EFFECTIVE LOCATION OF SHEAR WALLS AND BRACINGS FOR MULTISTORIED BUILDING

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Abstract - *Earthquake is the natural calamity, it produce strong ground motions which affect the structure. Small or weak motions that can or cannot be felt by the humans. Provision of shear walls and bracings are installed to can enhance the lateral stiffness, ductility, minimum lateral displacements and safety of the structure. Storey drift and lateral displacements are the critical issues in seismic design of buildings. Two types of frame models are developed and evaluated by Time history analysis by STAAD-Pro.*

In the present work G+9 multi Storey building is analyzed by using shear wall and braced frame at corner of the structure. It is analyzed and results of Storey drifts, maximum bending moment, maximum Sea force, deflections are evaluated and compared.

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.

2. SHEARWALLS

Shear walls are vertical members that resist pseudo static (seismic) forces. These are provided along the height to resist the in-plane loads. Shear wall mainly experience the seismic and wind loads. Generally, the loads are transferred to walls by Diaphragm (The structural element which transverse the lateral load to the vertical resisting elements of a structure. These are mainly in horizontal, but can be in sloped in special case like ramp for parking the vehicle.) They may be wood, concrete and masonry. Shear walls have high strength and stiffness to resist the lateral forces.
Shear wall are very important in high rise buildings in the seismic prone areas. Lateral displacement can be reduced by these shear wall. These are designed to resist both self-weight of the structure (gravity loads) and lateral forces.
Natural calamities (Earthquakes, wind forces) force causes several kinds of stresses such as shear, tension, and torsion etc., the structure may experience Storey displacement or may collapse suddenly. Shear wall reduces the severity of lateral displacement of the structure and indicate the failure of the structure.

1.2 Classification of Shear Wall

1. Simple rectangular
2. Coupled shear walls
3. Rigid frame shear walls
4. Framed walls in filled frames
5. Column supported shear wall
6. Core type shear walls

1.3 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.

3. 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

3.1 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

3.2 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.

TYPES OF BRACING

- ❖ Single diagonal
- ❖ Cross diagonal
- ❖ K- Bracing
- ❖ V – Bracing
- ❖ Eccentric bracing

4. 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 Properties of members

Young's modulus of concrete	2.1×10^7 kN/m^3
Poisson's ratio	0.17
Density	25 kN /m^3
Thermal coefficient	1e-005/^{o}C
Grade of concrete	M_{20}
Yield strength of steel	Fe_{415}

4.2 SEISMIC PARAMETERS

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

4.3 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.

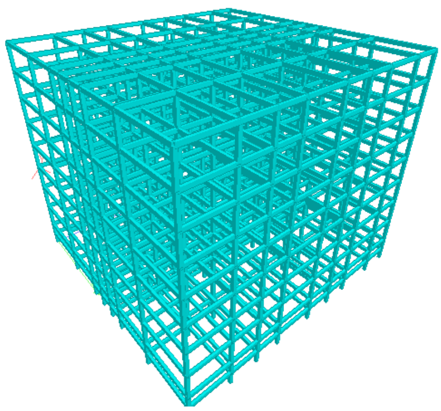

Fig-1: NORMAL BUILDING

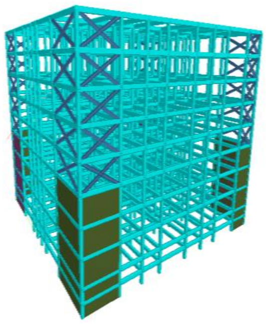

Fig-2: Dual system (building with shear-wall and bracings)

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
26.55	17.8	4.97
23.6	17.1	4.3
20.65	15.8	3.57
17.7	14.3	2.81
14.75	12.41	2.05
11.8	9.5	1.34
8.85	6.63	1
5.9	3.67	0.482
2.95	1.1	0.138
1.45	0.311	0.0484
0	0	0

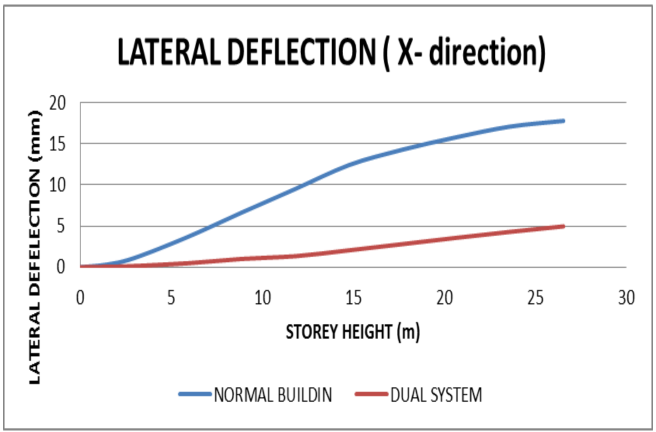

Fig-3: Graph showing lateral displacement in x-direction

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
26.55	17.8	4.84
23.6	17.1	4.19
20.65	16	3.47
17.7	14.2	2.69
14.75	12	1.89
11.8	9.41	1.14
8.85	6.56	0.886
5.9	3.63	0.392
2.95	1.09	0.12
1.45	0.303	0.041
0	0	0

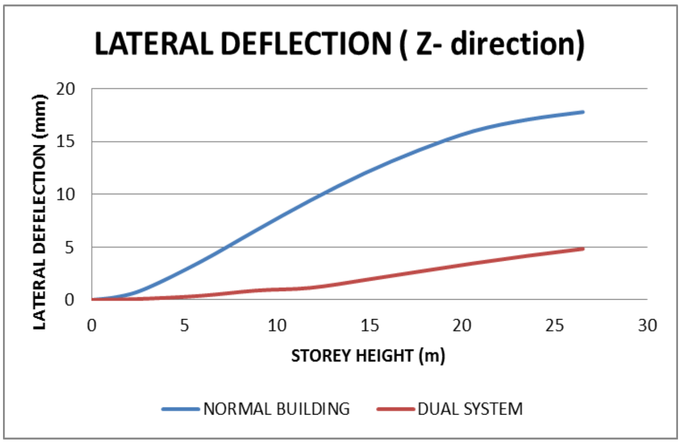

Fig-4: Graph showing lateral displacement in x-direction

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 4.84mm.
- ✓ 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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