International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Design & Analysis of Non-Linear Property of Material for Semi-Rigit, Fixed & Flexible Structural Frames

Devendra Marskolel[1], Dharmendra Kurmi[2], Prachi Chincolikar[3]

[1]*Mtech Scholar –Civil Engineering Department, VITM, Indore*
[2]*Assistant Professor –Civil Engineering Department, VITM, Indore*
[3]*Head of Department –Civil Engineering Department, VITM, Indore*

---***---

Abstract -During an earthquake, failure of structure starts off-evolved at factors of weak spot. This weak point arises due to discontinuity in mass, stiffness and geometry of structure. The systems having this discontinuity are termed as irregular systems. Irregular structures contribute a massive portion of city infrastructure. The effect of vertically irregularities within the seismic overall performance of systems will become definitely vital. The main objective of the analysis is to study the behavior of flat slab system in vertical irregular multi-storied building against different forces acting on it during earthquake. Also, the objective of analysis is to study the structural behavior of shear wall – flat slab interaction with opening. The analysis is made between in the three types of G+9 storey building with 0 % vertical irregularity, 200 % vertical irregularity and 300% vertical irregularity. In all these building's shear wall is provided with & without 20% opening. Total 15 modeled are studied and their results were compared.

Key Words: Flat slab, Vertical Geometric Irregularity, Shear wall with opening, Response Spectrum analysis, STAAD Pro2007

1. INTRODUCTION

It is assuming that the analysis of steel portal frames that beam-to-column connections are rigid and for trusses joints are pinned. Rigid connections, where no relative rotations occur between the connected members, transfer not only a significant amount of bending moments, but also shear and axial forces. Despite these facts, it is largely recognized that the great majority of joints does not exhibit such idealized behavior. These connections are called semi-rigid, and their design should be performed according to their actual structural behavior.

This thesis presents a semi-rigid low-rise portal frame nonlinear dynamic analysis. The main objective of this study is to propose a modelling strategy to represent the dynamical behaviour of semi-rigid joints under dynamic actions implemented on the SAP 2000 software.

The developed model included the material non-linearity and considered the influence of non-linear connection stiffness.

Types of Semi-Rigid Connections

i) Single web-angle and single plate connections
ii) Double web-angle connections
iii) Header plate connection
iv) Top and seat-angle connection
v) Extended/Flush end plate connections
vi) T-stub connections

2. ANALYSIS OF SEMI RIGID CONNECTION

A steel beam ISMB300 having length 6 m is used uniformly distributed load is 10 kN over total span. Analysis done with the help of SAP2000 as flexible, semi-rigid and rigid. First analysis done on simple beam (Figure 1) without semi-rigid connection to compare the results. We know that properties of semi-rigid connections are in between the flexible and rigid connections. To find the stiffness of semi-rigid connection the concept of End fixity factor was used. We know that the end fixity factor, r is 0 for flexible connection and 1 for rigid connection. For semi-rigid connections the end fixity factor lies somewhere 0 to 1. By using relation between stiffness and end fixity factor the stiffness's for end fixity factor 0.1, 0.2, 0.3, ...0.9 are find out and analysis are done for these stiffness's. Stiffness assign to the link is 8604 kN/rad.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

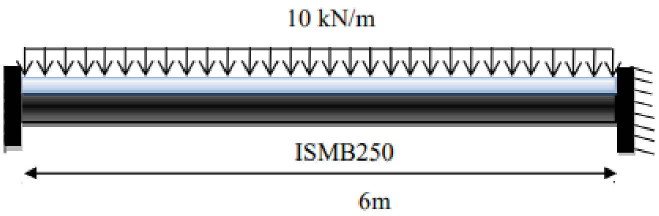

Figure 1 Fixed beams with UDL Stiffness

Following table gives the comparison between the structure with and without semi-rigid connection in beam.

