"ANALYSIS AND DESIGN OF MULTISTORED BUILDING IN HILLY AREAS USING STADD PRO"

Nikhil Ghuge[1], Neha Shahare[2], Mohini Tupsunder[3], Shivram Totewad[4], Nikhil Gaydhani[5], Kushal Yadav[6]

[1-6]Department of Civil Engineering, Wainganga College of Engineering And Management Wardha Road, Dongargaon, Nagpur, Maharashtra-44114

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Abstract–

India is the most populated country in the world. The on Hill is differ from other building. The Hilly Region is pulling construction industry towards it because most of the plain land is occupied for the purpose of urbanization and industrialization. To fulfill the need of housing for population it becomes to construct multistoried building in hilly region because plain land is scarcely available in urban areas. 3D Analytical model of G+5 is multistoried residential building have been generated and analyzed by using analysis tool "STADD-pro". The drafting and detailing work is done by using drafting software AUTO-cad.
This paper is properly planed Analysis and design the D+5 Residential RCC Building Constructed in hilly region using with IS code 456-2000.

Key Words: housing in hilly areas , STADD-pro, multi storied, AUTO-cad.

1. INTRODUCTION:

Due to increasing in population now a days in hilly region we have to construct multistoried building in hilly areas.

This project is Analysis and Design of hilly area multistoried residential building [G+5] using very popular analytical and designing software STADD-pro. Reason of choosing this software is it gives accuracy of solution, versatile nature of solving of problems, confirmation of IS codes.

Building in hilly area subjected to the lateral earth pressure at various levels in addition to other normal loads as specified on building on level ground. The soil profile is not uniform and the result into total collapse of the building.

The bearing capacity, cohesion, angle of internal friction etc. this project is drafted in drafting software AUTO-cad and after the plan is import in STADD-pro.

1.1 Literature Review

Shaikh imran, P.Rajesh (January 2017): Earth quake Analysis of RCC Building in Hilly:

The performance of irregular plan shaped building with vertical irregularity could prove more vulnerable than the regular plan shaped building with vertical irregularity. On plan ground, setback building attract less action forces as comparing with other configurations on sloping ground which make it more stable and it would not suffer more damages due to the lateral load action. On sloping ground set-step back building attract less action forces as comparing with step back building but if the cutting cost of sloping ground is with acceptable limits then setback building may be preferred. In step back building, the development of storey shear and moment and torsion were more than other configuration which found to be more vulnerable.

Mr. Tamboli Nikhil Vinod, et.al (2017): Stud Of Seismic Behavior Of Multi- Storied RCC Building Resting On Sloping Ground And Bracing System:

The height and length of building in a particular pattern are in multiple of blocks (in vertical and horizontal direction), the size of block is being maintained at 7 m x 5 m x 3.5 m. The height of all floors is 3.5m The depth of footing below ground level is taken as 1.8 m where, the hard stratum is available. The slope of ground is 27 degree with horizontal, which is neither too steep or nor too flat. Basically model consists of two bays with four groups of building configurations. The dynamic analysis is carried out using response spectrum method to the step back and step back and step back building frames. Three dimensional space frame analysis is carried out for four different configurations of buildings ranging from eight, ten and twelve storey resting on sloping ground under the action of seismic load by using E-tabs software. In these way to analysis of these system.

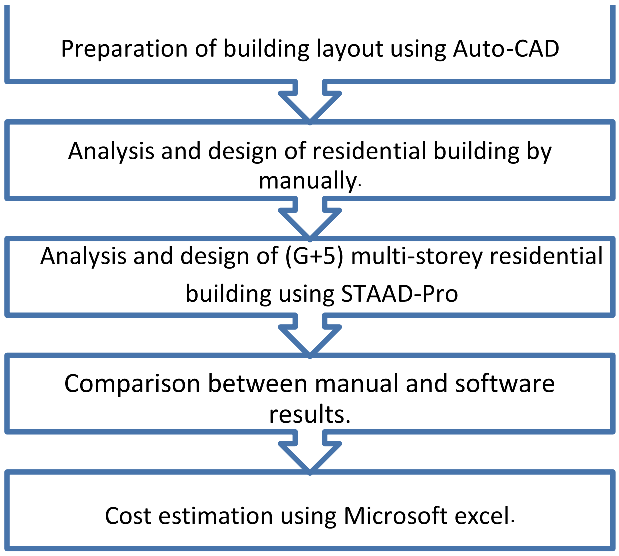
Rahul Manojsingh Pawar (June 2017) : Analysis Of Set Back Step Back Building Resting On Sloping Ground:

Buildings resting on sloping ground have less base shear compared to buildings on Plain ground. Base shear increases as slope of ground increase Buildings resting on sloping ground have more lateral displacement compared to buildings on Plain ground. Buildings with set back – step back is showing less displacement than step back model. Building is showing high value of displacement in z- direction than in x direction. The critical axial force in columns is more on plain ground than on sloping ground. The shear force and moment in columns is more on sloping ground than on plain ground. The shear force and bending moment value in beams is high in plain ground model than on sloping ground model. The performance of set- step back building during seismic excitation could prove more vulnerable than other configurations of Buildings. The development of moments in set - step back buildings is higher than that in the set-back building. Hence, Set back building are found to be less vulnerable building against seismic ground motion. Step back Set back buildings, overall economic cost involved in leveling the sloping ground and other related issues needs to be studied in detail.

Inguva Sai surya prakash, et.al (2018): A Study On Comparative Analysis Of RCC Building Resting On Plain And Hilly Terrain.

Although, the buildings on plain ground attract less action forces as compared to buildings on sloping ground, overall economic cost involved in levelling the sloping ground. In buildings on sloping ground, it is observed that extreme left column at ground level, which are short, are the worst affected. Special attention should be given to these columns in design and detailing. The graph shows that there is significant reduction in bending moments of columns in Z Direction from R.C.C Structure on Plain Ground and Sloping Terrain. Base shear of R.C.C Structure on sloping terrain is very less compared to R.C.C structure plain ground. The storey drift in R.C.C Structure on Plain Ground and Sloping Terrain is nearly equal. This is because; steel structure is more flexible as compared to RCC structure. Bending moment is seem to be reduced due to step up columns in R.C.C Structure on sloping terrain. The bending moment in column is increase at base of frame due to the long column and short column effect in R.C.C Structure on sloping ground. From the study, it is observed that the building which are resting on sloping are subjected to short column effect , attract more forces and are worst affected during seismic excitation. Hence form design point of view, special attention should be given to the size, orientation, and ductility demand of short column

1.2 METHODOLOGY

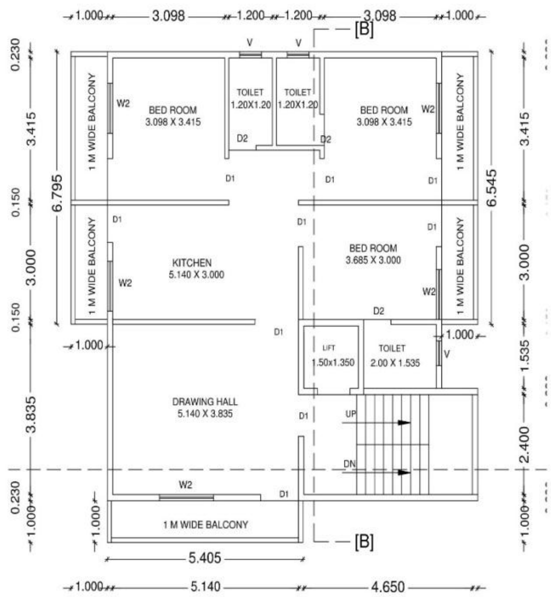


2.0 PROGRESS WORK

2.1 DATA OF THE BUILDING

Type of building: residential building
Type of structure: multi storey R.C.C
No. of storey: 6 (G+5)
Floor to floor height: 3 m.
External wall: 230mm.
Internal wall: 150mm.
Height of the Plinth: 0.6m.
Depth of the footing; 2.3m.

