Analysis of G+5 Multistored Building

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ABSTRACT: The design process of structural planning and design requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides the knowledge of practical aspects, such as recent design codes, bye laws, backed up by ample experience, intuition and judgment. The purpose of standards is to ensure and enhance the safety, keeping careful balance between economy and safety. In the present study G+6 building at Ananthapuram is designed (Slabs, Beams, Columns and Footings) using Auto CAD software. In order to design them, it is important to first obtain the plan of the particular building that is, positioning of the particular rooms (Drawing room, bed room, kitchen toilet etc.) such that they serve their respective purpose and also suiting to the requirement and comfort of the inhabitants. Thereby depending on the suitability; plan layout of beams and the position of columns are fixed. Thereafter, the loads are calculated namely the dead loads, which depend on the unit weight of the materials used (concrete, brick) and the live loads, which according to the code IS:456-2000 and HYSD BARS FE415 as per IS:1786-1985. Safe bearing capacity of soil is adopted as 350KN/M² at a depth of 6ft and same soil should extent 1.5 times the width of footing below the base of footing. Footings are designed based on the safe bearing capacity of soil. For designing of columns and beams, it is necessary to know the moments they are subjected to. For this purpose, frame analysis is done by limit state method. Designing of slabs depends upon whether it is a one - way or a two way slab, the end conditions and the loading. From the slabs, the loads are transferred to the beam. Thereafter, the loads (mainly shear) from the beams are taken by the columns. Finally, the sections must be checked for all the four components with regard to strength and serviceability.

I. INTRODUCTION

Buildings come in a wide amount of shapes and functions, and have been adapted throughout history for a wide number of factors, from building materials available, to weather conditions, to land prices, ground conditions, specific uses and aesthetic reasons. A Multi-Storey building is a building that has multiple floors above ground in the building. Multi-storey buildings aim to increase the floor area of the building without increasing the area of the land the building is built on, hence saving land and, in most cases, money (depending on material used and land prices in the area). The design process of multi-stored building requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides the knowledge of practical aspects, such as recent design codes, bye laws, backed up by ample experience, intuition and judgment. The purpose of standards is to ensure and enhance the safety, keeping careful balance between economy and safety. In the present study G+6 building at Ananthapuram, India is designed (Slabs, Beams, Columns and Footings). Architectural is an interdisciplinary field, drawing upon mathematics, science, art technology, social sciences, politics, history and philosophy. Vitruvius states: “architecture is a science, arising out of many other sciences, and adorned with much and varied learning: by the help of which is judgment is formed of those works which are result of other arts”. Most modern-day definition of “good buildings” recognize that because architecture does not exist in a vacuum, architectural form cannot be merely a completion of historical precedent, fictional necessities; and socially aware concerns, but most also be a trance dents synthesis of all of the former and a creation of worth in and of itself. As Nunziarodanini stated, “through its aesthetic dimension architecture goes beyond the functional aspects that it has in common with other human sciences…through its own particular way of expressing values, architecture can stimulate and influence social life without presuming that, in and of itself, it will promote social development. To restrict the
meaning of formalism to art for art’s sake is not only reactionary; it can be a purposeless quest for perfection or originality which degrades fro, into a mere

instrumentally” The term can be used to connect the implied architecture of abstract things such as music or mathematics the apparent architecture of natural things, such as geological formations or the structure of natural things such as geological formations or the structure of natural things such as geological formation or the structure of biological cells, or explicitly planned architectures of human made things such as software, computers, enterprises, and databases, in addition to buildings. In every usages an architecture may be seen as subjective mapping fro, a human perspective (that of the user in the case of abstract or physical artifacts) to the elements or components.

II. LITERATURE REVIEW

Major advances in both design and new material assisted roman architecture. Design was enhanced architectural developments in the construction of arches and roof domes. Arches improved the efficiency and capability of bridges and aqueducts (fewer supports columns were needed to support the structure), while domed roofs not only permitted the building of larger open areas undercover, but also lent the exterior an impressive. he social unit that lives in a house is known as a household. Most commonly, a household is family unit of a same kind, though households can be other social groups, such as single person, or groups of unrelated individuals. Settled agrarian and industrial societies are composed of household units living permanently in housing of various types, according to a variety of farms of lands tenure. English-speaking people generally call any building there routinely occupy “home”. Many people leave their houses during the day for work and recreation, and return to them to sleep or for other activities.

III. DESIGN METHODOLOGY

Design of slab
i) Data:-
Clear span = 4.83 m
Wall thickness = 0.23 m
Live load = 2 kn/m²
Floor finish = 1 kn/m²
Fck = 20 kn/m²
Fy = 415 kn/m²
dx = 4.83 m, dy = 6.02 m
dy/dx = 6.02/4.83 = 1.246 < 2
hence the slab is to be designed as a two way slab.

ii) Thickness of slab :-
Assume effective depth = span/28
= 4830/28
  = 172.5 say 175 mm

Adopting clear cover 20 mm & using 10 mm bars
Overall depth : D = 175 + 20 + 10/2
  = 200 mm

iii) Effective span:-
Least of the following,
Lx = 4.83 + 0.175 = 5.005 m
Ly = 6.02 + 0.175 = 6.195 m
Ly/Lx = 6.195/5.005 = 1.238

iv) Loads :-
Self wt of slab = 0.200 x 1 x 25
= 5 kn/m²  
Live load = 2 kn/m²  
Floor finish = 1 kn/m²  
Total load = 8 kn/m²  
Factored load (W_u) = 1.5 × 8 = 12 kn/m²  

v) Design moments & shear forces :-
The slab is simply supported on all the four sides. The corners are not held down. Hence moment coefficients are obtained from table 27 of IS 456.