Table 1 Results obtained for beam with UDL

Results for	Flexible connection	Rigid connection	Semi-rigid connection
Maximum +ve BM, (kNm)	46.95	15.65	28.17
Maximum –ve BM, (kNm)	-	31.30	18.28
Shear force, (kN)	31.3	31.3	31.3
Frequency, (rad)	26.59	50.8	35.41

Following are the moment v/s End fixity factor and frequency v/s End fixity factor curves of semi-rigid beam

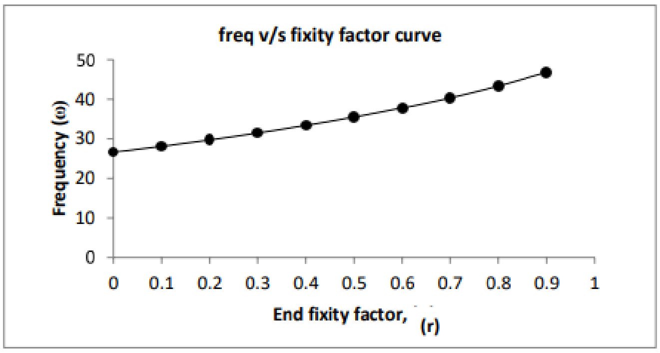

Figure 2 Natural frequency vs end fixity factor

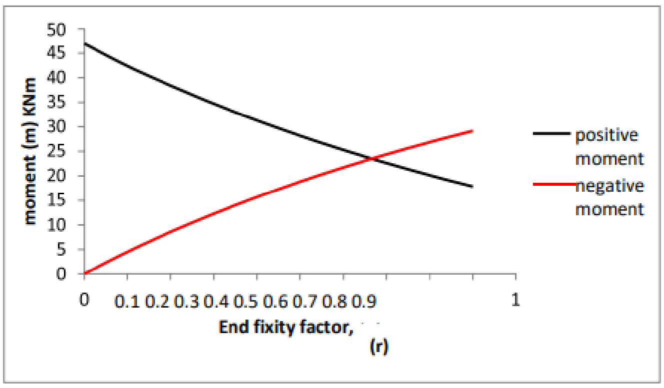

Figure 3 Moment vs end fixity factor

3. CALCULATION OF STIFFNESS

Stiffness is calculated by using following relations. As per IS 800: 2007

Table 2 Connection Classification Limits

Nature of the connection	In terms of strength	In terms of stiffness	K
Rigid connection	$m^1 \geq 0.7$	$m^1 \geq 2.5\ \theta^1$	$K \geq 2.5$
Semi-Rigid connection	$0.7 > m^1 > 0.2$	$2.5\ \theta^1 > m^1 > 0.5\ \theta^1$	$2.5 > K > 0.5$
Flexible connection	$m^1 \leq 0.2$	$m^1 \leq 0.5\ \theta^1$	$K \leq 0.5$

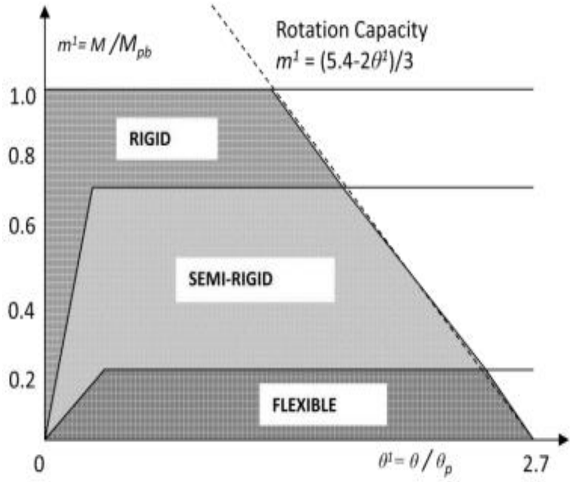

Figure 4 Classification of connection according to Bjorhovde (IS800, 2007)

4. PROBLEMS ANALYSIS

(i) **Problem description:** Bay width = 6m Storey height = 4m
Dead load = 10.23 KN/m
Live load = 6 KN/m
Beam section = ISMB200
Column section = ISBM 600
Plastic moment of beam,
Mp = 116.43
KNm Line mass – 1.345 kg/m
Assuming 150 mm thickness of concrete slab.