2.2 PLAN OF RESIDENTIAL BUILDING: (AUTO-cad PLAN):



2.3 DESIGN OF BUILDING COMPONANTS:

Slab design:

L_x = 3.288m L_y = 3.87m

L_y/L_x = 1.177 < 2.

hence it is two-way slab.

live load = 2 KN/M^2

modification factor = 1.4

basic value = 20

f_{ck} = 20 N/mm^2 f_y = 415 N/mm^2

b(width) = 1000 mm

Step2. Estimations of slab thickness

As l_x>3.5, and steel is Fe415

L/d = 20 x M.F. =117.43 mm

say d = 150 mm

Assuming covers = 15mm

and 10mm ϕ main

D=d + cover + $\phi/2$ = 170 mm

Step3. Effective span:

l_{ex} = 3.438 m l_{ey} = 4.020m

Step4. loads calculation

self-weight of slab = 1x0.170x25 = 4.25KN/M

floor finish = 1 kN/M

live load = 2 KN/M

total load(w) =9.25 KN/M

factor load (w_d) =1.5x9.25 = 13.875 KN/m

Step5. Factors of bending moments

for X-direction

Mx = α_x x wd x l_{ex}^2

l_y/l_x = 1.1963

interpolation method

l_y/l_x	α_x
1.1	0.075
1.196	x = α_x
1.2	0.084

x = 0.080

Mx = 13.185 KN-M …….1st equation

for Y-direction

My = α_y x wd x

l_{ex}^2 l_y/l_x = 1.196

interpolation method

l_y/l_x	α_y
1.1	0.061
1.196	y = α_y
1.2	0.059

y = 0.0598

My = 9.80 kN-M……2nd equation

Step6. Effective depth of slab

$M_{xd} = Mu_{limit}$

$d_{required}$ =69.11. mm

$d_{required} < d_{available}$,

hence OK

Step7. Area and Spacing of Steel

At X-Direction

$$A_{st} = 0.5\frac{f_{ck}}{f_y}\left(1-\sqrt{1-\frac{4.6M_u}{f_{ck}Bd^2}}\right)Bd$$

Ast_x = 252.40 mm

Ast_{min} =0.12% x b x D

= 204 mm

$Ast_x > Ast_{min}$,

hence provided Ast_x.

spacing of 10 mm ϕ bar

spacing = $\frac{ast\ x\ b}{Ast}$ = 311.20 mm say as spacing = 240 mm …….1st equation

S=3d = 450 mm ……..2nd equation

S=300 mm……..3rd equation

provide minimum value.

At Y-Direction d' = d- ϕ = 140 mm

$$A_{st} = 0.5\frac{f_{ck}}{f_y}\left(1-\sqrt{1-\frac{4.6M_u}{f_{ck}Bd^2}}\right)Bd$$

Ast_y = 200.053mm

$Ast_y < Ast_{min}$,

hence provided Ast_{min}

spacing of 8 ϕ mm

spacing = $\frac{ast\ x\ b}{Astmin}$ = 246.431 mm

say spacing = 225mm

S=3d' = 420 mm

S=300mm

provided minimum value

Step8. check for Shear

maximum shear force in either direction.

1. Vu= $\frac{wd\ x\ lex}{2}$ =23.851 KN
2. $\tau_v = \frac{Vu}{b\ x\ d}$ =0.159 N/mm2
3. τ_{cmax} =2.8 N/mm2

$\tau_v < \tau_{cmax}$.

