Research Article Impact Factor: 4.226 ISSN: 2319-507X
A. R. Gupta, IJPRET, 2017; Volume 6 (2): 45-51 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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SPECIAL ISSUE FOR
INTERNATIONAL LEVEL CONFERENCE
"ADVANCES IN SCIENCE, TECHNOLOGY & MANAGEMENT"
(IC-ASTM)

DESIGN OF RCC SHEAR WALL

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Accepted Date: 05/09/2017; Published Date: 10/10/2017

Abstract: Among the entire natural hazard, earthquake is one of the most dangerous. For safety of the buildings, it is essential that structures should have adequate lateral stability, strength, and sufficient ductility. There are various types of lateral load resistance structural systems for reducing the effect of earthquake forces for RC buildings. This research work focuses on comparison of seismic analysis of G+5 building stiffened with Steel Shear Wall and RCC shear wall. The performance of the building is analyzed in Zone III. The scope of present work is to understand that the structures need to have suitable Earthquake resisting features to safely resist large lateral forces that are imposed on them during Earthquake. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing Earthquake damage in structure. A well designed system of shear wall in building frame improves seismic performance significantly. The properties of seismic shear walls dominate the response of the buildings, and therefore it is important to evaluate the seismic response of the shear walls appropriately. Also it is necessary to find out the effective location of shear wall in the structure.

Keywords: RC Shear wall, Steel shear wall, equivalent static load, Lateral loading.

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How to Cite This Article:

A. R. Gupta, IJPRET, 2017; Volume 6 (2): 45-51

PAPER-QR CODE

INTRODUCTION

1.1 General: Shear Walls are structural elements in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided both length and width of buildings. Shear walls are like vertically – oriented wide beams that carry earthquake loads downwards to the foundation. Properly designed and detailed building with shear walls has shown very good performance in past earthquakes. Shear wall in high seismic regions require special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries. They are efficient, both in terms of construction cost and efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non-structural elements.

Most Reinforced Concrete buildings with shear walls also have columns; these columns primarily carry gravity loads. Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and there by reduces damage to structure and its contents. Shear walls carry large horizontal earthquake forces; the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear walls should be provided along preferably both length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane must be provided along the other direction to resist strong earthquake effects.

Steel shear walls have been used as the primary lateral load resisting System in several modern and important structures. In structural engineering, a shear wall is a structural system composed of braced panels to counter the effects of lateral load acting on a structure. Wind and seismic loads are the most common loads that shear walls are designed to carry. Under several building codes, including the International Building Code and Uniform Building code, all exterior wall lines in wood or steel frame construction must be braced. Depending on the size of the building some interior walls must be braced as well. A structure of shear walls in the center of a large building.

1.2 Objective:

1. To study seismic effect of building.
2. To study methods of Seismic Analysis.
3. To study Earthquake resistant tools.
4. To study Analysis of Design process of share wall.
5. To Analysis steel shear wall.
6. To Analysis RCC shear wall.
7. To do comparative Analysis of steel and RCC shear wall

1. Literature Review:

Sameh A. El-Betar et.al.(1) In this literature the author introduced the main parameters of earthquake sources. The earthquakes disasters basically occur due to buildings damage not because of the earth shaking. Similarly, Gaurav Joshi et.al. (2) In this paper, seismic analysis of soft storey buildings considering structural and geometrical parameters have been carried out using STAAD-PRO software. Soft storeys have been created by increasing the floor heights. Effect of infill has been ignored. Results, in terms of moment, displacement, shear force, axial force and drift are critically examined and salient conclusions are drawn. Similarly, Marco Valent et.al. (3) This paper investigates a new type of friction damper for improving the seismic performance of precast concrete frame structures. The friction damper is used externally at selected beam-tocolumn joints of the frame to dissipate energy during severe earthquakes. A simplified model describing the hysteretic behaviour of the friction device was developed and parametric analyses were carried out in order to establish the optimum value of the slip force of the device for the different precast structures. Similarly, Bowang Chen et.al. (4) In the paper shear wall of tall building structures, some kinds of calculation methods towards Multi- Vertical-Line-Element Model are discussed in detail. A more reasonable element stiffness matrix and a improved Multi-Vertical-Line-Element Model are given. Combined with hysteretic axial model and hysteretic shear model, nonlinear analysis of a shear wall is put through. The calculation result indicates that the improved model has relatively well accuracy compared with test result.

Similarly, Tarun Shrivastava et.al. (5) In this paper describes importance of shear wall frame structure in multi-storey building. Some cases are prepared such as bare frame and shear wall models. Seismic analysis is done with response spectrum method. This analysis will produce the effect of maximum horizontal displacement, storey drift index, bending moment, and shear forces.

