Study of Effect of Location of Lift Core Shear Wall under Earthquake Load

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Abstract

Increased frequency and intensity of earthquake fetching a need of more earthquake resistance in building. Shear wall is the best way to control deflection during earthquake. But the providing shear wall is sometimes not feasible and hence avoided. Lift core, which are the mandatory to be used in multi-storey building and are frequently used as core type shear wall can be best option. In general, lift cores are provided with convenience of users. In this paper, various positions of lift core are modelled and were analysed under static earthquake loading in V earthquake zone of India. The results were compared with bare frame.  

Keywords: Earthquake Loading, Shear Wall, Lift Core, Static Analysis, Storey Drift

I. INTRODUCTION

The design of a multi-storey building is governed by lateral loads and it should be prime concern of the designer to provide adequately safe structure against lateral loads. The modern buildings are having light curtain walls, lightweight flexible partitions along with high strength concrete and steel reinforcement. This reduces the safety margins provided by non-structural components. Shear wall system is one of the most commonly used lateral load resisting system in high rise buildings. A shear wall is a structural system providing stability against wind, earthquake and blast deriving its stiffness from inherent structural forms. The shear wall can be either planar, open sections, or closed sections around elevators and stair cores.

II. OBJECTIVE OF STUDY

Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be either shear walls, floors, foundation walls, slabs or footings. Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway.  

The objectives of the study are:

- Structural analysis of multi-storeyed building with and without shear wall using Staad pro and determine lateral displacement, and storey drift.
- Study of behaviour of structure (Moment, Shear and Axial) with different location of shear wall and with different earthquake zone.
- Study of optimum location of lift core shear wall for multistoried frame keeping other parameters same.

III. METHODOLOGY

A. Method of Analysis:

1) Equivalent Lateral Force Procedure:

The equivalent lateral force procedure is the simplest method of analysis and requires less computational effort because the forces depend on the code based fundamental period of structures with some empirical modifier. The design base shear shall first be computed as a whole, then be distributed along the height of the buildings based on simple formulas for buildings with regular distribution of mass and stiffness. The design lateral force obtained at each floor level shall then be distributed to individual lateral load resisting elements depending upon floor diaphragm action. The following are the major steps for determining the forces by equivalent static procedure.

a) Details of model:

For the study, three models were considered:

- Simple bare frame without any shear wall
- Simple frame with Lift core at centre of building plan
- Simple frame with lift core at the edge of building

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**NOMENCLATURE**

SF= Simple Frame
SWC1= shear wall configuration 1 (lift core at centre)
SWC2= Shear wall configuration 2 (lift core at edge of building)
SWC3= Shear wall configuration 3 (lift core at alternate corners of building)

All models are of 10 storey each having standard height of 3m and hence height of building will be 30m.
Plan of all building is 35m X 30m.

**A. Section Properties:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Thickness/ width (mm)</th>
<th>Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam section</td>
<td>450</td>
<td>550</td>
</tr>
<tr>
<td>Column Section</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Shear wall</td>
<td>300</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 1: Section properties

All supports are taken as Fixed.

**B. Loadings Considered:**

The static earthquake force is considered from X and Z direction for zone IV and V of IS1893:2002\(^1\)

Following load combinations were used:

1) Live Load – 3 KN/m² on all the floors.
2) Dead load for floor = -4kN/m²
3) Self-weight of building
4) Dead load of curtain wall = -15kN/m of the peripheral wall only
5) Earthquake Load – As per IS 1893 (Part-I):2002

**C. Load Combinations:**

Load Combinations considered for static analysis are as follows:

1) 1.5(DL + LL)
2) 1.2(DL + LL + EQX)
3) 1.2(DL + LL - EQZ)
4) 1.2(DL + LL + EQZ)
5) 1.2(DL + LL – EQZ)
6) 1.5(DL + EQX)
7) 1.5(DL – EQX)
8) 1.5(DL + EQZ)
9) 1.5(DL – EQZ)
10) 0.9DL + 1.5EQX
11) 0.9DL - 1.5EQX
12) 0.9DL + 1.5EQZ
13) 0.9DL – 1.5EQZ

D. Parameters and Different Aspects of Study:

1) Section Displacement:
Net displacement of each floor with respect to fixed point at ground is studied.

2) Storey Drift:
Controlling storey sway or inter storey drift of a building is an important aspect because:
- It prevents pounding of adjacent buildings in urban areas.
- It prevents shear (brittle) failure.
- It restricts damage to fragile non-structural elements, which can be costlier than the building.
- Drift limitation provides stability to individual column as well as the structure as a whole.
- Limited drift also provides comfort to occupants of such buildings.

As per clause 7.11.1 of IS 1893 (Part I):2002, the storey drift in any storey due to specified design lateral force with partial load factor of 1 shall not exceed 0.004 times the storey height.

3) Drift Reduction Factor:
Use of shear walls with frame changes in the drift values. Therefore drift reduction is one parameter to be studied. It is equal to ratio of difference of Storey drift without shear wall and with shear wall to storey drift without shear wall.

IV. RESULT AND DISCUSSION

The study examines the performance of shear walls in multi-storey buildings, cases studied are buildings without shear wall and with shear wall at centre and edge location. In present study we have been compared bare frame with system having different cases of shear wall. To study the effectiveness of all these models, section displacement, the storey drift, drift reduction factor, worked out and are presented in figures. The results organized in various figures are discussed in detail.
From above study following points can be concluded:

1) It is better to use a lift core as a shear wall so as to increase seismic resistance of building as the provided lift core as shear wall reduces the storey drift.

2) In comparison, providing lift core at the corner or at edge of building, have better drift reduction factor as compare to providing core at centre of building.

3) Providing lift at corner is not a good idea in view of its functionality hence lift core should be provided at edge of building so that it can serves its function efficiently as well as control deflection during earthquake.

In further study, performance of core during earthquake can also be assessed by using dynamic method and/or time history analysis. Furthermore, one can compare other parameters also for comparison.

REFERENCES


