Planning, Analysis and Designing of Multi-Speciality Hospital Building

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Abstract— The aim of the project "Planning, Analysis and Design of Multi-Speciality Hospital Building" is to develop a multi-speciality hospital building with economical design using manual design techniques and computer aided design. The project summary report emphasizes the structural analysis and design finding of hospital building. The main scope of this project is to apply class room knowledge in the real world designing of a hospital building there building require large and clear area unobstructed by columns. Here the hospital building is of four story RCC structure with 300 no. of beds and capacity of 22500sq.m which is planned using AUTOCAD for floor plan and STAAD PRO for analysis. The multi-speciality hospital building is located in Avadi. The basic requirements of hospital building is taken from): IS 12433 (part3-2001) and the member are designed using IS 456:2000.

Key words: STAAD PRO, AUTOCAD, Planning, Analysis and Designing

I. Introduction

Hospital is a health care institution providing patient treatment with specialized medical and nursing staff and medical equipment...The medical facility smaller than a hospital is generally called a clinic. Hospital have a range of department (e.g: surgery and urgent care) and specialist units such as cardiology"

Types of hospital:

1) Academic Medical Centre
2) Acute Hospital
3) Ambulatory Surgery Centre
4) Childrens Hospital
5) Clinic
6) Fedral hospital
7) Multi-specialty hospital
8) Government hospital
9) General funded hospital

II. Literature review

A. Literature 1

1) MVK.Sathish etal (2017) :Planning , Analysis and Design of (G+5) Hospital Building using STAAD. Pro

This paper is about design of G+3 hospital building and its facility arrangements reaction to various loads were study using STAAD.Pro . By applying suitable loads and section details to the components to achieve the factors using STAAD.Pro for analysis. The hospital building analysed by a substitute frame using software over manual method and comparative analysis were determined.

The dead loads and live loads were taken from BS6399:1997 and seismic loads intensity is based on equivalent static force in UBC 1994. The result of the building can withstand of any intensity of earthquake located near the epicentre of earthquake. By calculating base shear and displacement along the member indicates variation in different zone using a comparative analysis. The earthquake loads were analysed by equivalent static method with base shear criteria. The G+3 structure was analysed for structure stability towards considered forces.

B. Literature 2

1) Planning, Analysis & Design of Hospital Building Using Staad Prov8

Dr.Ashok kumar N, Navaneethan M, Naviya B, Gopalakrishnan D, Atun RoyChoudhury

The study aims at identifying and optimum structural shape of building which could withstand the forces under consideration. This study shows that STAAD.Pro is more flexible when compared to ETABS software in terms of analysis of structure. The shear force and bending moment over each component of building was calculated for different combination of loads. Beams and columns were modelled as frame elements. It represents the strength and deformation capacity of members and the properties to be assigned are cross sectional dimensions, reinforcement details and the type of materials used are determined.

C. Literature 3

1) IJESRT-Design of g+4 Hospital Building for Earthquake Resistant

J.Sankar, E.V.Raghava Rao, N.Chennakesavulu

This chapter deals with the modelling RC plane frames of G+3 storey building and analysed by using STAAD.Pro. all loads acting on building such as dead load and live load were considered except the wind load. It was assumed that wind load will not governed the demands on the members and storey level. The unit weight of some material are taken from Table 1, IS 875(part-1):1987. To represent the structural aspects of typical frame in a building and exhibit its behaviour under external loading.

D. Critical Summary on Literature

– Adequate space occupied by per person has been determined.
– Based on direction of span, the slab has been designed as one way and two way slab.
– Member forces were determined using structural analysis.
– The planning and designing other facilities are designed on applicable codes as a part of normal professional practice

III. METHODOLOGY

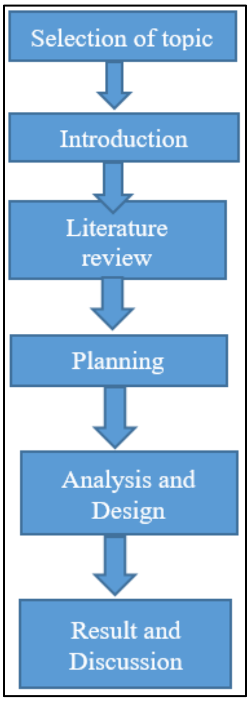

Fig. 1:

IV. PLANNING

Fig. 2: Ground Floor

V. ANALYSIS

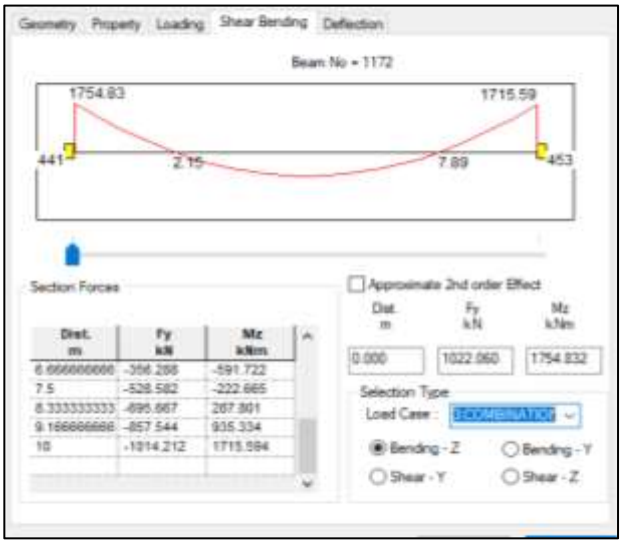

Fig. 3: Reaction of Beam

VI. DESIGNING

No of Slab	11
Slab sizes	10x9m 9x5m 10x5m 10x10m 10x8m 10x12m 5x5m 8x5m 5x4m 10x4m 12x5m
No of Beam	2
Beam size	300mmx600mm
No of Column	3
Column size	450mmx600mm
Footing	1
Footing depth	450mm
SBC	150 kN/mm^2

Table 1: Specification

A. Design of Slab

1) Design of Floor Slab (S_1) (Rectangle)

a) Data For Design

Lx = 9m,

Ly = 10m

Fck =20N/mm^2

Fy = 415N/mm^2

Ly/Lx = 10/9 =1.1.

Therefore it should be designed as two way slab.

b) Cross Sectional Dimension

Effective depth, d =320mm

d' =30 mm

Overall depth, D = 350mm

b =1000mm

c) Effective Span

Effective span = 9320mm

d) Load Calculation

Self-weight of slab = 8.75 kN/m^2
Live load = 2.5 N/m^2
Floor finish = 1 kN/ m^2
Total load = 12.25 kN/m^2
e) Bending Moment & Shear Force
V_u = 85.75x10^3N
M_{ux} =59.13x10^6 N-mm
M_{uy} = 51.1410^6 N-mm
f) Check For Section
M_{ulim} = 282.5X10^6N-mm
M_{ulim}> M_{ux}
The section has to be designed as under reinforced section.
g) A_{ST} Calculation
Ast_x =530mm^2
ast_x =3.14/4X12^2=113mm^2
Spacing =200mmc/c
Provide 12ϕ @ 200mmc/c
Ast_y = 456mm^2
ast_y = 113mm^2
Spacing =200mmc/c
Provide 12ϕ @ 200 mm c/c
h) Distribution Reinforcement
M_{ux} =59.13x10^6 N-mm
i) Distribution Reinforcement
Ast =285mm^2
a_{st} =50.4mm^2
Spacing =150mm c/c
Provide 8ϕ @ 150mm c/c
j) Reinforcement For Edge Strip
L_x/8 =1125mm
L_y/8 =1250mm
k) Torsion Reinforcement
=75 % of Ast_x
=397.5mm^2
Provide 8ϕ @ 100 mm c/c
l) Check For Shear Stress
τ_c =0.26 N/mm^2
P_t = 0.16%
τ_v =0.28N/mm^2
$\tau_v < \tau_c$
Hence it is under reinforcement
m) Check For Service
$(l/d)_{max}$ =36
$(l/d)_{act}$ =28.12
$(l/d)_{max}$> $(l/d)_{act}$
The design is with in permissible limit.

B. Design of Beam

1) Simply Supported (One End Fixed & Other End Continous)

B =300mm
D = 600mm
l =5m
fck =20N/mm^2
F_y = 415 N/mm^2
a) Cross Section Dimension
Effective depth = 250mm
Effective span = 5230mm
b) Load Calculation
Self-weight of beam = 3.45kN/m
Wall =12.42kN/m
Slab load = 54.92kN/m
W =51.26kN/m
W_{ur} = 44.4kN/m
c) Ultimate Moment
$M_{u.max}$ = 140.21kN.m
$M_{u.max}$ = 192.027kN.
$M_{u.max}$>M_u
Section is under reinforcement. Therefore assistance of flange need not to be considered, it can be designed as ordinary beam.
V_u =128.15kN
d) Tension Reinfoceme
A_{st} = 706.21mm^2
a_{st} = 113.04mm^2
No of bars = 4 bars
A_{stpro} = 791.28mm^2
e) Check For Shear Stress
τ_c =0.927N/mm^2
P_t = 57.33%
Refer table 19 of IS 456:2000
τ_v = 0.54N/mm^2
$\tau_c > \tau_v$
Hence shear reinforcement should be provided
V_{us} =84.335x10^3N
S_v = 184.84mm
But spacing of stirrups should not be greater than 0.75xd or 300mm whichever less is
S_v = 412.5mm or 300mm
Provide 10mm dia 2 legged stirrups @300mm centres throughtout length of beam
f) Check For Deflection Control
P_t = 0.57%
(L/d) = 9.0
$(L/d)_{max}$ = 22
=9.09<22
Deflection control is satisfactory.

