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RESEARCH ARTICLE

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SHEAR WALL DESIGN FOR G+8 FLOORS RESIDENTIAL BUILDING

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ABSTRACT

Besides, food and clothing, shelter is a basic human need. India has been successful in meeting the food and clothing requirements of its vast population; however the problem of providing shelter of all is defying solutions. “While there has been an impressive growth in the total housing stock from 65 million in 1947 to 187.05 million in 2001, a large gap still exists between the demand and supply of housing units. The Working Group on Housing for the 9th five-year plan estimated the housing shortage in 2001 at 19.4 million units- 12.76 million in rural area and 6.64 million in urban area. The shortage of housing is acutely felt in urban areas –more so in the 35 Indian cities, which according to the 2001 census have a population of more than a million”.

Hence in order to overcome this problem construction process should be quick, tall and effective to accommodate huge population in a given area. So we have chosen this topic of “DESIGN OF SHEAR WALLS”. This type of shear wall construction helps to build tall structure of about 5 to 20 floors within no time. Hence the construction process will become much quicker and efficient.

Constructions made of shear walls are high in strength, they majorly resist the seismic force, wind forces and even can be build on soils of weak bases by adopting various ground improvement techniques. Not only the quickness in construction process but the strength parameters and effectiveness to bare horizontal loads is very high. Shear walls generally used in high earth quake prone areas, as they are highly efficient in taking the loads. Not only the earthquake loads but also winds loads which are quite high in some zones can be taken by these shear walls efficiently and effectively. In this document here we design shear wall for G+8 floors residential building with manual calculations.

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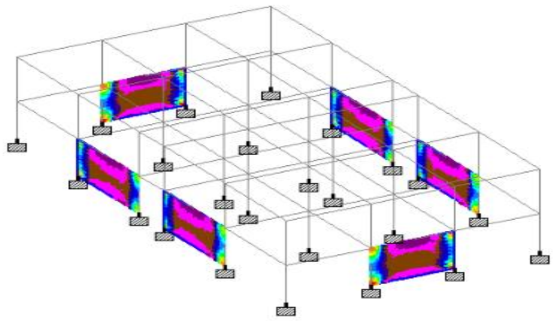
INTRODUCTION

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.

Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces. Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces.

In this project hear we are designing the shear wall design at lower portion.

THE FIGURE SHOWS THE LOCATION OF SHEAR WALL



Scope of the work

The aim of the shear wall is to investigate the different ways in which the tall structures can be stabilized against the effects of strong horizontal wind loading and seismic loading.

Some other reasons why we use shear walls are tall structures can be constructed which reduces the area used and we can accommodate a large population in that particular area.

Other objective is to construct a cost effective structure in less period of time.

This study helps in the investigation of strength and ductility of walls.

The scope is to analyze the constructed shear wall that is to be constructed. Firstly the model is implemented into known computer software and then it is analyzed based on the investigation of strength and ductility.

The strength of shear walls tested are compared with the calculated strengths based on design codes.

1.3 Objective

Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind.

Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building.

Shear walls are quick in construction, and in a country like India where shelter is very important in a short lapse of time shear walls can be built very quickly. The precision to which they are built is also very high compared to normally built brick structures. Hence the key objective of shear wall is to build a safe, tall, aesthetic building.

Literature Review

Review of literature: Development of shear wall system for construction has advanced dramatically over the past few years. Shear wall systems were initially developed to reduce damage due to earth quakes labour requirements, increase strength of the building, shorten construction time reduce cost increase quality of life.

U.H. Varyani described about shear walled buildings under horizontal loads. Considering in his design "Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on shear walls of a building".

S.K. Duggal on his profound interest on structures gave a detailed description about reinforced concrete buildings in his book "Earth quake resistant design of structures "describing a wall in a building which resist lateral loads originating from wind or earthquakes are known as shear walls". He considered flexural strength in the wall to be dominant force based on which design of structure to be carried out in tall shear walls. He described in detail about various types of shear walls with their load bearing capacities as per code requirements.

Mr A.P. Jadhav Associate Professor Rajarambapu Institute of technology rajaramnagar, Islampurhas given a detailed report on the form work used for the construction of shear walls.

