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Analysis of G+12 Structures with different material of Shear wall using SAP2000

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***Abstract* - Shear walls is a structural member used to resist lateral forces acting on building. Laterals forces occur due to earthquakes and other parameters. The use of shear wall in buildings is quite common in some earthquake prone region. During seismic excitation shear wall contribute in absorbing moments, shear forces and reduce torsional moments and make building safe against lateral load. RCC shear wall is commonly used for residential and commercial buildings. In this study Steel plate shear wall (SPSW) is used in same frame model which is used for RCC shear wall with same material properties are used for both models instead of RCC shear wall replace it with Steel plate shear wall (SPSW). Modeling and analysis of structures is done using standard software SAP2000 Version 17.2 which is based on finite element method. SPSW boundary elements are calculated as per IS 800:2007.**

***IndexTerms* – Shear wall, SAP2000, Steel plate shear wall (SPSW).**

I. INTRODUCTION

The main function of steel plate shear wall is act as lateral load resisting system and resist horizontal story shear. In general, steel plate shear wall system consists of a steel plate wall (web element), vertical boundary element (column) and horizontal boundary element (beams). Together, the steel plate wall and boundary columns act as a vertical plate girder. The columns act as flanges of the vertical plate girder and the steel plate wall acts as its web. The horizontal floor beams act, more-or-less, as transverse stiffeners in a plate girder.

Fig.1 Unstiffened steel plate shear wall

Initially Steel plate shear wall (SPSW) used for seismic retrofit of low and medium-rise existing commercial, hospitals and other structures. Steel plate shear wall initially designed with relatively closely spaced horizontal and vertical stiffeners also design was implemented as a primary load resisting system. The first important structure in California using steel plate shear walls was Sylmar Hospital in northern Los Angeles. Initially, only heavily stiffened steel plate shear wall were used in order to resist the shear forces within their elastic buckling limits, as in the Sylmar Hospital in Los Angeles, the Nippon Steel Building in Tokyo but the analytical and experimental research carried out by Berman, Elgally, it was observed that the post-buckling ductile behavior of the unstiffened SPSW is much more effective than the elastic behavior of the stiffened SPSW in resisting seismic forces. Also, the unstiffened plates exhibit substantial strength, stiffness, and ductility and their energy dissipation behavior is stable and pronounced. In this paper unstiffened steel plate shear wall are used for result of SPSW and its result compare with RCC shear wall results.

II. METHODOLOGY

Modeling of structure is done in standard software SAP2000 version 17 which is based on finite element method. The space frame G+12 model is prepared considering special moment resisting frame. Column base are assigned as fixed support. Column and beam are model as line element, slab and shear wall are area section but slab are assigned as membrane and shear wall assigned as shell element.

A multistory frame building is taken into consideration. Building having a RCC shear wall throughout the height of building. Details of multistory frame building are as follows Storey of building : G+ 12 storey, Frame type : Special moment resisting frame structure ,Floor to floor height : 3.5 m Seismic zone : Zone III ,Soil type : Medium soil (Type II) Shear wall : 230 mm thick and Beam in X-direction : 230 x 650 mm, Beam in Y direction : 300 X 750 mm, Column: 400 x 800 mm, RCC slab: 150 mm thick and load cases used for analysis

Table 1 Load Cases

SR.NO	Load cases	Load
1.	Dead load	Gravity
2.	Live load	Gravity
3.	Super imposed DL	Gravity
4.	EQX	User define
5.	EQY	User define
6.	WINDX	IS875:1987
7.	WINDY	IS875:1987

And load combination used as per IS 800: 2007, the following load cases have to be consider for analysis