4. $Ast_p = \frac{ast\ x\ b}{sx}$ = 327.291667 mm²
5. $pt_p = \frac{Astp}{b\ x\ d}$ $x100$ = 0.21819%

interpolation method.

pt	τ_c
0.15	0.28
0.21	x = τ_c
0.25	0.36

X = 0.328 N/mm²

Design shear strength in slab

$\tau_c' = k\ x\ \tau_c$ = 0.41

Thus, $\tau_v < \tau_c'$

Hence OK

Beam Design :

Span(le) = 1.190m

Effective Depth (d) = 450 mm

Depth (D) = 500 mm

Width (b) = 230mm

Flange thickness (Df) = 170 mm

Thickness of Support (t) = 230 mm

f_{ck} = 20 N/mm² f_y = 415 N/mm²

Equivalent udl

Step1. Total Service Load

(W_d) = 24.20 KN/M

Step2. Moment of Resistance

Md= $\frac{W\ x\ l^2}{2}$ = 17.137 KN-M

Step3. Limiting Moment of Resistance

Md1=0.138f_{ck}bd² = 128.54 KN/M

Step4. Comparison of Md and Md1

Md < Md1

Hence Singly Reinforced

Step5. Main Steel

$$A_{st} = 0.5\frac{f_{ck}}{f_y}\left(1-\sqrt{1-\frac{4.6M_u}{f_{ck}Bd^2}}\right)Bd$$

z

Ast = 107.84 mm²

Diameter 8 mm ϕ

bar Area of bars =

50.240 mm^2

Number of bars

= 2.840

Bars Provided = 3 NOS

Ast Provided =150.720 mm^2

Step6. Design of Shear

a) Shear Force, Vu=W x le = 28.798 KN

b) Nominal Shear Stress

$\tau_v = \frac{Vu}{b \times d} = 0.278$

c) τ_{cmax}=2.8 N/mm2

$\tau_v < \tau_{cmax}$, OK

d) Shear strength of concrete, τ_c

$Pt = \frac{Ast}{b \times d} x100 = 0.146\%$

0.150 0.280

0.250 0.360

τ_c = 0.276 N/mm^2

e) As $\tau_v > \tau_c$

Shear Reinforcement is Required.

f) Shear Force

Vus= vu-(τ_c.bd) = 180.40 KN

Vusv=Vus

Provided 6 mm ϕ two legged M.S. Vertical Stirrups

g) Spacing

$Sv = \frac{0.87 fy.Ast.d}{Vusv} = 30664.60$ mm

Check,

01) Minimum Spacing

$Sv \leq \frac{0.87 fy.Ast}{0.4b} = 133.621$ mm

02) Maximum Spacing

0.75d or 300 mm

Provided Spacing 300 mm

Step8. Check for Development length

$Ld_{required} = \frac{0.87 fy\Phi}{4\tau bd} = 169.922$ mm

$Ld_{available}$ = t+(8 ϕ -d') = 253 mm

Step9. Check for Serviceability

Pt required = 0.146

Modification factor = 1.38

Basic L/d (rb) = 7.0

Allowable L/d (ra) = 9.660

Required d=L/d (ra) = 123.188

Design of column

Step1. Axial Load = 2036.12 KN

Step2. Size of column

L = 3000 mm b = 230 mm

Step3. Percentage of steel (Asc)

Pt > 0.8%Pt < 6%

Assuming percentage (%) = 2.0

Asc = 2%Ag = 0.02

Ac=0.02Ag = 0.98

Step4. Depth Required

Pu=0.4fckAc+0.67fyAsc

Ag = 151960.30 mm2

D=Ag/b = 660.70 mm

Provided D =680 mm

Provided Ag = 156400.00 mm^2

Step5.Check for Eccentricity and Slenderness ratio

Le/D = 4.41 Le/D<12 OK

$e_{min} = \frac{L}{50} + \frac{D}{30} = 28.67$ mm

e_{min} > 20 mm

e_{max} = 0.05D =

34.00 mm

$e_{min} < e_{max}$ OK

Step6. Area of Steel and Percentage Steel

Asc required = 3128 mm^2

Bar used 25 mm ϕ

Area of bar =

490.63 mm^2

No. of bars Required = 6.38

No. of bars

Provided=8

Ast Provided = 3925

mm^2

Pt of steel provided = 2.51

Pt>0.8%Pt<6%OK

Step7. Design of transverse steel

a) Diameter of links = $\frac{1}{4}$ x ϕ and

6 mm Greater is 6.25 mm

Say 8 mm dia. of link

b) Spacing

i)least lateral dimension = 680 mm

ii)16ϕ = 400 mm

iii)300 mm

Provided Spacing = 300 mm

Reinforcement Details 8 No.-25mm at 300 mm c/c.