α_x = 0.074  
α_y = 0.056  
Mux = α_x ω l_x²  
= 0.074 × 12 × 5.005²  
= 22.24 kn-m  
Muy = α_y ω l_x²  
= 0.056 × 12 × 5.005²  
= 16.83 kn-m  

Factored shear force (V_u) = W_u.l/2  
= 12 × 5.005/2  
= 30.03 KN  

vi) Min depth required :
The minimum depth required to resist the bending moment
M_u = 0.138 f_c k b d^2  
22.24 × 10^6 = 0.138 × 20 × 1000 × d²  
d = √(22.24 × 10^6 /0.138 × 20 × 1000)  
d = 89.76 mm < 175 mm  

vii) Reinforcement :-
Along x- direction
Mux = 0.87 f_y Ast d (1- f_y Ast/ f_c k b d)  
22.24 × 10^6 = 0.87 × 415 × Ast × 175 (1-415 × Ast/20 × 1000 × 175)  
Ast = 368.05 mm²  
Using 8 mm dia bars , spacing of bars
S = ast/Ast × 1000  
= (Π/4 × 8²)/368.05 × 1000  
= 136.57 mm say 130 mm  

Maximum spacing is (1) 3d = 3 × 175 = 525 mm  
(2) 300 mm whichever is less  
Hence, provide 8 mm bars at 130 mm c/c Along y-direction. These bars will be placed above the bars in x-direction  
Hence, d = 175-8 = 167 mm  
Muy = 0.87 f_y Ast d (1-f_y Ast/f_c k b d)  
16.83 × 10^6 = 0.87 × 415 × Ast × 167 (1-415 Ast/20 × 1000 × 167)  
Ast = 289.54 mm²  
Using 8 mm dia bars, spacing of bars
S = ast/Ast × 1000  
= (Π/4 × 8²)/289.54 × 1000  
= 173.6 mm say 170 mm  

Max. spacing is (1) 3d = 3 × 167 = 501 mm  
(2) 300 mm whichever is less  
Hence, provide 8 mm bars at 170 mm c/c
viii) Reinforcement in Edge strip :-
   Ast = 0.12% of gross area
   = 0.12/100 × 1000 × 200
   Ast = 240 mm²
   Using 8 mm dia bars, spacing of bars
   S = ast/Ast × 1000
      = (Π/4 × 8²) / 240 × 1000
      = 209.44 mm say 200 mm
   Max. Spacing is (1) 5d = 5 × 175 = 875 mm
   (2) 450 mm whichever is less
   Hence provide 8 mm bars at 200 mm c/c in edge strips in both directions
ix) Torsion Reinforcement :- Area of reinforcement in each layer
   At = ¾ Astx = ¾ × 368.05 = 276.04 mm²
   Distance over which Torsion reinforcement is to be provided = 1/5 short span
      = 1/5 lx
      = 500/5
      = 100 mm
   Using 6 mm bars, spacing
   S = ast/Ast × 1000
      = (Π/4 × 6²) / 276.04 × 1000
      = 102.43 mm say 100 mm
   Hence provide 6 mm bars at 100mm c/c at all the four corners in four layers
x) Check for deflection :-
   For simply supported slabs basic value of l/d ratio = 20
   Modification factor tension steel F1
   % of steel,
   = Ast/bd × 100
   = (368.05/1000×175) × 100
   = 0.21 %

   Fs = 0.58 × fy = 0.58 × 415 = 240 N/mm²
   From fig 4 of IS 456, modification factor = 1.5
   Maximum permitted l/d ratio = 1.5 × 20 = 30
   L/d provided = 500/175 = 28.6 < 30
   Hence deflection control is safe

B) DESIGN OF BEAM:
1) Data:
   fck =20N/mm²
   fy = 415N/mm²
   l = 6.02N/mm²

2) Depth of beam :
   Selecting the depth in range of l/12 to l/15 based on stiffness
   d = 6020/15
      = 401.33mm
   Adopt d = 410mm
   D = 450 mm

3) Effective span:
C/c distance between the supports = 6.02+0.23
                   = 6.25m
Clear span + d = 6.02+0.41
                   = 6.43m
Hence effective span = 6.25m

4) loads :
     Self weight of the beam  = 0.23x0.45x1x25
                   = 2.58kn/m²
     Load from slab = 8kn/m²
     Total load        = 10.58kn/m²
     Factored load  = 1.5x10.58 =15.87kn/m

