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PERFORMANCE ASSESSMENT OF MULTI-STOREYED REINFORCED CONCRETE SMRF AND OMRF BUILDINGS USING SAP2000: A REVIEW

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Abstract - To resist earthquakes, Reinforced concrete special moment frames are utilized as part of seismic force-resisting structures in buildings. Columns, Beams, and beam-column joints in moment frames are balanced & detailed to resist flexural, axial, & shearing movements. The main purpose of current investigation is the study of comparative performance of SMRF and OMRF frames, designed as per IS codes, via nonlinear analysis. Software program is utilized to design & model the structures. A performance of SMRF structure & OMRF structure with no infill & fixed support conditions result states that the base shear capacity of OMRF structures is 20 to 40% additional than that of SMRF structures. The behavior of SMRF structure & OMRF structure with no infill & hinged support condition result states that OMRF structures resist 2040% additional base shear than that be resisted by SMRF structures. The behavior of SMRF building with fixed & hinged support conditions states that an act of SMRF structures under fixed & hinged support condition is an identical. The SMRF structures with similar no. of bays and diverse no. of storeys experiment states that all the SMRF structures deliberated has exactly the similar amount of initial slope in the push over curve. The SMRF structures with similar no. of storeys & diverse no. of bays experiment gives the result that the no. of bays play huge part in the immovability of the structures measured for the current investigation.

Key Words: **SMRF, OMRF, Base Shear, Fixed Support, Hinged Support, Nonlinear Analysis, Infill, SAP 2000 etc.**

1. INTRODUCTION

SMRF introduced in India about 1993. IS 13920(1993) was utilized for proportioning and detailing of SMRF in India, which later was written in 2002. To resist earthquakes, Reinforced concrete special moment frames are utilized as part of seismic force-resisting structures in buildings. Columns, Beams, and beam-column joints in moment frames are balanced & detailed to resist flexural, axial, & shearing movements. Due to these forces structure sways over many displacement phases throughout strong earthquake ground shaking. Moment frames are mostly chosen as the seismic force-resisting arrangement when architectural space planning tractability is vital. Concrete moment frames are chosen for Seismic Zone III, IV or V, these are desired to be detailed as special RC moment frames. Balancing & detailing necessities for a special moment frame will allow the frame to securely go through wide inelastic deformations which are predictable in these seismic zones. It can be utilized in Seismic Zone I or II, though it will not be the best inexpensive design. It is essential to consider strength and stiffness both in the design of special moment frames. The design base shear eqn. of present building codes integrate a seismic force reduction factor R that shows the degree of inelastic response predictable for design-level ground motions, as well as the ductility capacity of the framing system. A SMRF should be predictable to retain multiple cycles of inelastic response if it experiences design level ground motion. When a structure sways during an earthquake, the spreading of damage over height depends on the spreading of lateral drift. If the structure has weak columns, drift tends to focus in one or a few stories, and may go beyond the drift capacity of the columns. On the other side, if columns deliver a stiff and strong spine over the structure height, drift will be more equivalently spread, and confined loss will be decreased. These type of failure is known as Beam Mechanism or Sway Mechanism. It is a design standard that should be firmly involved though designing SMRF. Structural Designers implements the strong-column/weak-beam standard by requiring that the addition of column strengths exceed the addition of beam strengths at each beam-column link of a special moment frame. Ductile response needs that members yield in flexure, and that shear failure be ignored. Shear failure, exclusively in columns, is comparatively brittle and can lead to quick loss of lateral strength and axial load-carrying capacity. Column shear failure is the maximum frequently mentioned reason of concrete structure failure and collapse in earthquakes. Shear failure is ignored by using of a capacity-design methodology. The common methodology is to classify flexural yielding regions, design those regions for code required moment strengths, and then determine design shears based on equilibrium supposing the flexural yielding regions form possible moment strengths.

The possible moment strength is estimated using processes that develop a higher estimation of the moment strength of the designed cross-section. Mostly hoops are provided at the ends of beams and columns, also at beam-column joints. It needs to be effective, hooks should be closed by 135° rooted in the concrete, and it avoids hooks to be opened if the cover of concrete removed. Cross-ties should involve longitudinal reinforcement around the perimeter to increase confinement efficiency. Hoops need to be closely distributed lengthwise of longitudinal axis of the member, both to restrain the concrete and confine buckling of longitudinal reinforcement. Cross-ties, which generally have 90° and 135° hooks to ease construction, must have their 90° and 135° hooks alternated along the length of the member to raise confinement efficiency. Especially if axial loads are low than shear strength reduces in members subjected to multiple inelastic deformation reversals. In these types of members it is needed that the involvement of concrete to shear resistance be ignored, that is, Vc= 0. So, shear reinforcement is essential to resist the whole shear force. Loss of concrete cover due to severe seismic loading can outcome as decrease development and lap-splice strength of longitudinal reinforcement. Lap splices should be provided away from maximum moment sections and must have locked hoops to restrain the splice in the event of cover spalling. Current study shows on several characteristics associated to the performance of SMRF buildings. The main purpose of current investigation is the study of comparative performance of SMRF and OMRF frames, designed as per IS codes, via nonlinear analysis. The more genuine performance of the OMRF and SMRF building needs modelling the stiffness and strength of the infill walls. The differences in the sort of the infill walls utilizing in Indian constructions are substantial. On the basis of modulus of elasticity and the strength, it may be categorized as strong or weak. SMRF buildings are generally built in earthquake prone nations like India since they offer much greater ductility. Failures perceived in previous earthquakes illustrate that the collapse of such buildings is primarily due to the development of soft-storey mechanism in the ground storey columns.