3. DETAIL STUDY

3.1 What is a Shear Wall?

Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

3.2 Types of Shear Wall

1. RC Shear Wall
2. Steel Shear Wall

3.2.1 RC Shear Wall

Main walls are RC shear walls with regular staggered openings. Sidewalls are also RC shear walls, connected to the main walls with coupling beams. Some of sidewalls contain continuous column of openings and the rest are solid. The walls, in a building, which resist lateral loads originating from wind or earthquakes, are known as shear walls. A large portion of the lateral load on a building, if not the whole amount, as well as the horizontal shear force resulting from the load, are often assigned to such structural elements made of RCC. These shear wall, may be added solely to resist horizontal force, or concrete walls enclosing stairways, elevated shafts, and utility cores may serve as share as shear wall. Shear walls not only have very large in-place stiffness and therefore resist lateral load control deflection very efficiently, but may also help to ensure development of all available plastic hinge locations throughout the structure prior to failure.

4. Verification problem and case consideration

I. Design of RC shear wall

Design a simple shear wall of length of 5m and thickness 250 mm subjected to a following forces use M-30 grade of concrete and Fe-415 steel. The wall is High Wall.

Load case	Axial Load	Moment	Shear Force
DL+LL	2500	750	40
Seismic Load	450	6000	1000

Solution:

Step 1: Design Loads

Load Combinations

Case 1: (From Clause 9.4.3 , IS-13920 ,Pg.No.-13)

P1=0.8(DL+IL) + 1.2 EQ ……(For axial load)

P1= (0.8 x 2500) + 1.2 x 450

= 2540 kN

Case 2: (From Table 18 , IS-456, Pg.No.- 68)

P2=1.2 (DL+IL) +1.2EQ ……(For axial load and lateral load)

P2=(1.2 x 2500) +(1.2 x 450)

= 3540 kN

Moment Mu = 1.2 x (750+6000)

= 8100kN

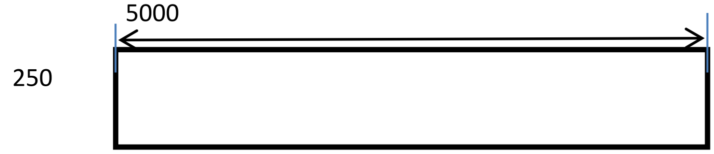
Shear Vu = 1.2 x (40+1000)
= 1248 kN

Step 2: Check For Need of Boundary Element Thickness of wall given as 250 mm

$I = bd^3/12$
$= (250 \times 5000^3) / 12$
$= 2.6 \times 10^{12}\ mm^4$

$A = b \times d$
$= 250 \times 5000$
$= 1.25 \times 10^6\ mm^2$

$Z = I/y$
$= 2.6 \times 10^{12} / 2500$
$= 1.04 \times 10^9\ mm^3$



To Find Stresses

FC = P/A ± M/Z P is maximum Value

$= (3540 \times 10^6/1.25 \times 10^6) \pm (8100 \times 10^6 / 1.04 \times 10^6)$

$Fcmax = 10.62\ N/mm^2$

$Fcmin = -4.95\ N/mm^2$

From Clause 9.4.1 IS 13920

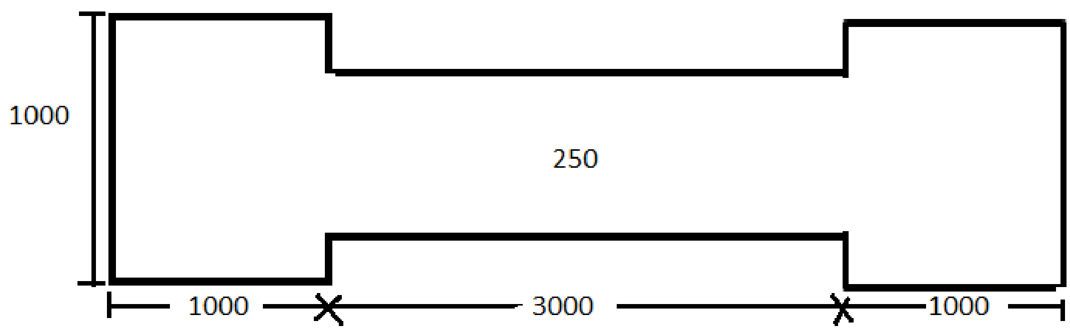
$Fcallow = 0.2 \times 30 = 6\ n/mm^2$

Here, Fcmax > Fcallow Hence , Boundry Element have to be provided.

For Value of Fcmax > Fcallow Either increase the Thickness of Shear wall or Increase the bar bell Size.

Trial Section:-

Adopt barbell type wall with two Enlarged ends of Size , 1000mm x 1000mm and the ceter pwet as 3000mm.



$I = 2(bd^3/12 + A \cdot h^2) + bd^3/12$
$= 2 \times ((1000 \times 1000^3)/ 12) + (10^6 \times 2000^2) + (250 \times 3000^3/12)$
$= 8.72 \times 10^{12}\ mm^4$

$A = 2.75 \times 10^6\ mm^2$

$Fc = P/A \pm M/Z$

$Fcmax = 3.60\ N/mm^2$

$Fcmin = -1.03\ N/mm^2$

Here , Fcmax < Fcallow , Hence OK.