Table 2 Load Combination

SR.NO	Load combinations
1.	DL + SIDL
2.	DL + LL + SIDL
3.	1.5 DL + 1.5 SIDL
4.	1.5 DL + 1.5 LL + 1.5 SIDL
5.	1.2 DL + 1.2 LL + 1.2 SIDL ± 0.6 WIND
6.	1.5 DL + 1.5 SIDL ± 1.5 WIND / 1.5 EQ
7.	1.5 DL + 1.5 SIDL ± 1.5 WIND / 1.5 EQ
8.	0.9 DL + 0.9 SIDL ± 1.5 WIND / 1.5 EQ

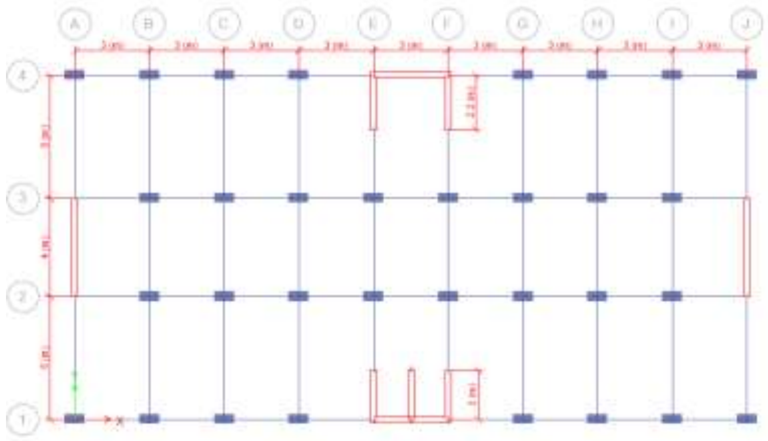

Fig.2 Plane view

III. SEISMIC ANALYSIS OF BUILDING

The Seismic Coefficient Method

This is the simplest of the available methods and is applicable to structures, which are simple, symmetric, and regular. In this method, the seismic load is idealized as a system of equivalent static loads, which is applied to the structure and an elastic analysis is performed to ensure that the stresses are within allowable limits. The sum of the equivalent static loads is proportional to the total weight of the structure and the constant of proportionality, known as the seismic coefficient, is taken as the product of various factors, which influence the design and are specified in the codes.

The seismic coefficient method gives conservative results but has the advantage of being simple and easy to use. It ignores the effect of higher modes and cannot accommodate irregularities in the structure. It is used for checking against moderate earthquakes since the emphasis is on resisting the earthquake loads by virtue of elastic strength rather than inelastic behavior. Therefore the only safeguards that can be provided against severe earthquakes is by following a design procedure, as in capacity design, along with a set of detailing rules, which will ensure some degree of ductility and energy dissipation capacity.

IV. STEEL PLATE SHEAR WALL

G+12 multistory building with Steel plate shear wall modeling and analysis is done on SAP2000 version 17 with same frame model which is used for the RCC shear wall building and similar properties are used. Typical SPSW system consists of steel panels (web element), vertical Boundary element (column), and horizontal boundary element (beams). The main function of steel plate shear wall is to act as lateral load resisting system and resist horizontal story shear. Lateral load is transferred to the steel plate shear wall in their respective direction. Frame model with boundary element of SPSW is prepared in STAAD Pro and so we get the required design storey shear and moments for various checks and design of steel plate shear wall manually. Web plate thicknesses (web element) as well as boundary elements decide as per clause 8.6.1.1(b) and clause 8.7.2.4 of IS 800:2007 respectively.