(ii) Nonlinear analysis data: NL Link type - Plastic (Wen) Property name – Lin1 Effective stiffness – K Effective damping – 0.02 Stiffness – K
Yield strength – Y Post

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

yield stiffness ratio – 0.2, 0.5, and 0.8
Yielding exponent – 5

(iii) Time History Data: The time history of Kobe earthquake considered. Time interval (DT) = 0.01 Header line to skip = 4 Prefix character per line to skip = 2 Number of points per line = 5 Number of output time step = 4096 Output time step size = 0.01

Case I & Case II Problems
Case I – Two Bay Three Storeys

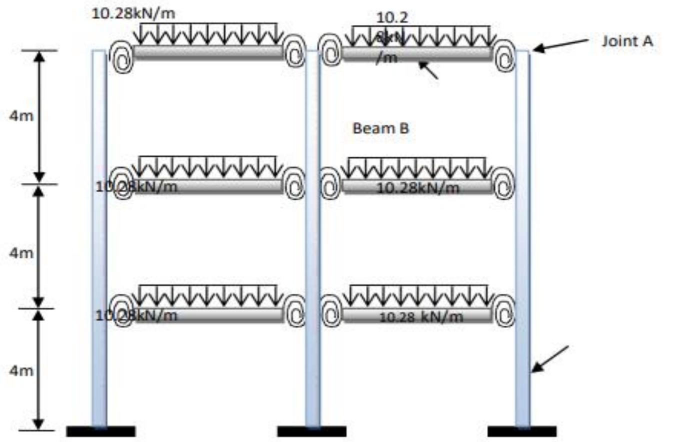

Figure 4 Two Bay Three Storey Frame

Following graphs shows frequency of building at each mode for different stiffness.

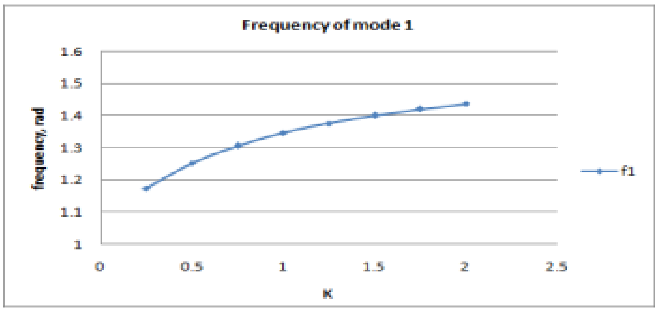

Figure 5 Variation of natural frequency of mode 1 with different stiffness

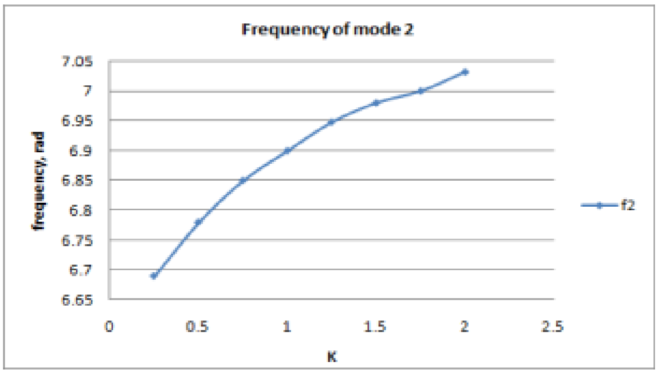

Figure 6 Variation of natural frequency of mode 2 with different stiffness

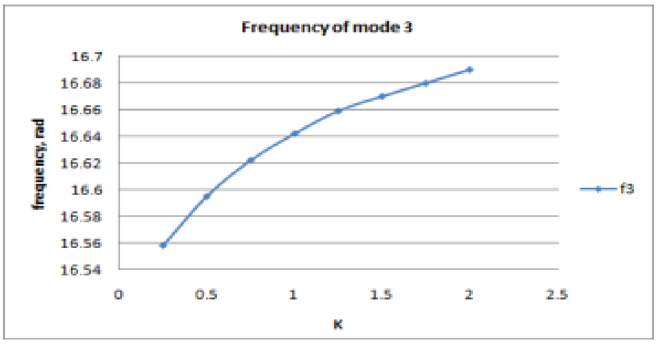

Figure 7 Variation of natural frequency of mode 3 with different stiffness

Observation:

- Frequency depends upon the Stiffness. It decreases with decrease in the value of Stiffness.
- Frequency does not depend upon the Yield strength.
- Frequency does not depend upon the Post yield stiffness ratio.