1.1 MOMENT RESISTING FRAMES

It is a frame which are formed by Beams and columns with a rigidly jointed connection. It's basically resist the flexure.

1.2 SPECIAL MOMENT-RESISTING FRAME

SMRF is designed and detailed as per IS 13920 code which delivers additional ductility requirements to the frame.

1.3 ORDINARY MOMENT RESITING FRAME

As per IS 456, a frame is designed is an ordinary moment resisting frame. Special ductility provisions as per IS 13920 is not considered.

1.4 OVERVIEW OF SAP2000

SAP2000 is a user friendly software to perform:
Modeling, Analysis, Design, and Reporting. SAP2000 has a wide selection of templates for quickly starting a new model. The frame element uses a general, three-dimensional, beam column formulation which includes the effects of biaxial bending, torsion, axial deformation, and biaxial shear deformations. SAP2000 has a built-in library of standard concrete, steel and composite section properties of both US and International Standard sections.

- Accuracy of the solution,
- Confirmation with the Indian Standard Codes,
- Resourceful nature of solving any type of problem,
- User friendly interface.

2. LITERATURE REVIEW

Some research has already been done on special moment resisting frames and ordinary moment resisting frames.

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Concluded that with increase in the number of bays Redundancy factor is also increases and Response reduction factor shows an increasing trend for all frames. Hence the frames with more number of bays possess higher redundancy. With number of bays in x directions ductility factor is increasing but in y direction it looks like there is no flow for that. It is revealed that value of Response reduction factor acquired is critical in the direction with less number of bays. Response reduction values should be taken as the least from both directions during design purposes with ductility and redundancy also to be considered.

Mukesh Rai & Prof. M.C. Paliwal found that the special moment resisting frame is more efficient than ordinary moment resisting braced type frame and SMRF reduces moments means reduces area of steel and also concluded that the special moment resisting frame is more efficient than ordinary moment resisting types frame and SMRF reduces nodal displacement means reduction in size of section.

Jay Prakash Kadali, M.K.M.V.Ratnam, Dr. U Ranga Raju found that the buildings designed as SMRF perform much better compared to the OMRF building. The ductility of SMRF buildings is almost 10 to 33% more than the OMRF buildings in all cases, the reason being the heavy confinement of concrete due to splicing and usage of more number of stirrups as ductile reinforcement. It is also found that the base shear capacity of OMRF buildings is 7 to 28% more than that of SMRF building.
The SMRF buildings with same number of bays and different number of storeys are compared. The pushover curve is plotted and it is found that the ductility and the magnitude of base shear that can be resisted, increases with increase in the number of storeys. It is observed that all the SMRF buildings considered has almost the same value of initial slope in the push over curve.

G.V.S.SivaPrasad, S. Adisesh studied both system of analysis results of OMRF & SMRF, and found that the storey drift is within permissible limit as per IS (1893 part1,clause no 7.11.1), but when compared with OMRF the SMRF structure having less story drift so the structure can resists the seismic loads more than the OMRF.

3. CONCLUSIONS

• This may be established that the SMRF structures with stronger infill consume base shear capacity of around 1.5 to 2.5 times additional than that of SMRF structures with weaker infill.

• This is instituted that all the SMRF structures deliberated has exactly the similar amount of initial slope in the push over curve.

• The behavior of SMRF building with fixed & hinged support conditions are compared. This is instituted that an act of SMRF structures under fixed & hinged support condition is an identical. So it is decided that hinged & fixed condition do not play big part in investigation.

• A performance of SMRF structure & OMRF structure with no infill & fixed support conditions are carried in comparison. This is instituted that the structures designed as SMRF execute ample superior related to the OMRF structure. Ductility of SMRF structures is nearly 75% to 200% additional than the OMRF structures in all circumstances, the object being the heavy limitation of concrete due to splicing & utilization of additional no. of rings as ductile reinforcement. This is also instituted that the base shear capacity of OMRF structures is 20 to 40% additional than that of SMRF structures.

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REFERENCES

1) Ruhullah Amiri, T. N. Patel (2018)," Assessment of Seismic Response Reduction Factor According to Redundancy of RC Buildings"

2) Mukesh Rai & Prof. M.C. Paliwal (2017)," A comparation of OMRF braced & SMRF RC frame considering earthquake loading".

3) Jay Prakash Kadali, M.K.M.V.Ratnam, Dr. U Ranga Raju (2015)," Static Analysis of Multistoreyed RC Buildings By Using Pushover Methodology".

4) G.V.S.SivaPrasad, S. Adiseshu (2013)," A comparative study of OMRF & SMRF structural system for tall & high rise buildings subjected to seismic load."

5) ACI 318, (2005) "Building code requirement for reinforced concrete and commentary", ACI 318-05/ACI 318R-05, American Concrete Institute.

6) Achyutha, H., R. Jagadish and S. S. Rahman (1982)," Effect of contact between infill and frame on the behaviour of infilled multi-storey frames", Proceedings of the 6th International Brick Masonry Conference. Rome. BIOGRAPHIES (Optional not mandatory)

7) Asokan, A., (2006) Modelling of Masonry Infill Walls for Nonlinear Static Analysis of Buildings under Seismic Loads. M. S. Thesis, Indian Institute of Technology Madras, Chennai.

8) A. Shuraim, A. Charif, (2007) Performance of pushover procedure in evaluating the seismic adequacy of reinforced concrete frames. King Saud University

9) ATC 40, (1996), "Seismic Evaluation and Retrofit of Concrete Buildings", Applied Technology Council, USA.

BIOGRAPHIES

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