Planning, Analyzing and Designing of Hospital Building By Using STAAD Pro

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ABSTRACT

Planning analysis and designing of Hospital Building is our study which is too proposed at Salem dt. The Hospital Building consist of In Ground Floor Ups Room, Waiting Hall, Pharmacy. In first floor Common toilet, Operation theater, Blood bank, Labour ward. In second floor Toilet, MRI Scan, Doctors Break Fast Room, Eye Care, Doctors Community Hall, Special Ward, Drafting method for design the plan is by AutoCAD. The framed type of construction is used for the construction and the designing of structure is carried out by limit state method with the IS 456: 2000 code book. The analysis is carried out by using limit state method STAAD Pro. The availability of men and materials is in local itself. The plan and structural elements are designed using limit state method STAAD Pro and the reinforced details has been obtained slabs and foundation has been designed using STAAD Pro. This study helps us in exploring knowledge about planning analyzing and designing a Hospital Building.

Keywords: Planning, Analysis, Designing, Hospital and Building

1. INTRODUCTION

A hospital is a health care institution providing patient treatment with specialized staff and equipment. Specialized hospitals can help reduce health care costs compared to general hospitals. Hospitals are usually funded by the public sector, by health organizations (for profit or non-profits), health insurance companies, or charities, including direct charitable donations. Types of specialized hospitals include trauma centers, rehabilitation hospitals, children’s hospitals, seniors' (geriatric) hospitals, and hospitals for dealing with specific medical needs such as psychiatric problems (see psychiatric hospital), certain disease categories such as cardiac, oncology, or orthopedic problems, and so forth. A hospital may be a single building or a number of buildings on a campus. Many hospitals with pre-twentieth-century origins began as one building and evolved into campuses. Some hospitals are affiliated with universities for medical research and the training of medical personnel such as physicians and nurses, often called teaching hospitals. Worldwide, most hospitals are run on a non-profit basis by governments or charities. There are however a few exceptions, e.g. China, where government funding only constitutes 10% of income of hospitals specialized hospitals can help reduce health care costs compared to general hospitals. For example, Narayna Hrudayalaya's Bangalore cardiac unit, which is specialized in cardiac surgery, allows for significantly greater number of patients. It has 3000 beds (more than 20 times the average American hospital) and in pediatric heart surgery alone, it performs 3000 heart operations annually, making it by far the largest such facility in the world.

2. DESIGN OF SLAB

\[
\begin{align*}
  f_{ck} & = 25 \text{ N/mm}^2 \\
  f_y & = 415 \text{ N/mm}^2 \\
  \text{Room size} & = 8.0 \times 8.0 \text{ m} \\
  \text{Support} & = 300 \text{ mm} \\
  \text{Thickness of slab} & = 200 \text{ mm}
\end{align*}
\]
2.1 Type Of Slab

\[ \frac{l_y}{l_x} = 8.0 / 8.0 \]
\[ = 1 < 2 \]
Hence designed as two way slab

2.1.1 Load Calculation

Consider 1m width of slab

Live load \( = 5 \text{ KN/m}^2 \)
Self-weight of slab \( = 1 \times b \times D \times \text{unit weight} \)
\( = 1 \times 1 \times 0.20 \times 25 \)
Weight of floor finish \( = 1 \times 1 \times 0.05 \times 20 = 1.0 \text{ KN/m}^2 \)
Total load \( = 11 \text{ KN/m} \)
Design load \( = 11 \times 1.5 = 16.5 \text{ KN/m} \)

2.1.2 Distributor Reinforcement

Provide 8 mm dia bars @ spacing 210 mm c/c

2.1.3 Main Reinforcement

2.1.3.1 For Shorter Span (max moment in shorter span)

Provide 10 mm dia bars @ spacing 140 mm c/c distance

2.1.3.2 For Longer Span

Provide 8 mm ∅ bar at spacing 90 mm c/c

2.2 Design of Beam

Center to center distance \( l_{cd} = 8.30 \text{ m} \)
\( B = 300 \text{ mm}, \)
\( d = 460 \text{ mm} \)
\( D = 500 \text{ mm (assumption)} \)
\( F_y = 415 \text{ N/mm}^2 \) &
\( f_{ck} = 25 \text{ N/mm}^2 \)
\( Q = 3.45 \) &
\( \% A_{st} = 1.197\% \)

