Technical development in modern construction industry

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ABSTRACT

The technical development in modern construction industry refers to the uses of computer and information technology to control over the features like doors and interiors. The systems have developed through remote systems with various level of intelligence. Construction appliances are adopted for the reasons of easy and secured life.

KEY WORDS: Technical, Construction industry.

1. INTRODUCTION

In modern construction industry have been increased its efficiency by its technical development in the case of interior design even in the wiring line to electrical power, telephones, TV cable, etc., when we discuss about the home appliances washing machine, refrigerators, bath tubs, water heaters, stove, these all reduce the level of labor consumption. Like this there are several development in the field of construction we will discuss about the technical based development in modern construction industry.

Greenhouse: Green Buildings are high performance structures that also meet certain standards for reducing natural resource consumption.

Characterized:
- Efficient management of energy and water resources
- Management of material resources and waste
- Restoration and protection of environmental quality
- Enhancement and protection of health and indoor environmental quality
- Reinforcement of natural systems
- Analysis of the life cycle costs and benefits of materials and methods
- Integration of the design decision-making process

2. METHODS & MATERIALS

Materials: The materials used in this project are Porotherm bricks, *Moringa oleifera*, Ground source heat pumps, Double glazed windows and Nano solar panel.

Specification:
- **Earthwork excavation:** Before the earth work is started the whole area where the work is to be done. Shall be cleared of grass, roots of trees. The excavation shall be carried out exactly as per drawing dimensions. No materials excavated from foundation trenches shall be placed nearer than one meter to the outer edges of the excavation. The water in trenches must be bailed or pumped out and where it is apprehended that the sides may fall down arrangement shall be made for adequate timber shoring.
- **Sand filling:** Sand is used for filling shall be free from dust, organic and forge in matter. Sand shall be spread uniformly to a layer not exceeding 200mm to the entire filling area. The sand shall be thoroughly saturated in water.
- **Cement concrete:** The mix of the concrete is 1:1/2:3, it shall be laid to a depth of 150mm and should be vibrated by using vibrators and compaction will be done before initial setting time.
- **Reinforcement:** Mild steel bars shall conform to the IS specification, free from loose rust, dust loose mill scales, coats of paints, oil or other coatings which may destroy or reduce bond. It shall be stored in such a way so as to avoid distortion and to prevent corrosion.
- **Walls:** Provide sound shaping devices as required for proper acoustics in the Auditorium. In the Dressing Rooms, Control Booth and Lobby, extend all walls to the deck above.
- **Materials:** Brick shall be porotherm brick of statement specification, regular in shape and size with sharp. Brick shall have an average compressive strength of not less than 100 kg per sq. cm and not more than 125 kg per sq.cm.
- **Mortar:** The brick work shall be done with the specified mortar mixing the ingredients in the specified proportion.
- **Damp proof course:** D.P.C of cement concrete should have a mix of 1:2:4 or 1:1½:3 usual thickness 2.5 cm to 4cm.
- **Lighting:** LED lighting where used which is connected to the window contact sensor and occupancy sensor.
- **Windows:** Windows of sizes 0.9m * 1.2m and 1.5 m * 1.5m are provided at places of building required.
- **Doors:** Doors of composite materials where used of size 1.2m*2.1m.
- **Planning aspects:** The building is planned to be constructed as normal residential building where greenhouse concept is introduced in it for the welfare of the future in terms of water resources, electricity, etc… by using availability of enough resources of our earth. The plan is of 25m² plot area where the nomenclature of our building norms in urban area was selected and according to it the plan was made. The entrance is of east facing and all the vastu was verified and plan was executed for the plot area.
Footing design – limit state method:
Load from column = 100 KN
Column size = 150 x 150mm
Safe bearing capacity = 220 KN
Fck = 20 N/mm^2
Fy = 415 N/mm^2
Self-Weight = 10% of load = 10 KN
Self-weight = 10 KN
Total load = 100 + 10 = 110 KN
Net upward pressure = 80 KN/m^2

Bending moment:
\[ M_u = \text{Load x Distance} \]
\[ D = 370 - 150 = 220 \text{mm} \]
\[ M = \text{Stress x Area} \]
\[ M = 62.5 \text{ KNm} \]
\[ M = Qbd^2 \]
\[ 62.5 \times 10^6 = 2.76 \times 370 \times d^2 \]
\[ d = 247.44 \text{ say 250 mm} \]
Assume effective cover = 50mm
\[ D = d + \text{eff. Cover} = 300 \]
\[ D = 310 \text{mm} \]
For safe against shear the overall depth = 2 x
\[ D = 600 \text{mm} \]
\[ D = 600 - 50 \]
\[ D = 550 \text{mm} \]