C. Design of Column

1) Design of Axially Loaded Column

Length, l = 3000mm
Size of column = 450mmx600mm
D_X =600mm
D_Y = 450mm
Characteristic load, P =2325.83 kN
P_u =3488.75kN
M_{20} and F_{e415}
a) Permissile Sresses
F_{ck} =20N/mm^2
F_y =415N/mm^2
b) Check For Slenderness Ratio
l_e = 1950mm
λ_x = 3.25<12
λ_Y = 4.22 <12
c) Check For Eccentricity
e_{ymin} = 26mm > 20mm
e_{miny} = 21mm > 20mm
Allowable eccentricity = 30mm
$e_x > e_{minx}$
hence the eccentricity within limits along X-direction
e_y =23
$e_y > e_{miny}$

Hence the eccentricity within limits along Y-direction
The above column can be designed as short axially loaded column
d) Longitudinal Reinforcement
P_u = $0.4f_{ck}A_c+0.67f_yA_{sc}$
A_g =$270x10^3mm^2$
A_{sc} =$4920mm^2$
Provide 25mm dia bars
a_{sc} = $490.625mm^2$
No of bars =10nos
e) Design Of Lateral Ties
Dia of lateral ties = 6.25mm
f) Spacing
Least lateral dimension = 450mm
16x dia of longitudinal reinforcement = 16x25=400mm
300mm
Choose the least value= 300mm

D. *Design of Footing*

a) Load Calculation
Size of column = 0.23m0.6m
M_{20} and F_{415} grade concrete and steel
Load = 899.67 KN
Self- weight of footing=10%
Total load = 989.637KN
b) Size Of Footing
Area of footing = $6.6m^2$
LxB = 6.6
Assume, L = 1.25B
B = 2.3m
L = 2.88m
Upward soil pressure= $149.40kN/m^2$
c) Bending Moment Calculation
Maximum Bending moment along Y- direction
M_{uy} = 18.61kN-m
Maximum Bending moment along X-direction
M_{ux} =6.45kN-m
d) Depth Of Footing
Assume overall thickness of footing as 500mm
D = 500mm
d =450mm
e) Shear Force
Shear force, V =968.44KN
Normal shear stress:
τ_c =$14.03N/mm^2$
τ_v =$2.8N/mm^2$
$\tau_v < \tau_c$
Hence safe
f) Reinforcement Details
Along X- direction
A_{st} = $113.96mm^2$
Along Y-direction
A_{st} = $280mm^2$
Minimum reinforcement
$A_{st\ min}$ = $540mm^2$
Provide 12mm dia bars
a_{st} = $113.09mm^2$
Spacing = 300 mm
g) Check For One Way Shear
P_t = 0.6%
Refer table 19 of IS456
τ_c =$57N/mm^2$
shear resisted by concrete
V_{uc} = $256.5x10^3N$
X =(2.88-0.6)/2
= 1.1m
Y =1.035m
Shear force, V_u = 145.67KN
$V_{uc} > V_u$
Hence safe in one way shear

E. *Design of Ramp*

Floor height = 3m
Going distance = 4000mm
F_{ck} = $20 N/mm^2$
F_y = $415N/mm^2$
a) Depth Calculation
Span /d = 28
d = 125mm
D = 150mm
b) Effective Span Calculation
Effective span = 7m
Effective width of ramp=1.75m
c) Load Calculation
Self-weight= $5.625kN/m^2$
Live load = $2kN/m^2$
Floor finish = $1kN/m^2$
Total load = $8.625kN/m^2$
Design load =$12.94kN/m^2$
Design of bending moment and shear force calculation
M_u =$4.95x10^6kN/m^2$
Shear force =25.88 N
d) Check For Depth
d_{req} = 34.57mm
$d_{req} < d$
Hence ok
e) A_{ST} Calculation
Ast =$109.69mm^2$
Provide 10mm dia bars
ast =$78.5mm^2$
f) Check For Shear
τ_v =$0.338N/mm^2$
P_t =8%
τ_c = $0.28N/mm^2$
Condition is satisfied

VII. Results & Discussion

1) Implementation of theoretical and class knowledge in real time project.
2) Gathered technical information for designing and analysis of Ramp using codal provisions (APPENDIX A to Part 1191)
3) Manual calculations of design of septic tank.
4) Gained knowledge in designing number of columns manually using computer software.
5) Planning and analysis on each design were determined using codal provisions of (IS 875-part 1&2, IS 456-2000, IS 12433 -part3-2001)

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