2.2.1 Load Calculation

Self-weight of beam \( = b \times D \times \text{unit wt} \)
\( = 0.3 \times 0.5 \times 25 = 3.75 \text{ KN/m} \)
Slab floor finish 1 \( = \text{perpendicular distance} \times tk \times \text{unit wt} \)
\( = 4.0 \times 0.05 \times 20 = 4 \text{ KN/m} \)
Slab self wt 1 \( = 4.0 \times 0.20 \times 25 = 20 \text{ KN/m} \)
Slab floor finish 2 \( = \text{perpendicular distance} \times tk \times \text{unit wt} \)
\( = 2.35 \times 0.05 \times 20 = 2.35 \text{ KN/m} \)
Slab self wt 2 \( = 2.35 \times 0.20 \times 25 = 11.75 \text{ KN/m} \)
Wall load \( = 0.30 \times 3.0 \times 19 = 17.1 \text{ KN/m} \)
Total load \( = 58.95 \text{ KN/M} \)
Factored load \( = 58.95 \times 1.5, F_d = 88.50 \text{ KN/m} \)

2.2.2 Reinforcement Details

• Provide 11 nos of 25 mm dia bars as tension reinforcement

11 nos of 20 mm dia bars as compression reinforcement

• Provide 2 legged 8 mm dia stirrups @ 70 mm c/c

2.3 Design Of Rectangular Column

Size of column \( = 600 \times 600 \text{ mm} \)
2.3.1 Load Calculation

2.3.2 Slab

Wt of slab (1) = $L \times B \times D \times \text{unit wt}$
= 2.7 x 2.2 x 0.20 x 25 = 29.7KN

Wt of slab ff (1) = $L \times B \times D \times \text{unit wt}$
= 2.7 x 2.2 x 0.05 x 20 = 5.94 KN

Live load (1) = 5.0 x 2.7 x 2.2 = 29.7 KN

Wt of slab (2) = $L \times B \times D \times \text{unit wt}$
= 4 x 2.2 x 0.20 x 25 = 44KN

Wt of slab ff (2) = $L \times B \times D \times \text{unit wt}$
= 4 x 2.2 x 0.05 x 20 = 8.8 KN

Live load (2) = 5 x 4 x 2.2 = 44 KN

Wt of slab (3) = $L \times B \times D \times \text{unit wt}$
= 4 x 4 x 0.20 x 25 = 80KN

Wt of slab ff (3) = $L \times B \times D \times \text{unit wt}$
= 4 x 4 x 0.05 x 20 = 16 KN

Live load (3) = 5 x 4 x 4 = 80 KN

Wt of slab (4) = $L \times B \times D \times \text{unit wt}$
= 2.7 x 4.0 x 0.20 x 25 = 54KN

Wt of slab ff (4) = $L \times B \times D \times \text{unit wt}$
= 2.7 x 4 x 0.05 x 20 = 10.8 KN

Live load (4) = 5 x 2.7 x 4 = 54 KN

2.3.3 Beam

Beam (1) = $L \times B \times D \times \text{unit wt}$
= 2.7 x 0.3 x 0.50 x 25 = 10.125 KN

Beam (2) = 2.2 x 0.3 x 0.50 x 25 = 8.25 KN

Beam (3) = 4 x 0.3 x 0.50 x 25 = 15 KN

Beam (4) = 4.0 x 0.3 x 0.50 x 25 = 15 KN

2.3.4 Wall

Wall load (1) = $L \times B \times H \times \text{unit wt}$
= 2.7 x 0.3 x 3.0 x 19 = 46.17 KN

Wall load (2) = 2.2 x 0.3 x 3.0 x 19 = 37.62 KN

Wall load (3) = 4.0 x 0.3 x 3.0 x 19 = 68.40 KN

Wall load (4) = 4.0 x 0.3 x 3.0 x 19 = 68.40 KN

2.3.5 Column

Self-weight of column = $L \times B \times H \times \text{unit wt}$
= 0.6 x 0.6 x 3.0 x 25 = 27 KN

Sum of all above loads = 755 KN

No of floor consideration = 755 x 3 = 2265 KN

2.3.6 Result

Size of column = 600 x 600 mm

Longitudinal reinforcement = 8 nos of 25 mm dia bars

Transverse reinforcement = 6mm dia at 300 mm c/c

2.4 Design of Footing

Size of column = 600 x 600 mm

Safe bearing capacity = 200 KN/m²

$f_k = 30 \text{ N/mm}^2$
Assume the self wt of footing as 10% of the column load

\[ W_1 = \frac{10}{100} \times 2265 = 226.5 \text{ KN} \]

Total load on soil

\[ = 2265 + 226.5 = 2491.5 \text{ say 2500 KN} \]

Area of footing required

\[ = \frac{2500}{200} = 12.5 \text{ m}^2 \]

Since it is a rectangular column

2.5 Tension Reinforcement

Provide 12 nos of 25mm dia bars in long direction at uniform spacing

3. STAAD REPORT

Figure 1 shows the Whole Structure of the Building.