To find MU limit:
\[ M_{u,\text{limit}} = Qbd^2 = 2.76 \times 370 \times 550^2 \]
\[ M_{u,\text{limit}} = 0.308 \times 10^9 \text{ N/mm}^2 \]
\[ M_{u,\text{limit}} = 308.9 \text{ KNm} \]
\[ M_u < M_{u,\text{limit}} \]
So, it’s under reinforced
\[ M_u = 0.87 \times f_y A_s t \]
\[ 62.5 \times 10^6 = 0.87 \times 415 \times A_s t \]
\[ A_s t = 173.1 \text{mm}^2 \]
Assume, 20mm
\[ A_s t = 314.159 \text{mm}^2 \]
No. of rods = 7.41 = 8 nos
No. of rod = 8 nos of each direction

Result:
Size of column = 150 x 150mm
Size of footing = 2.5 x 2.5m
To provide 8 nos of 20mm rod for each direction @ 300mm c/c.

Lateral ties:
Assume 6mm dia
\[ \frac{1}{4} \times d = \frac{1}{4} \times 20 = 5 \text{mm} \]
So we take 6mm \( \phi \) ties

Pitch:
LLD = 150mm
16xd = 16 x 20 = 320mm
300mm
6mm \( \phi \) ties @ 300mm c/c.
Result:
Size of column = 150 x 150mm
Size of footing = 2.5 x 2.5m
To provide 8 nos of 20mm rod for each direction @ 300mm c/c.

Column Design – Limit State Method:
Load from beam = 13 KN/m
Clear length = 3.4m
Fck = 20 N/mm²
Fy = 415 N/mm²
Load = 44.2KN ~ 45KN
Load = 45 x 1.5 = 67.5 ~ 70
Design load = 70KN
AC = Ag – Asc
Asc = 0.2% of Ag
AC = Ag – 0.02 Ag = 0.98 Ag
AC = 0.98 Ag
Pu = 0.4 fck AC + 0.67 fyAsc
1300 x 10³ = 0.4 x 20 x 0.98 Ag + (0.67 x 415 x 0.02 Ag)
Ag = 97.01 x 10³ mm²
a = 141.46mm ≈ 150mm
Ag = 150 x 150 = 22.5 x 10³ mm²
AC = 22.5 x 10³ – Asc
Pu = 70 x 10³ = 0.4 x 20 x (22.5 x 10³-Asc) + 0.67 x 415 x Asc
Asc = 236.97mm²
Assuming 20mm rod
A = 314.2mm²
No. of rods = 3.74 ≈ 4 nos
Asc (used) = 4 x 314.2 = 1256.8mm²
% of steel = 1.02%
Min% of steel = 0.8% < 1.02%
Max % of steel = 4% > 1.0.2%
So it’s safe

Beam Design - Limit State Method:
Clear span = 3m
Wall thickness = 230mm
Fck = 20 N/mm²
Fy = 415 /mm²
Effective depth = span/20
d =150mm
D= 200mm
b=150mm
Effective span = clear span + effective depth = 3.15m

<table>
<thead>
<tr>
<th>Lateral Ties</th>
<th>Pitch</th>
<th>Main Rod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume 6mm dia</td>
<td>LLD = 150mm</td>
<td>To provide 4 nos 20mm rod</td>
</tr>
<tr>
<td>¼ x d = ¼ x 20 = 5mm</td>
<td>16xd = 16 x 20 = 320mm</td>
<td></td>
</tr>
<tr>
<td>So we take 6mm φ ties</td>
<td>300mm</td>
<td></td>
</tr>
<tr>
<td>6mm φ ties @ 300mm c/c</td>
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</tbody>
</table>

Table.1. Specifications

Loads:

<table>
<thead>
<tr>
<th>Dead Load</th>
<th>Imposed Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall load = 3.75KN/m</td>
<td>Live load = 2 KN/m</td>
</tr>
<tr>
<td>Self-weight of slab = 2.5 KN/m</td>
<td>Design load= 3 KN/m</td>
</tr>
<tr>
<td>Self-weight of beam = 0.75 KN/m</td>
<td></td>
</tr>
<tr>
<td>Total load = 7 KN/m</td>
<td></td>
</tr>
<tr>
<td>Design Load =1.5 x 7 = 10.5 KN/m</td>
<td></td>
</tr>
</tbody>
</table>
To find moment:-

