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Design of Preheater Building

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Abstract:

Cement industry in the present scenario is under pressure due to increased competition, rising input costs, lower realisation and reducing profit margins. The need of the hour is to offset the continual increase in input costs and minimizing the producing cost through optimized operations. This can be achieved by incorporation of modern processing techniques in cement production. The present paper highlights the available modern processing design of preheater building in seismic environment s in the different areas of cement production and their expected benefits.

I. INTRODUCTION

Concrete is the most widely used building material now-a-days. Its properties greatly depend on the proportions and properties of its constituents. As cement is the major component of concrete and usually has relatively low unit cost, the selection of its proper type and use has vital importance in obtaining the balance of its desired properties in most economical way for any particular concrete mix. Type I/II Portland cements, which can provide sufficient levels of strength and durability, are the most common cements used by concrete users. However, some situations require the use of special cements to provide advanced levels of properties. For example, the need for high-early strength cements in pavement repairs and the use of blended cements in hostile environments with aggregates subjected to alkali-aggregate reactions are examples of such situations. The selection involves the exact knowledge of the connection between cement and performance required and, in particular, between kind of cement and either strength or durability or both the properties of concrete.

ASTM C 150 defines Portland cement as "hydraulic cement (cement that not only hardens by reacting with water but also forms a water-resistant product) produced by pulverizing clinkers consisting essentially of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulphate as an inter ground addition." Clinkers are small balls (diameters, 5-25 mm) of a fused material that is formed when a raw mixture of prearranged composition is heated to very high temperatures. The low cost and common availability of the limestone, shale and other naturally occurring raw materials make Portland cement one of the most economical materials extensively used over the previous century throughout the world. Concrete becomes one of the most adaptable construction materials available in the world. The production and composition of Portland cements, its hydration processes, and its chemical and physical properties have been frequently studied and researched.

II. RELATED WORK

Viswanath K.G et al (2010) studied on seismic analysis of steel braced reinforced concrete frames. The author studied, the seismic performance of reinforced concrete (RC) buildings rehabilitated using concentric steel bracing were investigated. For peripheral columns the bracings were provided. A 4 storey building was analyzed for seismic zone IV as per IS 1893: 2002 using STAAD Pro software in this paper. It was examined the effectiveness of various types of steel bracing in rehabilitating a 4 storey building. The seismic performance of the rehabilitated building was studied on the effect of the distribution of the steel bracing along the height of the RC frame. In terms of global and story drifts the performance of the building was evaluated. The downgrading percentage in the lateral displacement was founded out. The author concluded that the X type of steel bracing significantly contributed to the structural stiffness and reduces the maximum inter storey drift of the frames.

P.N.Sapkal, et.al. Presents an approach for the optimisation of air preheater design with inline & staggered tube arrangement. Air preheaters are designed to meet performance requirements with consideration of highly influencing parameters viz. heat transfer, leakage and pressure drop. The performance of tubular air preheater is evaluated with the help of CFD analysis for In-line & staggered tube arrangement with the latter being more thermally efficient. Thawan Sucharitakul et.al,. studies the performance of cross-flow heat exchanger, known as the primary air heater in a 300 MW lignite-fired power plant under particulate, no leakage, and leakage conditions. The leakage values of selected primary air heater were 6.31, 7.37, and 7.65 % when the power plant was run at the manufacturer guaranteed turbine generator capacity of 100, 80, and 60 % respectively. Under these conditions, the gas side efficiency of the selected primary air heater was found to be at the low level of 66.83, 65.44, and 62.12 % and X-ratios were 0.92, 0.88, and 0.79 respectively.

Rakesh Kumar&sanjay jain, here the performance of regenerative air pre heater has been evaluated at off design conditions. To assess the performance at different operating conditions and leakage rate, a regenerator leakage model is proposed. The performance improvements of existing non-performing air preheaters are discussed in brief. The performance improvement by improving element profile at cold end of an existing air preheater has been presented. With the change in element profile at cold end air side temperature can be increased up to 10°Cand gas side temperature can b e reduced up to 8.5°C. Bostjan Drobnic, et.al. They used a combination of fluid dynamics and a newly developed three-dimensional numerical model for heat transfer as the basis for a theoretical analysis of a rotary air preheater. The model enables studies of the flue-gas flow through the preheater and the adjoining channels as well as the regenerative heat transfer and the resulting temperature distribution in the matrix of the preheater. In MPM they are operating the boiler without air preheater, from literature review it is found out that for every 20°C rise in combustion air the efficiency of the boiler will increase by 1%. Reduction of flue exit temperature will also helps in reduction of harmful gases up to certain extent, also results in lesser coal consumption.

