MULTISTORIED BUILDING SUBJECTED TO SEISMIC FORCES WITH FLEXIBLE FOUNDATIONS

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Abstract - Though the structures are supported on soil, most of the designers do not consider the soil structure interaction and its subsequent effect on structure during an earthquake. Different soil properties can affect seismic waves as they pass through a soil layer. When a structure is subjected to an earthquake excitation, it interacts the foundation and soil, and thus changes the motion of the ground. It means that the movement of the whole ground structure system is influenced by type of soil as well as by the type of structure. Tall buildings are supposed to be of engineered construction in sense that they might have been analysed and designed to meet the provision of relevant codes of practice and building bye-laws. IS 1893: 2002 "Criteria for Earthquake Resistant Design of Structures" gives response spectrum for different types of soil such as hard, medium and soft? An attempt has been made in this paper to study the effect of rigid and flexible foundation for multi storeyed buildings with various positions of shear wall and bracings. Building is subjected to seismic forces with Rigid and Flexible foundation and analysed by Time-History Analysis using software STAAD Pro. The response of building frames such as Lateral deflection, Storey drift, Base shear, axial force and Column moment values for all building frames were presented in this paper.

Key Words: STAAD-PRO, Shear wall, bracings, dual system, storey drift, time history analysis.

1. INTRODUCTION

The main objective of this paper is to locate the position of shear wall and bracing for the building which is subjected to pseudo static (seismic) forces. The structure is analyzed by STAAD-PRO V8i by TIME HISTORY analysis. Storey drift, maximum shear force and maximum bending moment of the stories are compared.

Dual system is a structural system which provides resistance to lateral loads, gravity loads. In dual system, both frames and shear walls resist lateral loads. Group of beams and columns connected with each other by rigid joints.

Shear walls are RC walls that are projected along the structure from base. Shear walls reduce the Storey displacement when seismic forces counter the building. Since, the structure may not have aesthetic appearance if the structure is closed with shear wall along the building. Bracings are adopted to reduce the lateral forces and wind forces and these are easy to install and retrofitted even for the existing building. For low rise buildings bracings may not be suitable. So as to overcome these circumstances the combination of shear wall and bracings are adopted for the structure at different locations.

1.2 General Requirements of Shear Wall

- ✓ The thickness of shear wall should not be less than 150mm to avoid unusually thin sections.
- ✓ Effective flange width for the flanged wall sections from the face of web should be taken as least of
    - o Half the distance to an adjacent shear wall web and
    - o One – tenth of total wall height
- ✓ The minimum reinforcement in the longitudinal and transverse directions in the plan of the wall should be taken as 0.0025 times the gross area in each direction and distributed uniformly across the cross section of the wall.
- ✓ If the factored shear stress exceeds the $0.25\sqrt{f_{ck}}$ or if the wall thickness exceeds 200mm.
- ✓ The maximum spacing of reinforcement in either direction should be lesser than $\frac{l_w}{5}$, t_w, or 150 mm.

Diameter of bar should not exceed the one- tenth of the thickness of that part. This puts a check on the use of very large diameter bars in thin wall sections.

2. BRACINGS

A braced frame is a structural system is designed primarily to resist the earthquake and wind forces. These are designed to resist lateral forces and reversal of stress too. Lateral displacement and be resisted by the braced frame and also bending moment can be controlled in columns. These are economical easily erected and have the design flexibility to create stiffness and strength.

The resistance to horizontal forces is provided by two bracing systems

2.1 Vertical bracing

Bracing between column lines provides load paths for the transference of horizontal forces to ground level. Framed buildings required at least three planes of vertical bracing to brace both directions in plan and to resist torsion about a vertical axis

2.2 Horizontal bracing

The bracing at each floor level provides load paths for the transference of horizontal forces to the planes of vertical bracing. Horizontal bracing is needed at each floor level; however, the floor system itself may provide sufficient resistance.

3. STRUCTURAL MODEL

The plan area of the structure is 30.57 m× 26.97 m and height of the structure is 26.55 m. The combination of Shear wall and bracings are located at different positions of structure at corners and middle of the structure. The lateral displacement of the structure is compared of the structures.

4.1 SEISMIC PARAMETERS

Zone value	0.1
Response reduction factor	5
Importance factor	1
Damping ratio	0.05

4.2 SIZE OF MEMBERS

Width of beam	250mm
Depth of beam	400mm
Width of column	400mm
Breadth of column	400mmLength of
column	2.95m
Height of each floor	2.95m

LOAD CALCULATION Live load, dead load and load combinations are calculated as per IS 456:2000 and are assigned to the structure. IS 1893 - (part 1): 2002 provides Criteria for Earthquake Resistant Design of Structures. The different load combinations are as follows

Table – 1 LOAD COMBINATIONS

S.no	Load combinations
1	Dead load
2	Live load
3	Earthquake x+
4	Earthquake x-
5	Earthquake z+
6	Earthquake z-
7	1.5 (d.l + l.l)
8	1.5 (d.l +e.q x +)
9	1.5 (d.l +e.q x -)
10	1.5 (d.l +e.q z +)
11	1.5 (d.l +e.q z -)
12	1.2 (d.l + l.l+e.q x +)
13	1.2 (d.l + l.l+e.q x -)
14	1.2 (d.l + l.l+e.q z +)
15	1.2 (d.l + l.l+e.q z -)
16	0.9d.l +1.5 e.q x+
17	0.9d.l +1.5 e.q x -
18	0.9d.l +1.5 e.q z+
19	0.9d.l +1.5 e.q z-

ANALYSIS

The structure is analyzed by TIME HISTORY METHOD, in non-linear dynamic analyses, the detailed structural model subjected to a ground motion record produces estimates of component deformation for each degree of freedom in the model and modal responses are combined. Nonlinear properties of the structure are based on time-domain analysis. The data time vs. acceleration is given as input value. This approach is required by some building codes of unusual configuration or of special importance. The properties of the seismic response demand depend on the severity of seismic shaking, and various levels of intensity to represent different possible earthquake.