Middle of end span
- \[ M_1 = 0.87f_y A_s (d - f_y A_s / F_{ck bd}) \]
- \[ M_1 = 87.24 \text{ KNm} \]

Near Of End Support
- \[ M_2 = 0.87f_y A_s (d - f_y A_s / F_{ck bd}) \]
- \[ M_2 = -72.274 \text{ KNm} \]

Check For Depth:
- \[ \mu_{\text{limit}} = Q_{bd}^2 = 2.76 \times b d^2 \]
- \[ 87.24 \times 10^6 = 62.1 \times 10^6 \]
- So, it’s safe for depth

\[ A_s: \]
- \[ \mu = 0.87 f_y A_{s1} \]

IST Moment:
- \[ A_{s1} = 478.79 \text{ mm}^2 \]

IND Moment:
- \[ A_{s2} = 308.83 \text{ mm}^2 \]
- Assume 20mm dia
- \[ A_s = 315.20 \text{ mm}^2 \]
- No. of rod = 7.49 \sim 8 \text{ nos}
- Provide 8 nos of 20mm rod
- No. of rod = 4.9 \sim 5 \text{ nos}
- Provide 5 nos of 20mm rods

3. RESULT

Middle of end span
- \[ M_1 = 87.24 \text{ KNm} \]
- \[ A_{s1} = 478.79 \text{ mm}^2 \]
- Provide 8 nos of 20mm rods

ii) Near of next to end support
- \[ M_2 = (-) 65 \text{ KNm} \]
- \[ A_{s2} = 308.78 \text{ mm}^2 \]
- Provide 5 nos of 20mm rods.

Design of One Way Continuous Slab

Side radio:
- The side radio of each panel = 42.88/8.4 = 5.17 > 2
- The slab is designed as one way continuous slab.

Depth required for stiffness:
- C/c distances of support = 3m
- Basic value of l/d ratio = 26
- Assume modification factor of 1.15
- Effective depth of required = 3000 / (26*1.15)
- \[ D = 100 + 15 + (10/2) = 120 \text{ mm} \]
- \[ d = 100 \text{ mm} \]
- Provide a clear cover of 15mm and 10mm dia as main reinforcement.

Load:
- Consider 1m width of slab
- Live load = 1 * 1 * 3 = 3KN/m
- Dead load = 1 * 1 * 0.12 * 25 = 3KN/m
- Weight of floor finish = 1KN/m
- Total load = 7KN/m
- Design load = 10.5KN/m
Maximum B.M at support next to end support.
M_{max} = \frac{WF}{10} - \frac{WF}{10} = -0.69*3^2/10 - 0.69*3^2/9
= -9.081 + 11.64
= -21.45 kN.m

Depth required for strength
f_{ck} = m_{15} and f_y = f_{e415}
Effective depth required \( d = \sqrt{21.45*10^6/2.07*1000} = 101.8 \text{mm} < 105 \text{mm} \)
Hence ok

Design bending moment

- **B.M. near middle of end span**
  \( M_1 = \frac{w_1^2}{12} + \frac{w_1^2}{10} = 17.30 \text{ KNm} \)

- **B.M. at middle of end span**
  \( M_2 = \frac{w_1^2}{16} + \frac{w_1^2}{12} = 14.98 \text{ KNm} \)

- **B.M. at support next to end support**
  \( M_3 = -21.45 \text{ KNm} \)

- **B.M. at interior support**
  \( M_4 = \frac{w_1^2}{12} + \frac{w_1^2}{9} = -19.98 \text{ KNm} \)

**BM at end support with partially fixity**
\( M_5 = -8.15 \text{ KNm} \)

**Main Reinforcement – Area of Steel**

- **Area of Steel Required At Section 1:**
  \( Mu = 0.87fyAst \left( d - \frac{fyAst}{Fckbd^2} \right) \)
  \( Ast_1 = 530.61 \text{ mm}^2 \)

- **Area Of Steel Required At Section 2:**
  \( Mu = 0.87fyAst \left( d - \frac{fyAst}{Fckbd^2} \right) \)
  \( Ast_2 = 448 \text{ mm}^2 \)

- **Area Of Steel Required At Section 3:**
  \( Mu = 0.87fyAst \left( d - \frac{fyAst}{Fckbd^2} \right) \)
  \( Ast_3 = 692.2 \text{ mm}^2 \)

- **Area Of Steel Required At Section 4:**
  \( Mu = 0.87fyAst \left( d - \frac{fyAst}{Fckbd^2} \right) \)
  \( Ast_4 = 230 \text{ mm}^2 \)