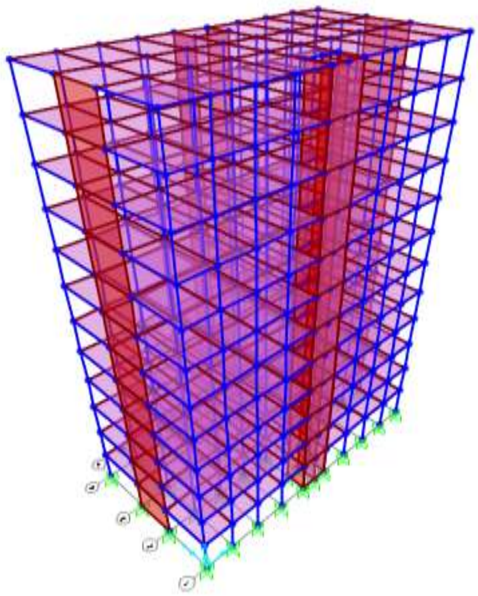

Fig.3 3D MODEL OF SPSW

Together, the steel plate wall and boundary column act as a vertical plate girder. Therefore design of SPSW is carried out by plate girder method.

V. RESULT

1. Story Displacement

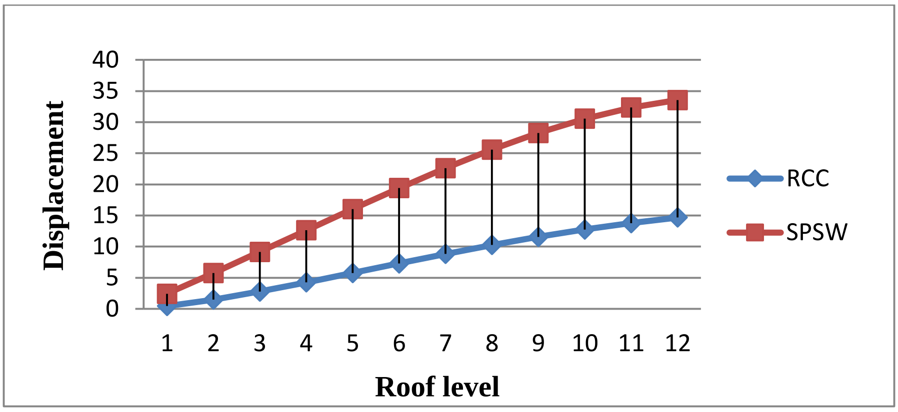

Fig.4 Story displacement

Above graph show the roof level displacement of both the numerical modal. Top storey displacement of the RCC shear wall modal is 14.68 mm and SPSW model is 33.553 mm, SPSW model is displace more because of SPSW are more flexible than the RCC shear wall.

2. Story Drift

As per IS 1893(part1): 2002 (Cl 7.11.1) storey shall not exceed 0.004 times of story height. In this study maximum story height is 3.5m and as per IS recommendation allowable story drift is 16.8mm.