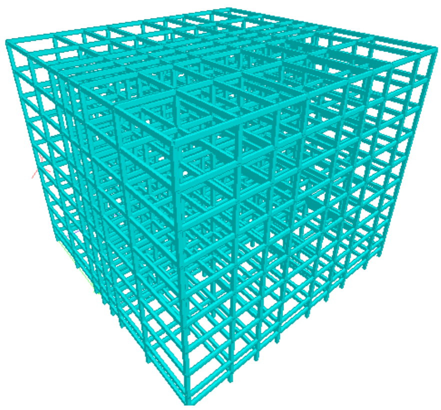

Fig-1: NORMAL BUILDING

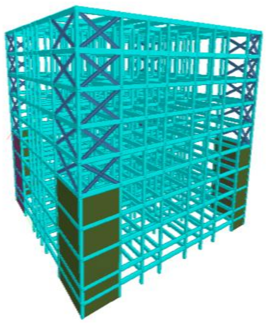

Fig-2: Dual system (building with shear-wall and bracings)

RESULTS

The results of lateral deflection of normal building and dual system (building with combination of shear wall and bracings) placed at corner are tabulated. The lateral deflection in both the X- axis and Z-axis are tabulated separately.

Table-2: Results showing lateral deflection (x-direction) of normal building and dual system (building combination of shear walls and bracings)

HEIGHT (in Meters)	Lateral Deflections (in mm)	
	NORMAL BUILDING	DUAL SYSTEM
	X- Direction	X- Direction
0	0	0
1.45	1.63	0.215
1.5	2.94	0.457
5.9	6.43	1.19
8.85	9.94	2.44
11.8	13.1	3.39
14.75	15.8	5.18
17.7	17.9	7.11
20.65	19.4	9.06
23.6	20.4	10.9
26.55	20.9	12.7

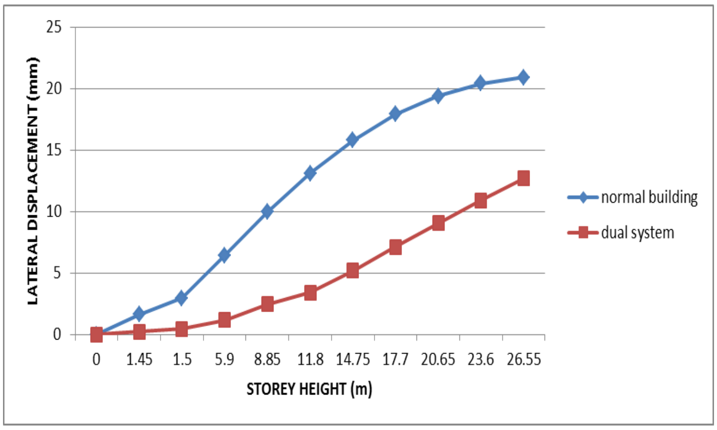

Fig-3: Graph showing lateral displacement in x-direction

Table-3: Results showing lateral deflection (x-direction) of normal building and dual system (building combination of shear walls and bracings)

HEIGHT (in Meters)	Lateral Deflections (in mm)	
	NORMAL BUILDING	DUAL SYSTEM
	Z-Direction	Z-Direction
0	0	0
1.45	1.35	0.136
1.5	2.67	0.379
5.9	5.67	0.916
8.85	8.85	2.17
11.8	11.9	2.66
14.75	14.7	4.44
17.7	17.1	6.27
20.65	19	8.04
23.6	20.3	9.67
26.55	21.2	11.1

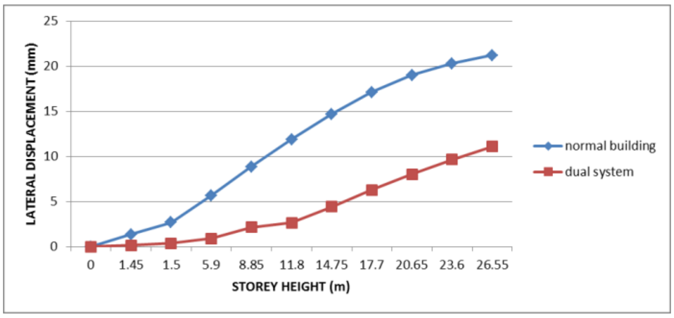

Fig-4: Graph showing lateral displacement in x-direction

CONCLUSIONS

From the result observed,

- ✓ It is found that the structure with the dual systems (combination of shear wall and bracings) at the corner will give minimum lateral displacement than the normal building at top reduces by 86%
- ✓ Lateral deflection is decreased by 86% in x-direction in dual system when compared to normal building
- ✓ Lateral deflection is decreased by 89% in z- direction in dual system when compared to normal building
- ✓ Maximum shear force in normal building is 1157.8 kN
- ✓ Maximum shear force in dual system is 1130.2 kN
- ✓ Maximum bending moment in normal building is 5.042 kNm

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