

NON LINEAR STATIC BEHAVIOR OF A IRREGULAR STRUCTURE ON PROGRESSIVE COLLAPSE DIFFERENT FAILURES OF COLUMNS

BONDLA MAHENDRA REDDY¹, P.RAJESH²

¹RESEARCH SCHOLAR, St.Mary's College of engineering.

²RESEARCH GUIDE, St.Mary's College of engineering

Abstract Progressive collapse denotes an extensive structural failure initiated by local structural damage, or a chain reaction of failures following damage to a relatively small portion of a structure. Prediction of possible progressive collapse under specific conditions may provide very important information that could be used to control or prevent progressive collapse. Pushover analysis method is a nonlinear static analysis method that could be used in earthquake engineering to calculate the residual capacity of two frames designed for different seismic region to resist progressive collapse under a missing column scenario.

The present study describes the comparison between the irregular steel space frameworks with and without having considerable progressive collapse cases using nonlinear static analysis. Pushover analyses using various invariant lateral load patterns and modal pushover analysis were performed on steel moment resisting frames. The results revealed that the steel space frameworks with progressive collapse cases showed a large decrement in the maximum base shear and maximum displacement capacity compared to their irregular steel space frameworks without progressive collapse cases. The results of the pushover analysis also confirmed that the irregular steel space frameworks with progressive collapse cases have significantly improved stability in seismic zones over their counterparts without progressive collapse cases.

KEYWORDS: PUSHOVER, PROGRESSIVE COLLAPSE, BASE SHEAR, CAPACITY CURVE, ZONES, DISPLACEMENT

Introduction:

A simple computer-based push-over analysis is a technique for performance-based design of building frameworks. Pushover 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:

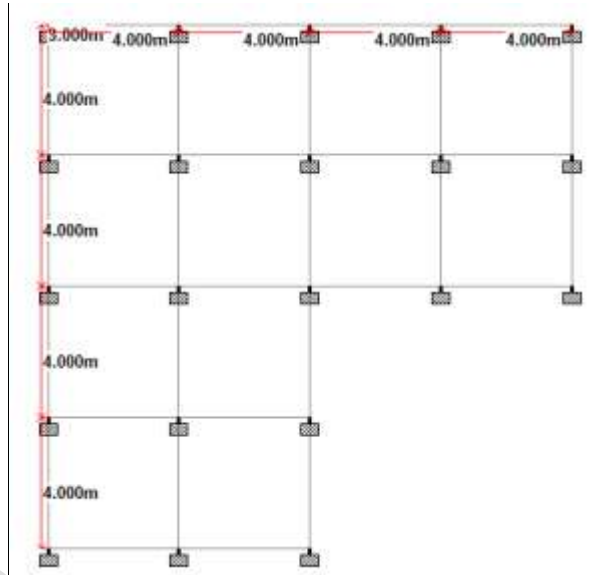
A pushover analysis is performed by subjecting a structure to a monotonically increasing pattern of lateral loads, representing the inertial forces which would be experienced by the structure when subjected to ground shaking. Under incrementally increasing loads various structural elements may yield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

IRREGULAR FRAMED STRUCTURE:

Case-(1): Irregular 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.



View of RF modelled in STAAD.Pro

Results and Discussions:

Comparison of base shears and displacements for steel space framed structure with different progressive collapse conditions:

SEISMIC ZONE	BASE SHEAR (KN) FOR						
	(IRF)	(IRFC-1)	(IRFC-2)	(IRFC-3)	(IRFC-4)	(IRFC-5)	(IRFC-6)
Seismic zone	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR	BASE SHEAR
	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)	(KN)
SEISMIC ZONE II	2134.086	155.300	127.213	207.324	144.369	170.827	177.498
SEISMIC ZONE III	2141.703	248.472	210.068	213.587	238.107	259.435	246.817
SEISMIC ZONE IV	2346.673	248.612	306.721	213.60	238.208	259.485	246.824
SEISMIC ZONE V	2346.782	248.663	310.068	311.663	238.480	260.10	258.10

Comparison of Base shears at all seismic zones for various progressive Collapse cases