5. MODELLING CONCLUSIONS

- While modelling of semi-rigid connections in SAP2000 software the most important step is to assign the constraints to the joint because if the constraints not assigned then all the components like connections, beam and column behave independently.
- Constraints may be different for a different case like in nonlinear analysis case its assign as Translation is constrained in Y direction and free to translate and rotate in other direction. But the case may different in case of linear analysis. Hence, it is better to go for trial and error.

- For Nonlinear analysis use of plastic (Wen) link is relevant it gives good results.

ANALYSIS CONCLUSIONS

- Frequency depends upon the Stiffness. It decreases with decrease in the value of Stiffness.
- Frequency does not depend upon the Yield strength.
- Frequency does not depend upon the Post yield stiffness ratio.
- Axial force in column is largely depends upon the Stiffness as it shows large deference in the results for different value of Stiffness.
- Axial force in column is decreases with decrease in the value of stiffness.
- Axial force in column is also depends upon Yield strength of beam. It decreases with decrease in value Yield strength.
- Axial force in column is also depends upon the Post yield stiffness ratio.
  It decreases with decrease in value of Post yield stiffness ratio.
- In rigid case which is for 0.8 Mp& 0.7 Mp. Axial force in column shows very less increase in value with increase in Post yield stiffness ratio and hence there is not much deference show in the plotted curves refer figure 4.8.

REFERENCES

1. Prabesh Sharma., D.R Rajendra .S, Vanisree C.N. (2016).“Scrutinizing the Structural Response of Regular and Irregular Structure (With and Without Shear Wall) Subjected to Seismic and Wind Loading.” International Journal on Recent and Innovation Trends in Computing and Communication, 4(3), 353 – 359.
2. Maikesh Chouhan., Ravi Kumar Makode (2016).“Dynamic Analysis of Multi-Storeyed Frame-Shear Wall Building Considering SSI.” Int. Journal of Engineering Research and Application, 6(8) part-I, 31-35.
3. Navjot Kaur Bhatia.,TusharGolait,(2016). “Studying the Response of Flat Slabs & Grid Slabs Systems in Conventional RCC Buildings.” International Journal of Trend in Research and Development,3(3), 334-337.
4. Mohd Atif., Prof. LaxmikantVairagade., Vikrant Nair., (2015).“COMPARATIVE STUDY ON SEISMIC ANALYSIS OF MULTISTOREY BUILDING STIFFENED WITH BRACING AND SHEAR WALL.” International Research Journal of Engineering and Technology (IRJET), 2(5), 1158-1170.
5. Akil Ahmed (2015). “Dynamic Analysis of Multi-storey RCC Building Frames.” International Conference on Inter Disciplinary Research in Engineering and Technology, 89-94.
6. Mr.K.LovaRaju., Dr.K.V.G.D.Balaji., (2015). “Effective location of shear wall on performance of building frame subjected to earthquake load.” International Advanced Research Journal in Science, Engineering and Technology. 2(1), 33-36
7. G.V. Sai Himaja., Ashwini.L.K., N. Jayaramappa.,(2015). “Comparative Study on NonLinear Analysis of Infilled Frames for Vertically Irregular Buildings.” International Journal of Engineering Science Invention. 4(6) 42-51.
8. N. Janardhana Reddy., D. GosePeera., T. Anil Kumar Reddy (2015) “Seismic Analysis of Multi-Storied Building with Shear Walls Using ETABS-2013” International Journal of Science and Research (IJSR) ,4(11), 1030-1040.
9. Ali Koçak, BaşakZengin, FethiKadioğlu (2014) “PERFORMANCE ASSESSMENT OF IRREGULAR RC BUILDINGS WITH SHEAR WALLS AFTER EARTHQUAKE” http://dx.doi.org/10.1016/j.engfailanal.2015.05.016
10. Anuja Walvekar, H.S. Jadhav (2015) “PARAMETRIC STUDY OF FLAT SLAB BUILDING WITH AND WITHOUT SHEAR WALL TO SEISMIC PERFORMANCE” International Journal of Research in Engineering and Technology. 4(4),601-607.

11. K. G. Patwari, L. G. Kalurkar (2016) "Comparative study of RC Flat Slab & Shear wall with Conventional Framed Structure in High Rise Building" International Journal of Engineering Research., 5(3), 612-616