![Figure 1 Whole Structure](image1)

Figure 2 shows the 3D Rendering View.

![Figure 2 3D Rendered View](image2)

Figure 3 shows the Beam 330 Bending Moment.

![Figure 3 Beam 330 Bending Moment](image3)

Figure 4 shows the Beam 330 Shear Force.

![Figure 4 Beam 330 Shear Force](image4)
Figure 5 shows the Beam Identification Diagram.

B E A M N O.     332   D E S I G N  R E S U L T S
M25                    Fe415 (Main)               Fe415 (Sec.)
LENGTH:  5400.0 mm      SIZE:   230.0 mm X  300.0 mm   COVE
R: 25.0 mm
SUMMARY OF REINF. AREA (Sq.mm)
SECTION      0.0 mm     1350.0 mm     2700.0 mm     4050.0 mm     5400.0 mm
TOP         721.40        127.19          0.00          0.00        465.49
REINF.      (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)
BOTTOM         3.78          0.00        185.29        126.72          0.00
REINF.      (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)
SUMMARY OF PROVIDED REINF. AREA
SECTION      0.0 mm     1350.0 mm     2700.0 mm     4050.0 mm     5400.0 mm
TOP       7-12í         2-12í         2-12í-12í         2-12í         5-12í
REINF.  2 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)
BOTTOM     2-12í         2-12í-12í-12í-12í         2-12í         2-12í-12í-12í-12í
REINF.   1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)
SHEAR 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í
REINF. @ 100 mm c/c @ 100 mm c/c @ 100 mm c/c @ 100 mm c/c @ 100 mm c/c
SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT
SHEAR DESIGN RESULTS AT  415.0 mm AWAY FROM START SUPPORT
VY =    42.63 MX = -0.20 LD=    1
Provide 2 Legged 8í @ 100 mm c/c
SHEAR DESIGN RESULTS AT  415.0 mm AWAY FROM END SUPPORT
VY = -37.07 MX = -0.20 LD=    1
Provide 2 Legged 8í @ 100 mm c/c

Figure 6 shows the Beam Concrete Design.
Figure 6 Beam Concrete Design

Figure 7 shows the Column Identification Diagram.

Figure 7 Column Identification Diagram

COLUMN NO. 238 DESIGN RESULTS
M25
LENGTH: 3000.0 mm CROSS SECTION: 300.0 mm X 300.0 mm COVER: 40.0 mm
** GUIDING LOAD CASE: 1 END JOINT: 79 SHORT COLUMN
REQD. STEEL AREA: 1007.57 Sq.mm.
REQD. CONCRETE AREA: 88992.43 Sq.mm.
MAIN REINFORCEMENT: Provide 12 - 12 dia. (1.51%, 1357.17 Sq.mm.)
(Equally distributed)
TIE REINFORCEMENT: Provide 8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
Puz : 1314.77 Muz1 : 46.49 Muy1 : 46.49
INTERACTION RATIO: 0.98 (as per Cl. 39.6, IS456:2000)
SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
WORST LOAD CASE: 1
END JOINT: 79 Puz : 1419.65 Muz : 54.89 Muy : 54.89 IR: 0.77

Figure 8 shows the Reinforcement Diagram.
*************** CONCRETE TAKE OFF ***************
(FOR BEAMS AND COLUMNS DESIGNED ABOVE)

TOTAL VOLUME OF CONCRETE = 112.18 CU.METER

<table>
<thead>
<tr>
<th>BAR DIA (in mm)</th>
<th>WEIGHT (in New)</th>
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<tbody>
<tr>
<td>8</td>
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</tr>
<tr>
<td>10</td>
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<td>12</td>
<td>38923.28</td>
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<tr>
<td>16</td>
<td>32287.48</td>
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</tbody>
</table>

TOTAL= 127159.51

4. DRAWING

Figure 9 shows the Plan of the Hospital Building.

5. CONCLUSION

For most participants, a new vision of care focused on the health of populations. Integration of services and practitioners, continuity of care, and a focus on health promotion and disease prevention would all be supported by new facilities and funding mechanisms. Patient navigators and advocates, along with case management and discharge planning would all work towards keeping people healthy and helping them manage their own care. Participants argue that investments in primary care that works towards this vision will yield savings in the long-term. Some newer hospitals now try to re-establish design that takes the patient's psychological needs into account, such as providing more fresh air, better views and more pleasant colour schemes. These ideas harkens back to the late eighteenth century,
when the concept of providing fresh air and access to the ‘healing powers of nature’ were first employed by hospital architects in improving their buildings.

References


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