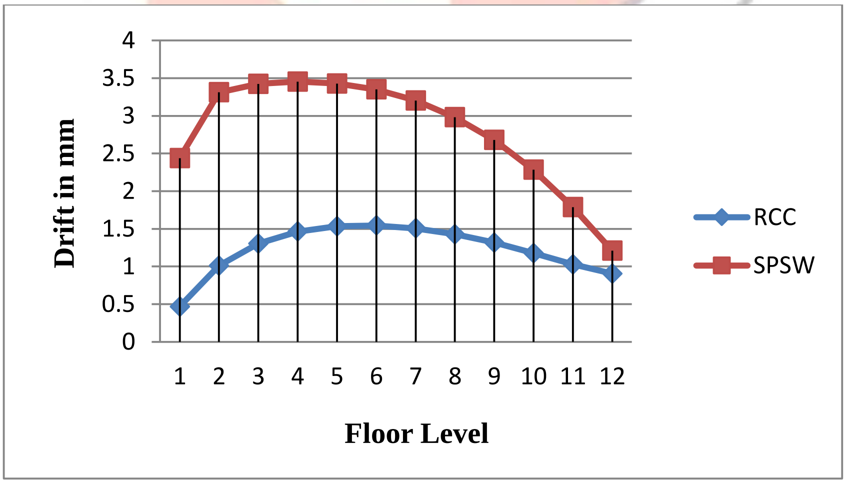

Fig.5 Story drift

3. Base reaction of shear wall

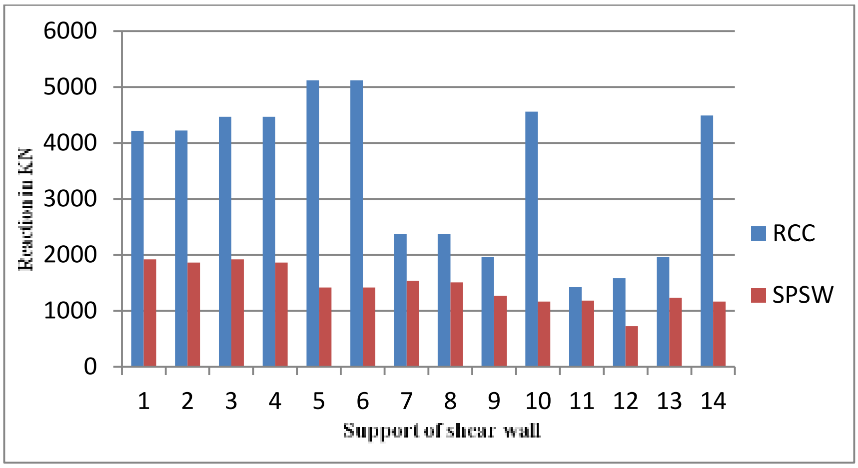

Fig.6 Base reaction of shear wall

The base reaction of RCC shear wall is more as compare to the steel plate shear wall. It implies that foundation size of the SPSW is much more less than the RCC shear wall and economy get Achieve in SPSW.

4. Time period

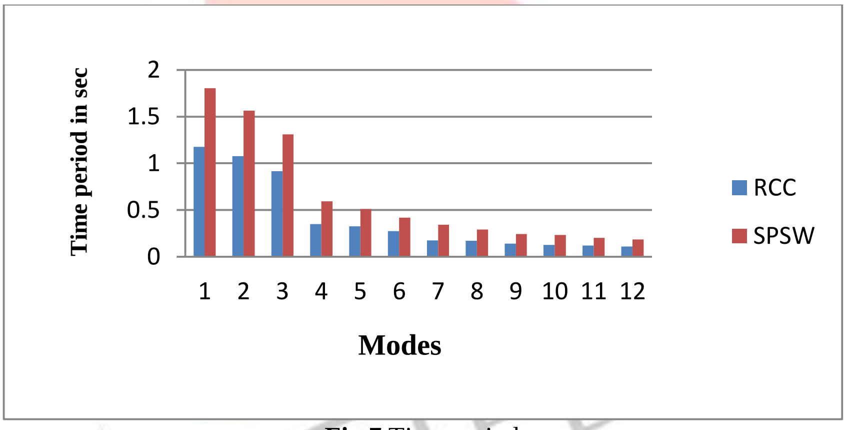

Fig.7 Time period

Fundamental natural periods T of normal single storey to 20 storey buildings are usually in the range of 0.05-2.00 sec. time period of building is more it means the structural damage of the building is minimum. It denotes that SPSW building is effective in earthquake prone area as compare to the RCC building.

5. Weight of shear wall

In present study weight of shear wall is also affect much on seismic weight of building. In this study 37.50% weight the RCC shear wall reduced using SPSW.

Table 3 Weight of Shear wall

Weight of RCC shear wall	5119 KN
Weight of SPSW	1920 KN

VI. CONCLUSION

- SPSW system is effective tool to seismically upgrade, damage and undamaged buildings.
- Ductility of steel plate shear wall is more than the RCC shear walls.
- Base shear of the SPSW building is inherently less, so that the column sizes getting less as compare to RCC shear wall and economy get achieved.
- SPSW occupy the less valuable place of building than RCC shear wall.
- Weight of the SPSW is much more less than the RCC shear wall, so the seismic weight of the building is reduce up to 37% than the RCC shear wall of building.

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