INDIAN STANDARD CODES:

I.S 456:2000

As per clause 32, design for wall describes, design of horizontal shear in clause 32.4 given details of how shear wall have to be constructed.

I.S:1893 Criteria of Earth Quake resistant Buildings Part (3) page 23, clause 4.2 gives the estimation of earth quake loads.

In IS: 13920:1993 it gives the ductile detailing of shear wall as per clause 9-9.6.

Ductile detailing, as per the code IS: 13920:1993 is considered very important as the ductile detailing gives the amount of reinforcement required and the alignment of bars.

MANUAL DESIGN OF SHEAR WALL

GRADE OF CONCRETE BEING USED M-20.

GRADE OF STEEL USED IS FE 415.

UNIT WEIGHT OF REINFORCED CONCRETE IS 25 KN/M^3

THICKNESS OF SLAB – 150mm

LIVE LOAD -2KN/M^2 (ON TERRACE)

IMPOSED LOAD ON ALL FLOORS - 4 KN/M^2

SEISMIC WEIGHTS:

TOTAL FLOOR AREA =Af =12*22=264 m^2

AT ROOF , NO IMPOSE LOAD TO BE LUMPED .THE ROOF LOAD CONSIST OF SELF WEIGHT OF SLAB +50% LOAD DUE TO WEIGHT OF WALL BELOW THE STOREY

WEIGHT OF WALL AT EACH FLOOR LEVEL

= (TOTAL LENGTH OF OUTER WALLS * THICKNESS * STOREY HEIGHT *UNIT WEIGHT OF BRICK MASONRY) + (TOTAL LENGTH OF INNER WALL * THICKNESS *STOREY WEIGHT OF MASONRY)

=2*(12+22) * 0.23*3*20 +(2*22+4*12)*0.115*3*20

=938.4+634.8

=1573.2 KN

ROOF LOAD W9

=(SELF WEIGHT OF SLAB + FLOOR FINISH) *Af +HALF WALL LOAD

=(25*.15+2)*264+1573.2/2

=1518+786.6

W9=2304.6KN

AT FLOOR LEVEL, ONLY 50% OF IMPOSEDLOAD IS LUMPED.

FLOOR LEVEL =(SELF WT OF SLAB +FF+50%LIVE LOAD)*Af

= (25*.15+1+.5*4)264

=1782KN

ASSESS LOAD AT EACH FLOOR W8,W7,…..W1.

=1782+1573.2

=3355.2KN

LOAD AT PLINTH =W_0=1573.2KN

TOTAL SEISMIC WEIGHT OF THE BUILDING =W

W=TOTAL LOAD

ΣWi =2304.6+ (8*3355.2)KN+1573.2KN

W=30719.4KN

THE FUNDAMENTAL NATURAL PERIOD OF VIBRATION (T) FOR THE BUILDING HAVING SHEAR WALL.

Ta =0.09h / d

h=29.5m

d=22m

Ta=0.09*29.5/ 22

Ta =0.56sec

FOR HARD SOIL Sa/g =2.5

I=IMPORTANCE FACTOR =1.0

R=RESPONSE REDUCTION FACTOR = 5

AS PER CODE IS 1893:2002 EARTHQUAKE

I/R=1/5=0.2

AS PER CODE IS 1893(PART 1):2002

I/R SHOULD NOT GREATHER THAN1

Z=0.16(ZONE III)

DESIGN HORIZONTAL SEISMIC COEFFICIENT

Ah = Z/2 *I/R *Sa/g

=0.16/2*1/5*2.5

=0.04

DESIGN SEISMIC BASE SHEAR VB = 0.04*30719.4KN

VB=1228.776KN

DESIGN LATERAL FORCE AT VARIOUS FLOOR LEVELS:

$Q_{i} = V_{b}\ W_i h_i^2 / \Sigma^{n}_{j=1} W_j h_j^2$

S.NO	Wi	hi	$Wihi^2$	$Wihi^2$ / $\Sigma Wihi^2$	LATERAL FORCE VB* $Wihi^2$ / $\Sigma Wihi^2$	SHEAR FORCE Vi
9 FLOOR	2304.6	29.5m	2005578.15	0.197	242	242
8 FLOOR	3355.2	26.5m	2356189.2	0.231	284	526
7 FLOOR	3355.2	23.5m	1852909.2	0.182	223.6	749.6
6 FLOOR	3355.2	20.5m	1410022.8	0.132	169.5	919.1
5 FLOOR	3355.2	17.5m	1027530	0.101	124.0	1043.1
4 FLOOR	3355.2	14.5m	705430.8	0.069	84.7	1127.8
3 FLOOR	3355.2	11.5m	443725.2	0.043	52.83	1180.63
2 FLOOR	3355.2	8.5m	242413.2	0.023	28.2	1208.8
1 FLOOR	3355.2	5.5m	101494.8	0.009	11.05	1219.8
GROUND FOOR	3355.2	2.5m	20970	0.002	2.42	1222.33
PLINTH BEAM	1573.2	0	0	0	0	0
			$\Sigma Wihi^2$=10166263.3		T- 1222.33	

MAXIMUM SHEAR FORCE AT BASE –(V) = 611.16KN
MAXIMUM BENDING MOMENT AT BASE - (M)
M=(1.22*2.5)+(5.52*5.5)(14.1*8.5)+(26.41*11.5)(42.35*14.5)+(62*17.5)(84.7*20.5)+(111.8*23.5)(142*26.5)+(121*29.5)
M=3.05+3638.64+186503.78+1883939.75+9886529.9+3569.5
M=11964184.62KN.M
Taking partial safety factor = 1.5
Mu=1.5*M
Factored bending moment (–Mu)
Mu = 17946276.93KNm
Factored shear force (Vu) = 1.5 X 611.16KN = 916.7
Length of wall (GF) = 4 m
Thickness of wall (F) = 0.23 m
Considering axial load acting = 3000KN
Factored axial load = 1.5 x 3000 = 4500KN
Providing uniformly distributed vertical reinforcement ratio
= 0.25%
$\Phi = 0.87 f_y \rho / f_{ck}$
=.87*415*0.0025/20
Φ =0.045

$\lambda = (p_u / f_{ck} t_w l_w)$
=4500*1000/20*4000*230
λ =0.245
β = 0.87Fy,/(0.0035* Es)
$\beta = 0.87*415/(0.0035*2*10^5) = 0.515$
$X_u/l_w = (\Phi + \lambda /2 \Phi + 0.36)$
$\{X_u/l_w\}$ = (0.045+0.245/2*0.045+0.36)
$\{X_u/l_w\}$ =0.644
$\{X_u^*/l_w\} = (0.0035/0.0035+0.87 f_y / E_s)$
$\{X_u^*/l_w\}$ =0.0035/0.0035+0.87*415*/2*10^5
$\{X_u^*/l_w\}$ =0.660
$\{X_u/l_w\} \leq \{X_u^*/l_w\}$
Where Xu is the depth of the neutral axis from extreme compression flange, is the balanced depth of neutral axis.
α is the inclination of the diagonal reinforcement in the coupling beam,
β is the soil-foundation factor (IS 1893: 2002),
ρ is the vertical reinforcement ratio,
Ast is the area of uniformly distributed vertical reinforcement, Es is the elastic modulus of steel, and Pu is the axial compression on the wall.
Then the moment of resistance

$M_{uv}/f_{ck}\ t_w\ l_w^2 = \Phi*[(1+\ \lambda / \Phi)*(1/2-0.416\ X_u/l_w)-(X_u^*/l_w)^2 (0.168 + \beta^2/3)]$

$=0.045*[(1+.245/0.045)*(1/2-0.416*0.64)-(0.66)^2(0.168+0.515^2/3)]$

$=0.045*[(6.44)(0.24)-(0.43)(0.256)]$

$=0.045\ [1.54-0.11]\ =0.045[1.43]$

$Mu / f_{ck}*t_w*l_w^2 = 0.064$

$Mu=0.064\ (f_{ck}*t_w*l^2_w)$

= 47328480knm

Mu > Mu

47328480.0 >17946276.9

Balance moment to be resisted by the edge reinforcement in each shear wall

= (47328480-17946276)

=29382203.07

Effective depth of wall $d_w= 0.9\ l_w= 0.9 \times 4000= 3600$

Area of steel = $Mu /0.87*Fy*d_w$

$=29382203.07*10^6 /(0.87*415*3600)$

= 22605520.22

Equal amount of reinforcement is provided on the vertical edges of the wall

Provide 40mm dia bars in two layers in the wall at each end.