5) factored B.M (Mu) & S.F:-
     Factored B.M (Mu) = Wul²/8
                           = 15.62x 6.25²
                           = 77.548kn-m
     Factored s.f (Vu) = Wul/2
                           = 15.882x6.25
                           = 49.63kn

6) Depth required:-
     The min depth req to resist b.m
     Mu = 0.138Fckbd²
          77.548x10⁶ = 0.138x20x250xd²
          D = 349.5 < 410mm
     Hence ok

7) Tension reinforcement:-
     Mu = 0.87 FyAstd(1-FyAst)
     Fckbd
     Ast = 0.87x415xAstx410( 1- 415xAst)
          20x230x410
     Ast = 604.19mm²
     Provide 4 bars of 16ф bars
     Ast provided = 804.248mm²

8) design shear stress :-
     Nominal shear stress (Tv) = Vu/bd
                           = 49.63x10⁴/ 230x410

DESIGN OF COLUMN
     Load from beam = 76.765 KN
     Self wt of column = 0.23x1x25
                   = 5.75 Kn/m
     Total load = 82.515 Kn/m
     Factored load (wu) = 1.5x82.515
                   = 123.77 Kn/m
     Length of column = 3.0 m
     Leff = 0.65 l
               = 0.65x3000
               = 1950 mm
     Check type of the column,
     1950/230 = 8.478 < 12
     Hence designed as a short column.
Side of the column on one side = 230 mm
Net gross area of column is = Ag
Assuming 1% of steel,
Asc = 1% Ag = 0.01 Ag

Area of concrete, Ac = Ag - Asc = Ag - 0.01Ag = 0.99 Ag
For axially loaded short columns,
Pu = 0.4fckAc + 0.67fyAsc
123.77×10³=0.4×20×0.99Ag + 0.67×415×0.01Ag
Ag = 115667.5 mm²
Since the column is rectangular & one side of the column is 230 mm, dimension of the other side
Ag/230 = 115667.5/230 = 502.9 mm say 500 mm
Adopt 230 mm × 500 mm rectangular column,
Asc = 0.01 Ag = 0.01 × 115667.5
= 1156.675 mm²
Provide 6 mm bars of 16 mm diameter,
Asc provided = 1206.4 mm²

Lateral ties :-

a) φ/4 = ¼ × 16 = 4 mm
b) 6 mm
Hence, adopt 6 mm diameter bars
Pitch of the ties shall be minimum of
a) least lateral dimension of column = 230 mm
b) 16 times of the dia of longitudinal bar = 16×16
= 256 mm
c) 300 mm

DESIGN OF FOOTING

a) Data :-
Axial load = 307.068 KN
Size of the column = 280×500mm
S.B.C of soil = 200kn/m²
Fck = 20kn/m²
Fy = 415kn

1) Size of footing:
Load from the column = 307.068kn
Self wt from of footing = 10% of column load = 307.068/10
Total load on the soil =337.775kn
Area of footing = 337.775/200 = 1.689m²
Provide 1.2×1.5m footing so that the cantilever projection of the footing from the column face is same equal to
1.2-0.23 1.5-0.5
(--------) =(--------) = 0.5mm
22
Area of footing provided = 1.2×1.5mm

2) Upward soil pressure:
Factored load Pu = 1.5×307.068

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Soil pressure at ultimate load =
Qu = Pu /area of footing
Qu = 460.602 /1.2×1.5 = 255.89kn/m² = 0.26n/mm

3) Depth of footing from B.M consideration:
The critical section for B.M will be at the face of the column as shown
\[ Mu = qul(B-b/8)^2 \]
\[ =0.16×1500(1200-230/8)^2 \]
\[ = 5.733×10^6N-mm \]

4) Reinforcement:
\[ Mu = 0.87 Fy \times 415 \times Ast \times 450 \times (1-415Ast/20\times1500\times250) \]
\[ Ast =557.25mm² \]
Using 16mm diameter bars, spacing of bars
\[ S = ast \times B / Ast \]
\[ = 304.42mm \]
Hence provide 12mm bars at 300mm/c

5) Check for one way shear:
The critical section for one way shear is at a dist d from the face of the column as shown in the fig ;
Fact S.F = Vu = soil pressure from the shaded area.

IV. CONCLUSION

In the present study G+5 building at Ananthapuramu, is designed (Slabs, Beams, Columns and Footings). The loads are calculated namely the dead loads which depend on the unit weight of the materials used (concrete, brick) and the live loads using the code IS:456 -2000 and HYSD BARS FE415 as per IS:1786-1985. The safety of G+5 reinforced concrete building will depend upon the initial architectural and structural configuration of the total building, the quality of the structural analysis, design and reinforcement detailing of the building frame to achieve stability of elements and their ductile performance. Proper quality of construction and stability of the infill walls and partitions are additional safety requirements of the structure as a whole.

REFERENCES

2. IS: 875(part – 3)- 1987 code of practice for design loads for building and structures.
3. SP: 16 designs for reinforce concrete.
4. Reinforcement concrete design by N.KRISHNA RAJU & R.N.PRANESH
5. Design of reinforced concrete structure by S.RAMAMURTHAM.
6. Internet