The maximum base shear and maximum displacement capacity of the Space frame with considering progressive collapse case is reduced by 92.2% and 89.8% when compared to Regular space frame in Seismic zone IV
4. The maximum base shear and maximum displacement capacity of the Space frame with considering progressive collapse case is reduced by 91.9% and 89.27% when compared to Regular space frame in 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 Seismic zone.

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