Research Paper Engineering

Push over Analysis of Buildings with Steel Plate Shear Walls Using SAP 2000

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ABSTRACT

Steel plate shear wall is one of the most economical and underutilized lateral load resisting system currently available to structural engineers. The main objective of this study is to carry out push over analysis of building containing steel plate shear wall using SAP2000 software. for this purpose a sample building was taken and a steel plate shear wall provided at different location such as inner periphery or outer periphery and result is compared. analytical result shows that a building have steel plate shear wall at outer periphery is more stable than other during earthquake.

Keywords : Steel plate shear wall, ductility, Shear Walls, Push Over analysis Base Shear Lateral displacement.

INTRODUCTION

Steel plate shear walls (SPSW) can be used in buildings to resist forces produced during an earthquake. Over the last decade, a general interest has been shown in the application of steel plate shear wall as a desirable resistant system against the lateral load in buildings. Experimental and numerical studies reported that As compared to the reinforced cement concrete (RCC)the steel has some important physical properties. SPSW systems have more ductility, high stiffness, excellent energy absorption capacity and stable hysteresis characteristics.

Being ductile, the steel structure give sufficient advance warning before failure by way of excessive deformations. These properties of steel are of very much important in case of the seismic resistant design. Through ductility, steel is able to undergo a large deformation beyond elastic limit without danger of fracture. Thus the ultimate capacity is far in excess of that estimated by the elastic design. Therefore, the structure should have sufficient stiffness and strength laterally to perform satisfactorily to these occasional loads.

ADVANTAGES OF SPSW

Wall Thickness : In comparison to the thickness of concrete shear walls SPSW allow less structural wall thickness. A practical performed for The Century project indicated an average wall thickness, including the furring, of 18" as opposed to a concrete shear wall thickness with an average of 28". This resulted in a savings of approximately 2% in gross square footage.

Building Weight : SPSW result in a lesser building weight in comparison to buildings that use concrete shear walls. A study performed for The Century project indicated that the total weight of the building as designed using SPSW was approximately 18% less than that of the building designed using a concrete shear wall core system, which results in a reduction of foundation loads due to gravity and overall building seismic loads.

Fast Construction : The use of a SPSW system reduces construction time. Not only is it fast to erect, but there also is no curing period. A scheduling study performed by a contractor for The Century project indicated a one-month reduction in construction time.

Ductility : A relatively thin steel plate has excellent post-buckling capacity. Research performed on the SPSW system indicates that the system can survive up to 4% drift without experiencing significant damage, even though most of the tests showed damage outside the steel plate panel. There was some pinching and tearing close to the corners of the panel due to bending. However, this tearing did not reduce the plate capacity and stiffness.

Tested System : At least two buildings that use SPSW as their primary lateral force resisting system have undergone significant earthquake ground shaking. Both buildings survived with insignificant structural damage. The system also has been tested since the 1970s. Easier retrofitting can be done with steel plate shear wall

DISADVANTAGES OF SPSW

Stiffness : SPSW systems are usually more flexible in comparison to concrete shear walls, primarily due to their flexural flexibility. Therefore, when using SPSW in tall buildings, the engineer must provide additional flexural stiffness

Construction Sequence : Excessive initial compressive force in the steel plate panel may delay the development of the tension-field action.

New System: Due to unfamiliarity with the system, a contractor will typically estimate a relatively high erected cost.

PROBLEM

Height of building : 36 m for sample model (varies from 36 m to 75.6 m).

Height of each storey : 3.6 m constant for all building.

Length of building along X direction :20 m

Length of building along Y direction :16 m

No. of bay along X direction : 4 nos.

No. of bay along Y direction : 4 nos.

Grade of steel: Fe-250

Density of concrete: 25 KN/m^3

Density of wall: 20 KN/m^3

Slab thickness: 120 mm

Wall thickness: 230 mm

Parapet wall height: 1 m

wTest Results

(1) **Steel shear wall at inner periphery**

a. Base Reaction

Load Comb	Earth Quake	Earth Quake	Push Over	Push Over
Joint	Force	Moment	Force	Moment
1	Fx=-18.37 KN	Mx=-0.005KNM	Fx=-260KN	Mx=404 KNM
	Fy=0.003 KN	My=-46.43KNM	Fy=0 KN	My=-625880 KNM
	Fz=-135.55KN	Mz=0.00KNM	Fz=799.85 KN	Mz=-0.116 KNM
221	Fx=-18.38KN	Mx=-7.14KNM	Fx=-252.32 KN	Mx=835.011 KNM
	Fy=-0.001KN	My=-464.55KNM	Fy=-0.73 KN	My=-617067 KNM
	Fz=140.97KN	Mz=1.89 KNM	Fz=241.75 KN	Mz=-0.113 KNM