III. DESIGN METHODOLOGY

STRUCTURAL DESIGN

A structure can be defined as a body, which can resist the applied loads without appreciable deformations. Civil engineering structures are created to serve soma specific like, Human habitation, transportation, bridges, storage etc. in safe and economical way. A structure is assembling of individual elements like pinned elements (truss elements), beam elements, column, shear wall slab able or arch. Structural engineering is concerned with the planning, designing and the construction of structures. Structural analysis involves the determination of the forces and displacements of the structures or components of a structure that make up the structural system. The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

The objectives of the design are,

- Slab Design.
- Beam Design.
- Column Design.
- Footing Design.

DESIGN OF SLAB

Slabs are plane structural members forming floors and roofs of building whose thickness is quit small compared to their other dimensions. These carry load primarily by flexure and are in various shapes such as square , rectangular , circular and triangular in buildings , tanks etc. inclined slabs may be used as ramps for multistoried as parking . A staircase is considered to be an inclined slab.

Slab may be supported by beam or walls and be simply supported or continuous over one or more supports. When the ratio of the length to the width of a slab is more then

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2, and then most of the load is carried by shorter span and in such a case is known as one-way in case the ratio is less than 2 then it is called a two-way slab, which is further classified as restrained and simply supported and simply supported slabs. The various other types of the slabs are flat slabs, which rest directly on columns with beams and grid floors or ribbed slabs.

The thickness of the reinforced concrete slabs ranges from 75mm to 300mm slabs are designed just like beams keeping the breadth of slab as unity depending on the system of units. Thus the total is assumed to the consisting of strips of unit width compression reinforcement is used only in exceptional basis in a slabs. Shear stress in a slab are very low and hence shear reinforcement is never provided and if necessary it is preferred to the increase the depth of the slab to reduce the stress than providing the reinforcement . Temperature reinforcement is provided at right angles to the main longitudinal reinforcement in a slab. The design of the slab is purely is accordance with the code IS-456 the designing process of the slabs the following assumption are made. M20 Concrete and Fe415 steel is used both for design and execution purpose

- The overall depth of the slab is restricted to 150mm with a clear cover of 20mm.
- The main reinforcement consists of steel bars and temperature reinforcement consists of mild steel bars.
- The total depth of the section is obtained from the maximum bending moment of all moments of the span

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
d = 172.5 say 175 mm
Adopting clear cover 20 mm & using 10 mm bars
Overall depth ; D = 175 + 20 + 10/2
D = 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 × 1 × 25
= 5 kn/m²
Live load = 2 kn/m²
Floor finish = 1 kn/m²
Total load = 8 kn/m²
Factored load (Wu) = 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.

$\alpha_x = 0.074$
$\alpha y = 0.056$
$Mux = \alpha_x \ \omega \ l_x^{\ 2}$
= 0.074×12×5.005²
= 22.24 kn-m
$Muy = \alpha y \ \omega \ l_x^{\ 2}$
= 0.056×12×5.005²
= 16.83 kn-m
Factored shear force (Vu) = Wu.l/2
= 12×5.005/2
= 30.03 KN

vi) Min depth required :-

The minimum depth required to resist the bending moment
Mu = 0.138 fck b d²
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 fy Ast d (1- fy.Ast/ fck.bd)
22.24 × 10^6 = 0.87×415×Ast×175 (1-415×Ast/20×1000×175)

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$Ast = 368.05\ mm^2$
Using 8 mm dia bars , spacing of bars
S = ast/Ast × 1000
$= (\Pi/4\times 8^2)/368.05 \times 1000$
= 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 fy Ast d (1-fy.Ast/fck.bd)
16.83 × 10^6 = 0.87 × 415 × Ast × 167 (1-415Ast/20×1000×167)
$Ast = 289.54\ mm^2$
Using 8 mm dia bars, spacing of bars
S = ast/Ast × 1000
$= (\Pi/4\times 8^2)/289.54 \times 1000$
= 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
$Ast = 240\ mm^2$
Using 8 mm dia bars, spacing of bars
S = ast/Ast × 1000
$= (\Pi/4\times 8^2)/240 \times 1000$
= 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
$At = ¾\ Astx = ¾ \times 368.05 = 276.04\ mm^2$
Distance over which Torsion reinforcement is to be provided = 1/5 short span
= 1/5 lx
= 5005/5
= 1001 mm

Using 6 mm bars, spacing
S = ast/Ast × 1000
$= (\Pi/4\times 6^2)/276.04 \times 1000$
= 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 %
$Fs = 0.58 \times fy = 0.58 \times 415 = 240\ N/mm^2$
From fig 4 of IS 456, modification factor = 1.5
Maximum permitted l/d ratio = 1.5 × 20 = 30
L/d provided = 5005/175 = 28.6 < 30
Hence deflection control is safe

DESIGN OF BEAMS

A reinforcement concrete beam should be able to resist tensile, compressive and shear stresses induced in it by the on the beam. Concrete is fairly strong in compression but very weak in tension. Paint concrete beams are thus limited in carrying capacity by the low tensile strength .steel is very strong in tension. Thus, the tensile weakness of concrete is overcome by the provision of reinforced steel in the tension zone round the concrete to make a reinforced concrete beam.