**Spacing of main bars:**

- **Spacing Of 10mm Dia Bars**
  \( S_1 = 145 \text{ mm} \)
  \( S_2 = 175 \text{ mm} \)
  \( S_3 = 110 \text{ mm} \)
  \( S_4 = 120 \text{ mm} \)
  \( S_5 = 340 \text{ mm} \)

**Distribution:**

- Area steel required = 150 mm^2
- Assume 8mm dia bars as distribution
- Spacing = 50\*1000/120 = 330 mm
- Maximum permitted spacing = least of 5d and 450 mm = 525 and 450 mm
- Provide 8mm dia Fe415 distributors at 330 mm c/c

**Check for shear:**

- \( V_u = 39770 \text{ N} \)
- Nominal shear stress = 0.678 N/mm^2
- 0.378 < 0.511 N/mm^2
- Hence slab is safe.

**Check for stiffness:**

- Area to be provided = 692.2 mm^2
- Area of steel required = 714 mm^2
- \( F_s = 233.35 \text{ N/mm}^2 \)
- \( MF = 99.36 \text{ mm} \)
- 105 > 99.36 mm
Hence Safe

Design of Two Way Slab
- Ly/Lx=1.28<2

Since it is two way slab

Depth of slab
- Depth = span /25 =140mm
- d=140mm
- D=165mm
- Effective span:
  - Effective span = clear span + effective depth =3.64mm

Load:
- Self-weight = 4.125KN/m²
- Live load = 4KN/m²
- Floor finish =0.6 KN.m²
- Total = 8.725 KN/m²
- Ultimate load = 13.08KN/m²
- Check for depth:
  - Mu (max) =0.138fckbd²
  - d=69.53mm<140mm
  - Hence sufficient.

Reinforcement:
- Mu=0.87fyAst (d-fyAst/Fckbd²)
- Ast= 980mm²
- Adopt 10mm dia bar at 250mm c/c
- Ast=213mm²

Check for shear stress:
- τv=Vu/bd= 0.17N/mm²
- Pt=100Ast/bd = 0.225
- Refer table from IS456
- kτ=0.39N/mm²>τv

Check for deflection:
- l/d=20
- l/d(max)=32
- l/d(actual)=26<32
  - Deflection checked.

Reinforcement at edge stirrups:
- Ast= 0.12% = 198mm² / m
- Provide 10mm dia bars at 300mm c/c.
- Ast= 262mm²

Design of staircase:
- R=160mm
- T=300mm
- Floor height=3.2
- No.of rise=20
- No of each flight=10
- No of treats=9
- Going length=2700
- Width of landing slab=1150mm
- Width of flight=1150mm

Effective span:
- Overall length=5200mm
- Provide (D)=265mm
- D=240mm

Load calculation:
- load on going:
• wn = 25x0.265 = 6.625KN/m
• ws = wn/t/√t+R²
• = 7.5KN/m
• Dead load on steps = 2KN/m
• Finishes = 0.5KN/m
• Live load = 3KN/m
• Total load = 13kN/m

Load on landing slab:
• Dead load of landing = 6.625KN/m
• Floor finish load = 0.5KN/m
• Live load = 3KN/m
• Total load = 10.125KN/m
• Finish load = 15018KN/m

Bending moment & shear forces:
• RA+RB = 91.06KN
• Vu = RA = RB = 45.53KN
• Mu = 63.16KNm
• d = √mu/Qb = 151.2 < 240mm

Find Ast:
• Mu = 0.87fyAst (d-fyAst/Fckbd²)
• Ast = 781.73mm²
• S = 350mm
• Ast(pro) = 897.59mm²
• Provide 20mm@350mmc/c

Distribution of steel:
• Ast = 318mm²
• S = 230mm
• 10mm dia @ 230mmc/c

Check for shear:
• v = 0.19N/mm²
• Pt = 0.37
• v < c  normal shear

4. CONCLUSION
Usage of porotherm bricks made the construction so easy and strength and stability will be maintained. With the help of sensors there will be much security to the house. Waste water with low turbidity can recycle and used effectively with the use of natural coagulants. Dead load of the building will be low. Capital cost of the building will be the same as normal residential building but maintenance cost will be much low as compared to the normal residential building. After 5 years there will be about 85% in the maintenance cost of the building. Thus the plan of building is made using AutoCAD, analyzed using STAAD. Pro and designed manually for green building concept and home automation system with varying cross-sectional depths.

REFERENCE