Step 3: Layers of Steel Provided

Depth of the Section resisting shear = 3000+ 1000
= 4000mm

Shear Stress (τv) = Vu/bd ....(from Clause 9.2.1. IS 13920)
= 1248000/(250 x 4000)
= 1.25 N/mm^2

Limiting Shear (τv) = 0.25 √ Fck ....(from cl. 9.1.5)
= 1.36 N/mm^2

From CL 9.1.5 ,IS -920 , pg. no. 12

τv < τvn and

Thickness >200mm so Steel has to be provided in two Layers (both faces).

Step4 : Steel Required

Min'^{m} Steel = 0.0025

Ag= 0.0025 x 1000 x 250
= 625 mm^2 ....(Clause 9.1.4.IS 13920)

Steel in one Layer =312.5 mm^2

Assuming # 10mm bars ,Spacing = 251.2 mm

From clause 9.1.7 IS 13920

Max^m Spacing = Min^m of (L/5 or 3b or 450mm)
= (3000/5) or (3 x 250) or 450
= 450 mm

from SP-16

provided # 10mm bars at 250mm c/c on both Faces Horizontally and vertically Ast Provided = 628 mm^2

Pt= 0.251 %

Step 5: Shear taken by steel

Pt provided = 0.251 %

τc = 0.37 N/mm^2 ....(from Table 19, IS-456)

τcmax = 3.5 N/mm^2 ......(from Table 20, IS-456)

Vus = (τv - τc) x bd
= (1.25 – 0.37) x 250 x1000
= 219.5 kN

Vus = 0.87 Fy Asv d/ Sv ......(from clause 40.4.9, IS-456)

Asv/Sv = 219500/0.87 x 415 x 1000
= 0.607

Provided Asv/SV per meter from

min steel Asv/Sv = 628/1000 =0.628

Min^m steel provided Satisfied Shear Requirment.

Step 6 : Flexural capacity of Web

P1 = 2540 Kn (Min^m Downword Force)

Load on Web Pw = Load x Web Area/ Total area
= 2540x3000x250/((3000x250)+(2x1000^2))
= 962.72 kN

From Anex A: IS-13920

λ = Pu/ Fck tw lw

= 692720/25x250x3000
= 0.0307
φ = 0.75 Fy ρ / Fck
= 0.87x415x0.0025/30
= 0.030
β = (0.87Fy/0.0035)xEs
= $0.87x415/0.0035x2x10^5$
= 0.515
Xu/lw = (φ+ λ)/ 2 φ+0.36
= 0.030+0.0307/2x0.030+0.36
= 0.143
Xu/lw* = 0.0035/(0.0035+(0.87FyEs)
= 0.66
a) for Xu/lw < Xu/lw*

Muv/Fcr tw lw^2 = $\varphi((1+ \lambda / \varphi)(1/2 – 0.416Xu/lw)-(Xu/lw)^2x(0.168+ \beta^3/3)$
Muv=0.026 x Fck x tw x lw^2
= 0.026 x 30 x250 x 3000^2
= 1771.4 kN-m

Step7- Force on Boundary Element

Moment on BE=8100-1771.4 = 6328.6kN-m
Equivalent Axial Load = 6328.6/4 =1582.15kN

Compression load from vertical loads (Max^m downward force)
Load on Boundary Element = Load x BE /Total area
= $(3540x1000^2)/(2.75x10^6)$
= 1287.2kN

Tension Load from vertical loads (Min^m. downward force)
Load on Boundary Element = Load x BE /Total area
= $(2540x1000^2)/(2.75x10^6)$
= 923.6kN

Boundary Elements are designed as column with lateral ties confinement anchorage and splice length.

Step8- Design of Boundary Element

Design the BE as a short column
Pu=0.4 Fck Ac + 0.67 Fy Asc .....(from cl.39.3 IS-456)
Assuming Pc = 0.8% (min^m Pc)
Asc = 0.008x1000x1000
= 8000 mm^2
Pu = $(0.4x25x1000^2x8000)$+(0.67x415x8000)
= 14128.4kN > 1582.15kN
Hence, OK.

Some steel will be provided on both the boundary elements, Provide 12 no. of #32mm bars.

Special Confining Reinforcement
From cl.7.4.8 IS-13920:1993
Ash= 0.18 Sh (Fck/Fy) ((Ag/Ak)-1)
Where, h=1000-(2x10)=920mm
Introducing a cross tie as h exceeds, 300mm
h = 920/2 = 460mm
s = 0.25 x b or 100 mm
= 1000/4 or 100mm

= 100mm

$Ak= 920^2 = 846400\ mm^2$

$Ash = 0.18x100x460x(25x415)x((1000^2/846400)-1)$

$= 108.62\ mm^2$

Provide #12mm @ 100mm c/c as special confining reinforcement.

5. CONCLUSION

On the basis of the work highlighted in this paper, it can be conclude that the Shear Wall should be constructed by considering the Seismic Forces on RC and Steel shear wall. Only RC wall is design according to the Seismic forces. And Analysis of shear wall on STAD-pro of Steel and RC shear wall is remaining. This work is to be done in next phase.

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