Ast provided at ends = 1256 x 40= 50240mm^2

Minimum reinforcement is provided in the vertical direction for a length of wall

$0.8\ l_w$ = 3200 mm.

Minimum area of steel required in the shear wall

= 0.0025 x 400 x 230 = 2300mm^2

Area of minimum reinforcement per meter length of wall ss= 0.0025 x 1000 x 230 = 570mm^2

Maximum permissible spacing = l_w /5 or $3t_w$ or 450

l_w /5 = 800

or $3t_w$ =690

Or 450

Therefore spacing between reinforcement = 450 mm c/c.

Provide 8mm or 10mm dia bars at 300 mm c/c in the vertical direction in two layers.

Vertical Reinforcement of shear wall

(As per clause 9.24 of IS: 13920: 1993)

If Then

As per clause 9.15:

If the factored shear stress in the wall exceeds 0.25 $\sqrt{fck}$ or if the wall thickness exceeds 200 mm then the reinforcement is provided in two directions. Each having running in horizontal and transverse directions.

The maximum spacing shall not be smaller than:

l_w /5 = 800 or $3t_w$ =690

Or 450

Spacing = 450 mm

Thus the reinforcement provided in horizontal direction = $2\times(\pi\times10^2)/4\times1000$

450

= 349.06 mm^2

But area of minimum reinforcement is 750MM$^{2.}$

Hence provide minimum reinforcement of 0.25% of the gross area of the wall, in the horizontal direction.

Provide 10 dia bars at 450 mm c/c

FIG : Horizontal reinforcement of shear wall

SHEAR WALL DESIGN USING STAAD PRO:

FC : 25.00MPA

FY : 415 MPA

CONCRETE COVER :25MM

MINIMUM REIN FORCEMENT RATIO

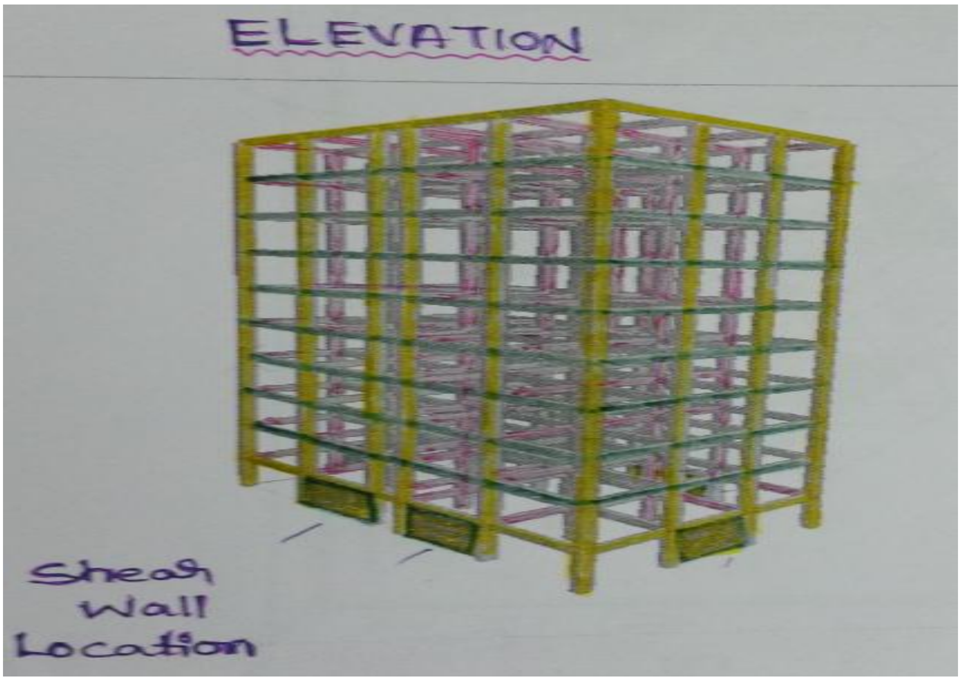
HORIZONTAL :0.00200

VERTICAL :0.00120

WIDTH : 800MM

THICKNESS :230MM

SHEARWALL : DESIGN CODE : IS 456-2000



WIDTH : 4.00 M

HEIGHT : 2.50

THICKNESS : 230.00 MM CONC. COVER : 25.000 MM

EDGE ELEMENTS : MIN. REINFORCING RATIO :

WIDTH : 800.00 MM HORIZONTAL : 0.00200

THICKNESS : 231.00 MM VERTICAL : 0.00120

Load combinations which are used in design:
7-Dead load + Live load
8-1.5(Dead load + Live load)
9-1.2(Dead load + Live load + earthquake X positive direction)
10-1.2(Dead load + Live load+ earthquake X negative direction)
11-1.2(Dead load + Live load+ earthquake Z positive direction)
12-1.2(Dead load + Live load+ earthquake Z negative direction)

DETAIL **OF REINFORCEMENT:**

REINFORCING SUMMARY (REBAR SPACING/AREA UNITS: MM/MM^2)

LEVEL (M) :	LEVEL GOV.LOAD LOADS FOR H/V/E	HORIZONTAL/ HORIZONTAL	VERTICAL/ VERTICAL	EDGE/ EDGE
0.25	7/12/7	8dia @218	36dia@100	8dia
0.50	7/11/7	8dia @218	20dia@450	8dia
0.75	7/11/7	8dia @218	20dia@450	8dia
1	7/11/7	8dia @218	20dia@450	8dia
1.25	7/11/7	8dia @218	20dia@450	8dia
1.5	7/12/7	8dia @218	12dia@25.26	8dia
1.75	7/12/7	8dia @218	12dia@31.58	8dia
2	7/11/7	8dia @218	16dia@48.98	8dia
2.5	7/11/7	8dia @218	12dia@33.33	8dia

NOTE :

- ALL HEIGHTS ARE IN LOCAL COORDINATE SYSTEM OF THE SURFACE.
- NUMBER OF REINFORCING LAYERS IN EACH DIRECTION : 2
- HORIZONTAL AND VERTICAL REINFORCING IS PER LAYER.
- REINFORCING DISTRIBUTION BETWEEN LAYERS IS 50/50.
- EDGE REINF. SHOWN IS PER EDGE. FORMAT IS (NO. OF BARS ALONG THICKNESS + 2 X NO. OF BARS ALONG FACES).

ADVANTAGES OF SHEAR WALLS IN BUILDINGS

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. Shear walls 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 (but had enough well-distributed reinforcement) were saved from collapse.

Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight forward and therefore easily implemented at site.

Shear walls are efficient, both interims of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements like glass windows and building Contents.

CONCLUSION

In this paper both manual design and staad pro design of shear wall are clearly mentioned and their detail reinforcement also given.

Thus shear walls are one of the most effective building elements in resisting lateral forces during earthquake. By constructing shear walls damages due to effect of lateral forces due to earthquake and high winds can be minimized. Shear walls construction will provide larger stiffness to the buildings there by reducing the damage to structure and its contents. Not only its strength , in order to accommodate huge number of population in a small area tall's structures' with shear walls are considered to be most useful.

Hence for a developing nation like India shear wall construction is considered to be a back bone for construction industry.

REFERENCES

[1]. S.K. Duggal in his " Earth quake resistant design of structures" Page no:301 ,8.12 about Shear wall. S.K. Duggal in his " Earth quake resistant design of structures" 8.16 Design of Shear walls

[2]. U.H. Varnayi in his second edition of "Design of structuress" which is also given in Is code 13920:1993 I.S 456:2000As per clause 32, design for wall describes, design of horizontal shear in clause 32.4 given In IS: 13920:1993 it gives the ductile detailing of shear wall .

[3]. Structural analysis and design staad .(staad.pro.v8i) bought by Bentley