PUSHOVER ANALYSIS OF 2D RC BUILDING FRAME

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Abstract - Reinforced Concrete Special Moment Resisting Frames are used as a part of seismic force-resisting systems in buildings that are designed to resist earthquakes. Beams, columns and beam-column joints in moment frames are proportioned and detailed to resist flexural, axial and shearing actions that result as a building sways through multiple displacement cycles during strong earthquake ground shaking, Special proportioning and detailing requirements result in a frame capable of resisting strong earthquake shaking without significant loss of stiffness or strength, These moment-resisting frames are called " Special Moment Resisting Frames" because of these additional requirements, which improve the seismic resistance in comparison with less stringently detailed Intermediate and Ordinary Moment Resisting Frames.

The design criteria for SMRF buildings are given in IS 13920 (2002). In this study, the buildings are designed both as SMRF and OMRF, and their performance is compared. For this, the buildings are modeled and pushover analysis is performed in SAP 2000. The pushover curves are plotted from the analysis results and the behavior of buildings is studied for various support conditions and infill conditions. The behavior parameters are also found for each building using the values obtained from pushover curve and is investigated.

Key Words*:* RC 2D multi-storey building, moment Resisting Frames, Non-linear Static Analysis, Pushover analysis.

1.INTRODUCTION

Moment resisting frames are the most commonly used framing system for reinforced concrete structures. According to the current Indian practice, designers have two options for the seismic design of reinforced concrete frames (IS 1893-2000 part [1]). The first option is to design a ductile frame, which involves special design and detailing provisions to ensure ductile behavior i.e. design based on IS456-2000 and IS13920-1993. The second option is to design a nominally ductile frame. This option involves designing frames based on provision of IS 456-2000 only, without taking all the special provisions for good detailing in the design of frame members.

The seismic design lateral loads and level of seismic reinforcement detailing incorporated in a reinforced concrete moment resisting framed structure depend on its available ductility capacity. In "ductile" moment resisting frames, the design lateral loads reduce significantly, but high ductility capacity is ensured through strict detailing requirements to avoid premature modes of brittle failure. For frames with " nominal ductility", the design loads are higher, but very little seismic reinforcement detailing is required. According to the seismic design philosophy of the Indian Standard, both approaches should offer the same level of seismic protection against the design earthquake at the construction site.

1.1 OVERALL VIEW OF PRESENT STUDY:

R.C.C Multi-storeyed buildings as Residential building(Refer Figure 3.2) are analysed for Pushover under following circumstances:

1. Ordinary Moment Resisting Frame with fixed base.
2. Special Moment Resisting Frame with fixed base.
3. Ordinary Moment Resisting Frame with hinged base.
4. Special Moment Resisting Frame with hinged base

1.2 PROBLEM DETAILS:

1.2.1 GENERAL DESCRIPTION

1. The example building consist of a block having 8 bays along x y-direction, width of each bay along x and y-direction is 3m. Hence length and width of the building is 24m respectively as shown in Figure 3.2
2. The building will be used as a Residential building, so that there are no cantilever projections anywhere in building.
3. The main beams rest centrally on columns to avoid local eccentricity.
4. For all structural elements, grade of concrete is used as per exposure condition mentioned in IS 456-2000.
5. The floor diaphragm are assumed to be rigid.

- Live Load: $3 kN/m^2$
- Floor Finish: $0.5 kN/m^2$
- Parapet Weight : $2.5 kN/m^2$
- Storey height: 3.5m for all storey
- Thickness of floor slabs : 150mm

1.2.2 SEISMIC DATA:

As per IS 1893-2002 part-1

- Seismic Zone: V
- Zone factor (Z): 0.36

- Response reduction factor (R): 5 for SMRF
  : 3 for OMRF
- Importance factor (I) : 1
- Soil Type : Medium
- Damping : 5%
- Frame type: SMRF and OMRF

1.2.3 MATERIAL PROPERTY*:*

Concrete:

Compressive strength of concrete : 25 N/mm²
Poisson's ratio :0.2
Density :25 kN/m³
Modulus of Elasticity :5000 √fck
:25000 N/mm²

Steel:

- HYSD reinforcement of grade Fe 415 confirming to IS: 1786 is used throughout.