Design of Staircase

Type of slab = Waist slab

Riser =150 mm Tread = 270 mm

Height =3 m

No. of riser = 20nos

No. of riser in each flight=10nos

No. of trends in each flights =9nos

Going(G)=3.115m

Provided width of landing = 0.9m

Width of stair= 1.027m

Live load = 3 KN

fck =20 N/mm^2 fy = 415 N/mm2

Effective span

= Going + half of support + half of support

=3.115+0.9/2+0.9/2

=4.015m

M.F. = 1.6

2.0 Load and bending moment

Assume depth of slab D =170mm
Assume width of slab =1000mm

(a) Load of slab per meter of horizontal span = 4.861KN/m

(b) Steps:

Load on one step=1/2*R*T*25=0.50625KN

Load of step per meter=0.50625*1/0.27=1.875KN/m

(c) Live load=3 KN/m

(d) Floor finish= 1 KN/m

Total load w= 10.7361KN/m

Factored load wd=16.104KN/m

Factored moment Md = 32.450 KN/m

3.0 Depth of slab:

0.138*bd^2*fck = Md

d^2= 11976.27mm

d = 109.4m

Assuming 10mm dia of bar and 25mm cover =139.4mm

139.4mm<170mm OK

Depth required for deflection = 125.46mm

D =170mm

D= 140mm

4.0 Calculate Main Steel

$$A_{st} = 0.5\frac{f_{ck}}{f_y}\left(1-\sqrt{1-\frac{4.6M_u}{f_{ck}Bd^2}}\right)Bd$$

Ast = 718.89 mm^2

Provide 10 mm ϕ bar

Area of bar = 78.54

mm^2

Spacing = $\frac{A\phi}{\ } x1000$

Ast

= 109.25 mm, say 100 mm c/c

5.0 Area of distribution Steel

Astd = 0.15%of b.D

= 225 mm^2

Provide 6 mm ϕ bars

Spacing $= \frac{A\phi}{Astd} x1000$

= 110.82mm say110 mm

(<5d or 450mm whichever is less, <5*120 or 450=4

STAAD.Pro OUTPUT:

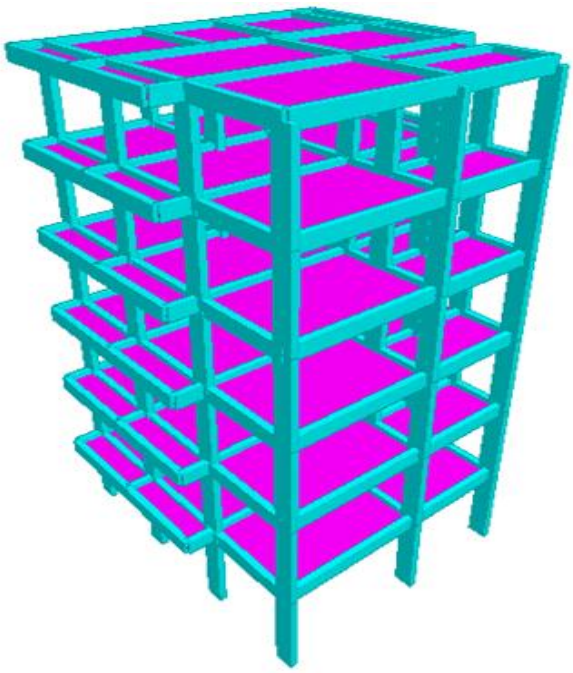


Fig1: 3D rendering model of building plan

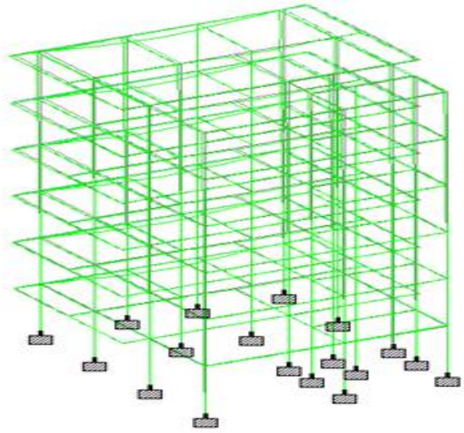


Fig2: Displacement on member

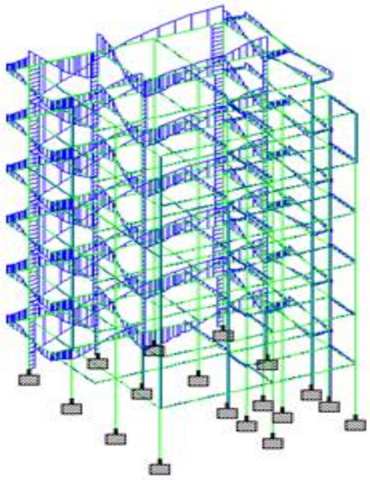


Fig3: Shear force on member

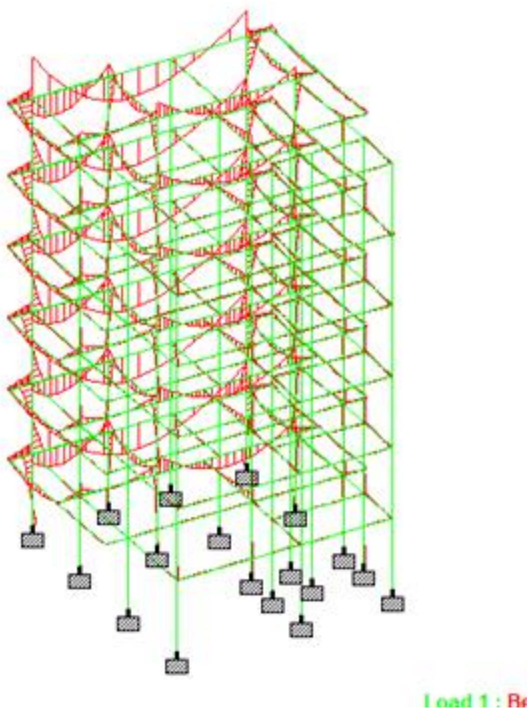


Fig4: Bending moment on member

3. CONCLUSIONS

1. This paper is based on design and analysis multistoried residential building(G+5) using commercial software STAAD-pro.
2. Plan of the building is drafted with the help of the drafting software with required dimensions.
3. We applied different kind of the loads on the building Earthquake load, live load and the respective load combination. We found the structure is capable to sustain applied loads.
4. It is included that with the help of the using software STAAD-pro etc, there is possibility of having stable and safe construction of the structure with the provided load.
5. By using the STAAD-pro software it is easy to get fast, efficient and accurate platform for analyzing and designing software.

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BIOGRAPHIES

Nikhil.B.Ghuge
BE Final year student,
Civil Department,
Wainganga College of Engineering & Management
Nagpur

Neha.Y.Shahare
BE Final year student,
Civil Department,
Wainganga College of Engineering & Management
Nagpur

Mohini.B.Tupsunder
BE Final year student,
Civil Department,
Wainganga College of Engineering & Management
Nagpur

Shivram Totewad
BE Final year student,
Civil Department,
Wainganga College of Engineering& Management
Nagpur

Nikhil Gaydhani
BE Final year student,
Civil Department,
Wainganga College of Engineering & Management
Nagpur

Kushal Yadav
Assistant Professor
Civil Department,
Wainganga College of Engineering & Management
Nagpur