The beams and slabs in concrete structure are cast monolithic. Hence the structure becomes a slab, which is stiffened by concrete ribs in which the intermediate beams act as ―T‖ beam, and beams round the stair case. Lift openings. Supports frames, etc.act as ―L‖ beams. The portion of the slab that acts as a flange of T or L beams on its own thickness and span.

For a T- beam or L – beam action the following condition shall be satisfied:

1) The slab shall be cast integrally with the web, or the web and the slab shall be effectively bounded together in any other manner.
2) If the main reinforcement of the slab is parallel to the beam, the transverse reinforcement shall not be less than 60% of the main rein for cement and at mid span of the slab.

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 = 0.23×0.45×1×25

= 2.58kn/m²

Load from slab = 8kn/m²

Total load = 10.58kn/m²

Factored load = 1.5×10.58 =15.87kn/m

5) factored B.M (Mu) & S.F:-

Factored B.M (Mu) = Wul²/8

= 15.62× 6.25²

= 77.548kn-m

Factored s.f (Vu) = Wul/2

= 15.882×6.25

= 49.63kn

6) **Depth required:-**

The min depth req to resist b.m

Mu = 0.138Fckbd²

77.548×10^6 = 0.138×20×250×d²

D = 349.5 < 410mm

Hence ok

7) **Tension reinforcement**:-

Mu = 0.87 FyAstd(1-FyAst)

Fckbd

Ast = 0.87×415×Ast×410(1- 415×Ast)

20×230×410

Ast = 604.19mm²

Provide 4 bars of 16ф bars

Ast provided = 804.248mm²

8) **design shear stress** :-

Nominal shear stress (Tv) = Vu/bd

= 49.63×10^3/ 230×410

DESIGN OF COLUMN

Load from beam = 76.765 KN

Self wt of column = 0.23×1×25

= 5.75 Kn/m

Total load = 82.515 Kn/m

Factored load (wu) = 1.5×82.515

= 123.77 Kn/m

Length of column = 3.0 m

Leff = 0.65 l

= 0.65×3000

= 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‖

Assming 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) ф/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

$$\left(\frac{1.2-0.23}{2}\right) = \left(\frac{1.5-0.5}{2}\right) = 0.5mm$$

Area of footing provided = 1.2×1.5mm

2) Upward soil pressure:

Factored load Pu = 1.5 ×307.068
= 460.602kn
Soil pressure at ultimate load =
Qu = Pu/area of footing
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 c 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 ×415×Ast × 450 (1-415Ast/20×1500×250)
Ast =557.25mm²
Using 16mm diameter bars, spacing of bars
S = ast ×B / Ast
= 304.42mm
Hence provide 12mm bars at 300mmc/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.

CONCLUSION

The cement production cost depends on the adopted production process. The wet process cannot defeat the dry process as regards energy consumption. At the technical level of quality and productivity, there is no reason why the adoption of the dry process should be impeded. The improvement of a cement plant, however, needs large investment. The timing of the investment of process improvement must be carefully determined taking into consideration the budgetary condition of enterprises and the outlook of the cement market.

As technology and engineering adoptions are advertising new methodology of interlinking and completing the industries via computer applications are created with a similar improvement in hardware capacities. This is turn facilities the implementations of more effective and professional engineering software. As the applications adventure in functionality, one can hope that they will be more affordable to promote their widespread usage amongst civil engineering at a global scale.

REFERENCES

1. Reinforced concrete design with FRP composites by Hota V. S. GangaRao, Narendra Taly, P. V. Vijay.
2. Composite materials: testing and design by Ravi B. Deo, Charles R. Saff.
3. Composite materials in concrete construction by Ravindra K. Dhir, Kevin A. Paine, Moray D. Newlands.
4. Is: 456-2000 design for reinforced.
5. IS: 875(part – 3)- 1987 code of practice for design loads for building and structures.
6. SP: 16 designs for reinforce concrete.
7. Reinforcement concrete design by N.KRISHNA RAJU & R.N.PRANESH
8. Design of reinforced concrete structure by S.RAMAMURTHAM.