1.3 SOFTWARE PACKAGE (SAP-2000)

Computer modeling of the building is performed using the finite element softwareSAP-2000 (nonlinear version). R.C Buildings of different storey are modeled as beam-column building

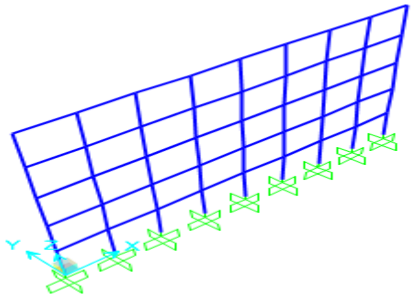


Fig. 1 : Picture of 5S8B OMRF (5 STOREY 8 BAY OMRF)

2. RESULTS

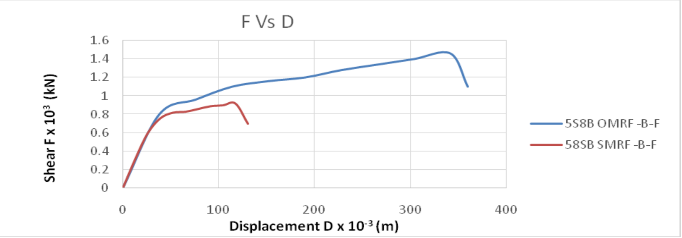
2.1 INTRODUCTION

As discussed in the previous chapter, various models with different configuration are subjected to Pushover analysis and the results are obtained in terms of Base shear Vs Displacement curve at each analysis step. In this chapter, a comparative study of these curves for different models is carried out to understand the difference in response and behavior of the building with different structural systems.

2.2 COMPARISION OF SMRF AND OMRF: BARE FRAME, FIXED SUPPORT

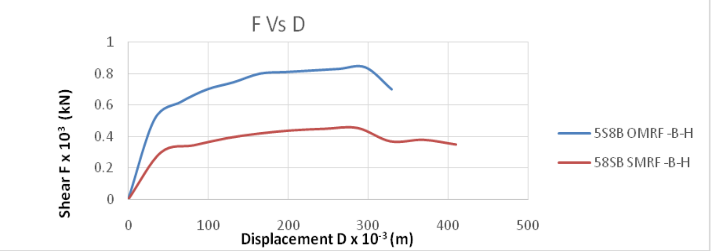
In this comparison, the performance of Ordinary moment resisting frames and Special moment resisting frames with fixed support conditions are considered. The result in form of Base shear Vs Displacement curve are presented below :

CASE 1 :- 5S8B BARE FRAME - FIXED SUPPORT



The Chart1: Shows the pushover curved of 5S8B bare frames designed as both SMRF and OMRF with fixed support conditions.

CASE 2 :- 5S8B BARE FRAME – HINGED SUPPORT



The chart 2: Shows the pushover curved of 5S8B bare frames designed as both SMRF and OMRF with hinged support conditions.

3. CONCLUSIONS

1. From Chart1: Initially, in both the frames, base shear increases linearly with the roof displacement and yield almost simultaneously at a particular Base shear. However, the 5S8B frame designed as OMRF exhibit a higher capacity of base shear as well as displacement than that of 5S8B SMRF frame. Since, we design building only up to the elastic limit, the performance of 5S8B SMRF is similar to that of 5S8B OMRF, however the capacity of OMRF is twice that of SMRF.

2. From Chart2: Initially, in both the frames, base shear increases linearly with the roof displacement but 5S8B OMRF yields very much later than SMRF. The 5S8B frame designed as OMRF exhibit a higher capacity of base shear than that of 5S8B SMRF frame. But, the displacement of SMRF is little more than OMRF

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