b. Frame Reaction

Element	Parameters	EQ	Push	Element	Parameters	EQ	Push
1	Axial Force(KN)	135.55	-422.64	201	Axial Force(KN)	-146.97	-1761.2
	Torsion (KNM)	0	0		Torsion (KNM)	0	0
	V2 (KN)	18.37	414.16		V2(KN)	18.38	403.5
	V3(KN)	-0.04	0.104		V3(KN)	-0.001	-0.769
	M2(KNM)	0.086	-110.25		M2(KNM)	-0.007	-1.1629
	M3(KNM)	46.43	767.1		M3(KNM)	46.45	767.05
	Deflection	0	0		Deflection	0	0

c. Shear Wall Stresses

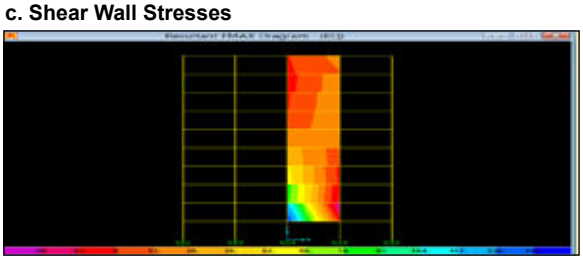

Fig 1. Shear Wall Stresses for Earth Quake case in KN/M^2

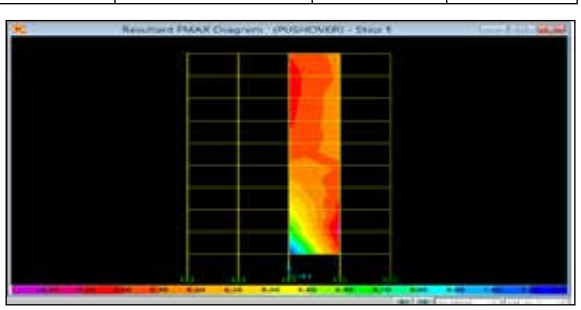

Fig 2.Shear Wall Stresses for Push over case in KN/M^2

(2) Steel shear wall at outer periphery

a. Base Reaction

Joint	Earth Quake	Earth Quake	Push Over	Push Over
	Force	Moment	Force	Moment
1	Fx=35.70 KN	Mx=-0.0067 KNM	Fx=-277	Mx=0.77
	Fy=0.003 KN	My=-77.72 KNM	Fy=0.59	My=591.624
	Fz=-124.22 KN	Mz=0.00 KNM	Fz=1006.71	Mz=0.0004
221	Fx=-41.85 KN	Mx=0.355 KNM	Fx=-324.47	Mx=2.98
	Fy=-0.27 KN	My=-85.95 KNM	Fy=-2.31	My=-6.35
	Fz=557.178 KN	Mz=0 KNM	Fz=4680.54	Mz=0.0001

b. Frame Reaction

Element	Parameters	EQ	Push	Element	Parameters	EQ	Push
1	Axial Force(KN)	124.22	712.87	201	Axial Force	-577.17	1811.6
	Torsion (KNM)	-0.0001	0.175		Torsion	-0.0001	0.1762
	V2 (KN)	35.7	417.77		V2	41.58	420.52
	V3 (KN)	-0.033	15.95		V3	-0.274	74.39
	M2 (KNM)	0.066	120.02		M2	0.355	134.36
	M3 (KNM)	77.72	763.6		M3	85.95	765.35
	Deflection	0	0		Deflection	0	0

c. Shear Wall Stresses

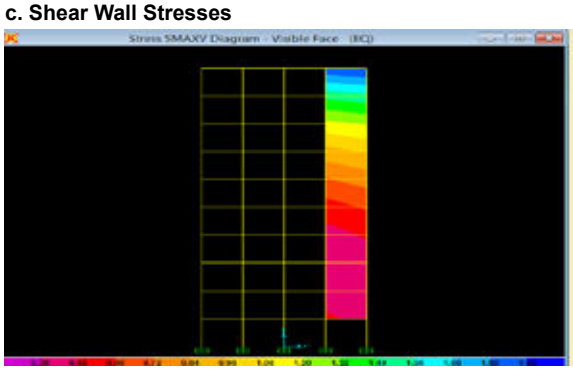

Fig 3. Shear Wall Stresses for Earth Quake case in KN/M2

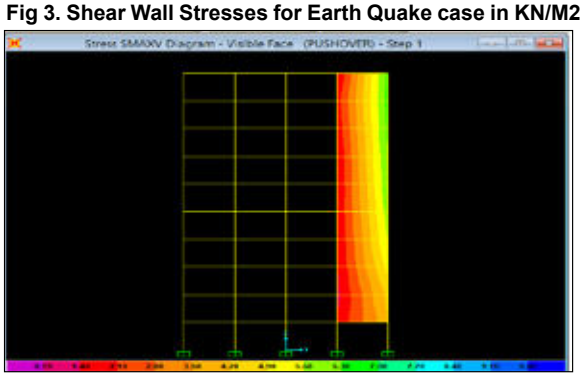

Fig. Shear Wall Stresses for Push over case in KN/M^2

Conclusions

From the results as above mentioned , It is concluded that

1) Behavior of steel plate shear wall is dependent on position.
2) A shear wall located at the corner of the structure has more shear resisting capacity than a shear wall near to the centre of structure.
3) For safer practice it is desirable to locate shear wall as near as possible to the corner of structure.

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