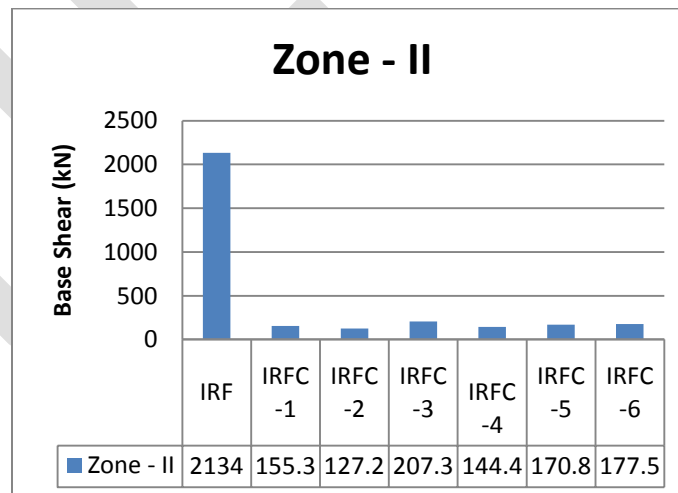
SEISMIC ZONE	DISPALCEMENT (mm) FOR						
	(IRF)	(IRFC-1)	(IRFC-2)	(IRFC-3)	(IRFC-4)	(IRFC-5)	(IRFC-6)
Seismic zone	DISPLACEMENT	DISPLACEMENT	DISPLACEMENT	DISPLACEMENT	DISPLACEMENT	DISPLACEMENT	DISPLACEMENT
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
SEISMIC ZONE II	50.274	7.028	5.632	7.852	5.871	6.524	6.779
SEISMIC ZONE III	54.411	7.560	6.166	5.350	6.158	6.500	6.184
SEISMIC ZONE IV	52.468	7.558	6.875	6.90	6.316	6.808	6.526
SEISMIC ZONE V	58.795	7.560	6.896	7.806	6.54	6.890	6.782

Comparison of Displacements at all seismic zones for various progressive Collapse cases

IRREGULAR FRAMED STRUCTURE:

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

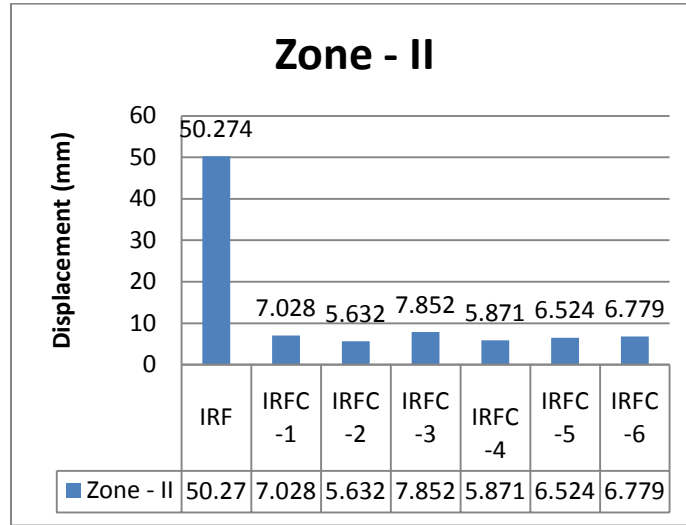
BASE SHEAR:



Comparison of Base shear at Seismic zone-II

It was observed that the base shear capacity of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, and IRFC-5, IRFC-6 is reduced by 92.22%, 92.28, 92.4%, 92.04%, 92.21% and 92 % when compared to Irregular space frame IRF.

DISPLACEMENT:

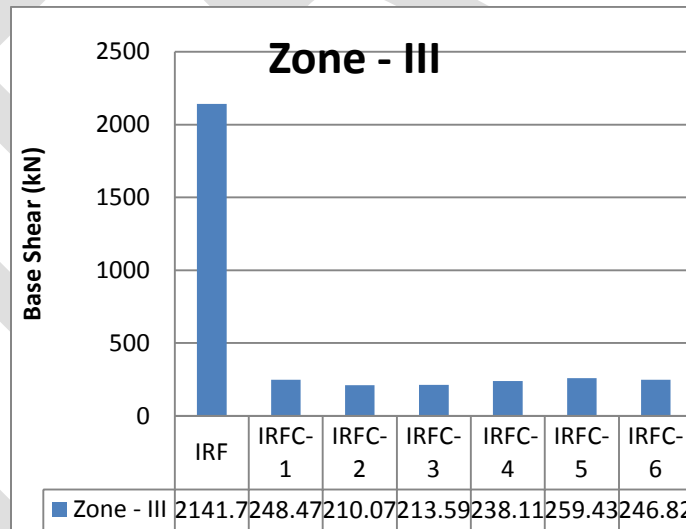


Comparison of displacements at Seismic zone-II

it is observed that the displacements of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 89.8%, 90.003%, 89.1%, 89.8% , 89.9%, 89.6 % when compared to Irregular space frame IRF.

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

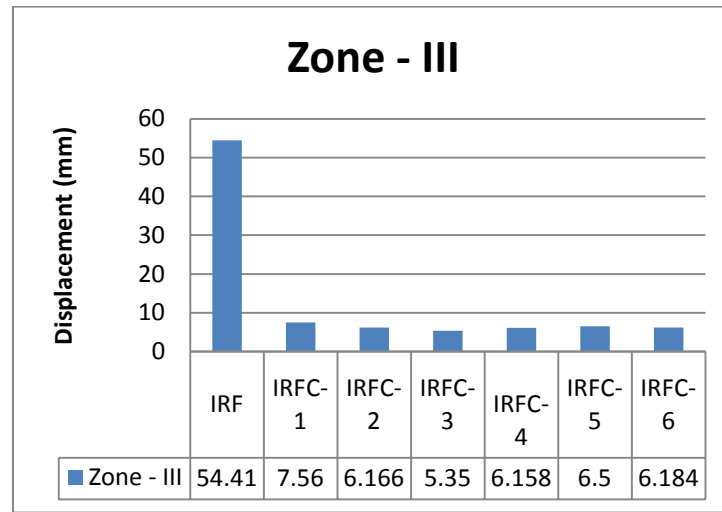
BASE SHEAR:



Comparison of Base shear at Seismic zone-III

It was observed that the base shear capacity of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 91.9%, 92.2%, 92.2%, 92.3% , 92.2%, 92.2 % when compared to Irregular space frame IRF.

DISPLACEMENT:

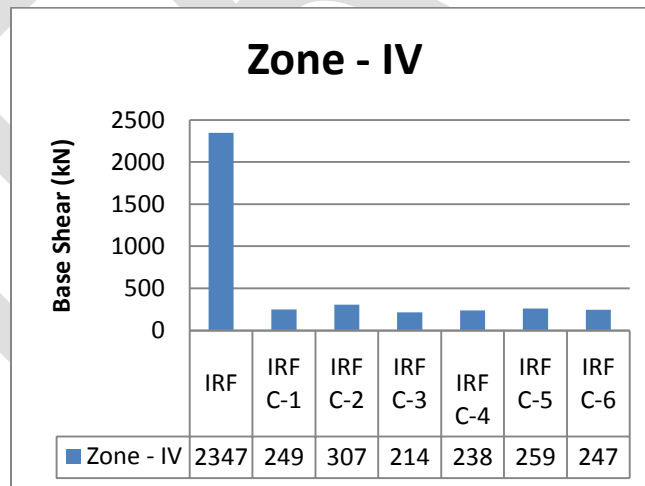


Comparison of displacements at Seismic zone-III

It was observed that the displacements of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 89.5%, 89.6%, 89.7%, 89.9%, 89.9%, 89.8% when compared to Irregular space frame IRF.

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

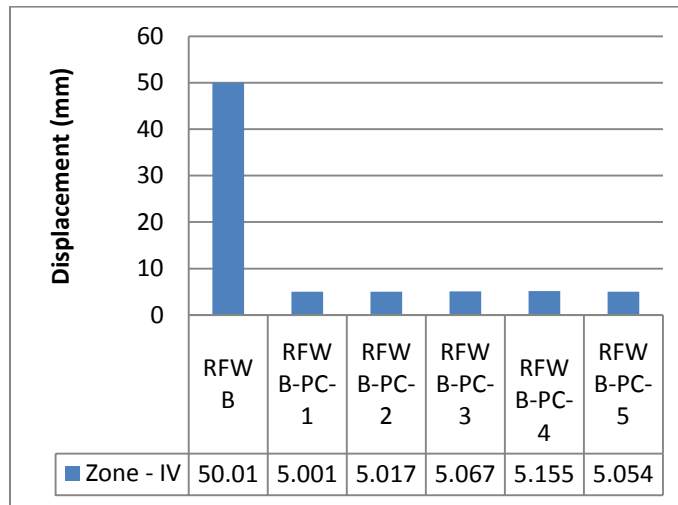
BASE SHEAR:



Comparison of Base shear at Seismic zone-IV

It was observed that the base shear capacity of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 92.2%, 92.12%, 92.12%, 91.6%, 92.1%, 92.1% when compared to Irregular space frame IRF.

DISPLACEMENT:

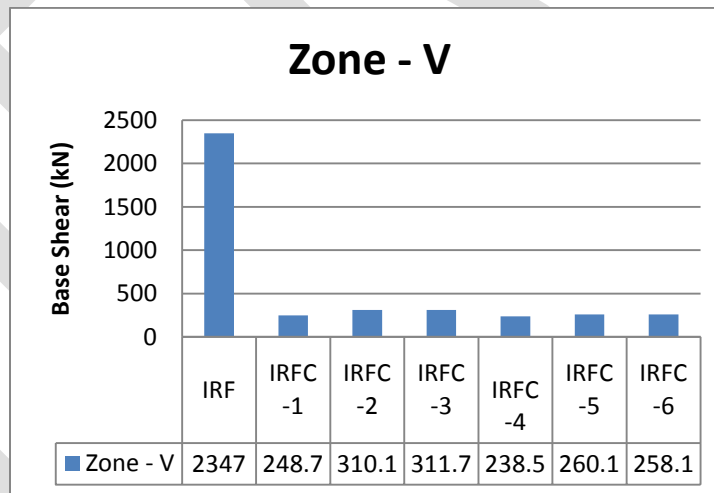


Comparison of displacement at Seismic zone-IV

It was observed that the displacements of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 89.8%, 88.9%, 89.5%, 89% , 89.6% 89.6 % when compared to Irregular space frame IRF.

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

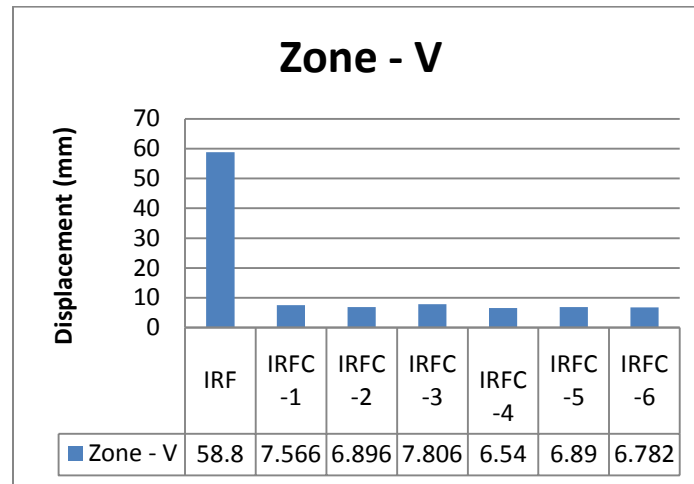
BASE SHEAR:



Comparison of base shear at Seismic zone-V

It was observed that the base shear capacity of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 91.5%, 91.8%, 91.8%, 91.9% , 91.7%, 91.8 % when compared to Irregular space frame IRF.

DISPLACEMENT:



Comparison of displacement at Seismic zone-V

It was observed that the displacements of the Space frames IRFC-1, IRFC-2, IRFC-3, IRFC-4, IRFC-5, IRFC-6 is reduced by 88.9%, 89.17%, 89.26%, 89.3%, 89.29%, 89.27% when compared to Irregular space frame IRF.

Conclusion:

1. The maximum base shear and maximum displacement capacity of the Space frame with considering progressive collapse case is reduced by 92.4% and 90.093% when compared to Irregular space 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 Irregular 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 Irregular 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 Irregular space frame in Seismic zone V
5. Out of all the seismic zones compared the percentage change in reduction of both base shear and displacements is very minute in all progressive collapse load cases of same zones.

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