

Design and Analysis of RCC silo

Hemesh JS¹, Surya Prakash S², Adlin Rose R³

¹U.G. student, Department of Civil Engineering, St. Joseph's College of Engineering, Chennai, Tamil Nadu

²U.G. student, Department of Civil Engineering, St. Joseph's College of Engineering, Chennai, Tamil Nadu

³Assistant Professor, Department of Civil Engineering, St. Joseph's College of Engineering, Chennai, Tamil Nadu

Abstract – Silos are the structures meant for storing materials like food grains, cement, coal, ore, crushed stone, gravel, clinker etc., in large quantities. In this project planning, analysis, structural design and has been done for a concrete silo based on all Indian standard code for practice. Detailing drawings pertaining to the structural design of market building are presented. All the structural members like slabs, Ring beams, columns, hopper and footings are designed using Indian Standard code IS 4995 PART I & II, IS 456-2000 and IS 875. The structural components are designed by limit state method. Materials were used as specified by National Building Code. Concrete M20 grade and Fe415 steel bars were considered for all the design. Cylindrical walls are 120 mm thick. All the dimensions are given in metric units.

Key Words: silo, beam, dome, slab, limit state method, design, analysis

1. INTRODUCTION

1.1 GENERAL

This Silos are the structures meant for storing materials like food grains, cement, coal, ore, crushed stone, gravel, clinker etc., in large quantities. In general, bunkers or bins are used to store gravel, stone and coal whereas cement and grains are stored in silos. They can be constructed as either ground supported or elevated. With the advent of green revolution, there is a need for the proper storage of huge quantity of crops for future use after it has been harvested. To fulfill this demand of storing crops and grains, the construction of silos became essential. The silo plays a vital role in agricultural, industrial and military domain for the purpose of storing materials.

The materials for construction of silos comprises of steel or reinforced concrete. The silo mainly consists of bin and hopper for storing and discharging materials respectively. For the purpose of self-cleaning and emptying, the silo is supported on a number of columns. The bin is covered by a roof with suitable manhole. The foundation of the silo may be mat, raft or pile based on the soil condition.

1.2 OBJECTIVE

1. To plan, analyze and design various structural elements like beams, slabs, columns and footing in an RCC structure as per Indian Standards.
2. To check the stability of the building against lateral loads
3. To analyze the building with the help of software like Auto CADD and STAAD Pro.

1.3 SCOPE

Analysis and design of a circular silo with fulfilled design requirements such as serviceability and durability.

1.4 CODES CONSIDERED IN THE STUDY

Indian Standard - IS 4995: 1974. The guidelines recommended by the Bureau of Indian Standard for the design of reinforced concrete silos were explained in 'Criteria for Design of Reinforced concrete bins for the storage of Granular and Powdery materials. The silos load determination is described in Part 1 – General Requirements and assessment of Bin loads. The criteria for the design of the silo are given in Part 2 – Design Criteria. In 1968, this standard was published by considering the requirements of structural design for food grain storage bins (silos). In the year 1974, the revision was adopted to design silo for storing all kinds of materials in addition to food grains. The physical nature of the materials to be stored in the bins are taken into account and the code classified the stored materials as granular and powdery materials as shown in Table 1. In this project, accumulated form of solid coal is the material which is stored in the silos.

Table 1 Classification of Materials

| Materials | Particle size |
|-----------|---------------|
| Granular | > 0.2 mm |
| Powdery | < 0.06 mm |

The Part 1 of this standard has given the guidelines for the assessment of bin loads exerted by the stored material based on the different treatments taking into account the granular or powdery nature of the material.

This standard deals with various types of bins namely circular, polygonal or interstice bins. The

definition of terms such as silo, bunker and interstice bins is presented in Table 2.

Table 2 Definitions of Terms

| Silo | Bunker | Interstice bins |
|---------------------------------------|---------------------------------------|--|
| Bins of circular or polygonal in plan | Bins of square or rectangular in plan | Bin formed out of space enclosed by battery of interconnected bins |

2. PLANNING CONSIDERATIONS

The plan of the silos was achieved using AUTOCADD software. The proposed silo is 12 meters tall. The diameter of silo is 4.2 meters. The other dimensions are in the following

1. Height of cylindrical portion = 8.35m
2. Depth of hopper bottom = 1.85m
3. Diameter of opening = 0.5m
4. Density of RCC (D_c) = 25 kN/m³
5. Angle of repose (θ) = 35°
6. Typical of reinforcement = 415 HYSD bars
7. Grade of concrete = M20
8. Wall thickness provided = 120mm
9. Density of coal (w) = 8 kN/m³
10. Height of the dome = 1.15 m
11. Total height of silo = 13.15 m

3. METHODOLOGY

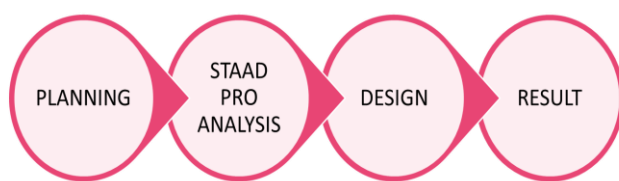
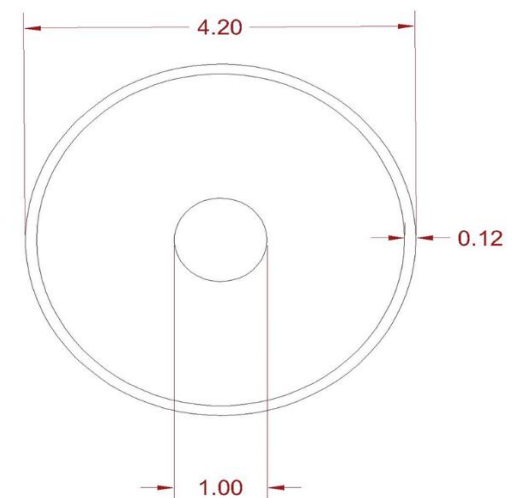


Fig-1: Methodology chart

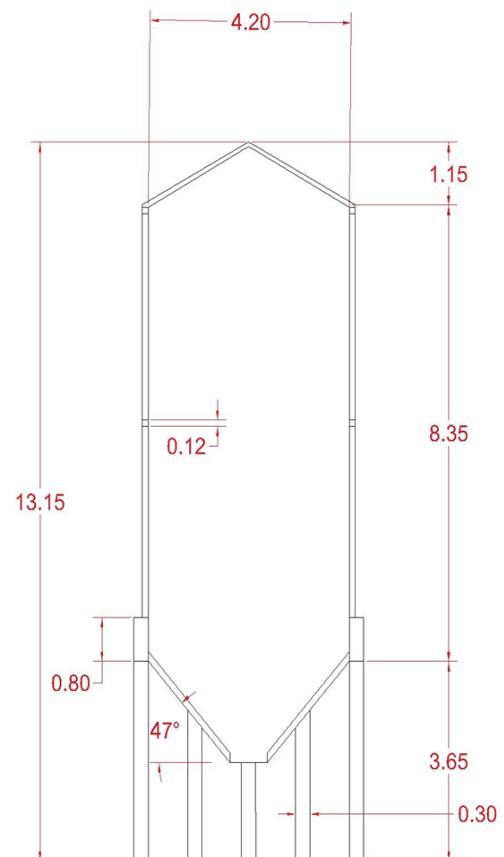
4. PLAN, TOP VIEW AND SECTIONAL VIEW OF SILOS

A plan is a drawing which gives an orthographic projection looking down on the object, such as in a floor plan. It is a fundamental and challenging activity in the execution of construction projects. This helps the engineers to complete the project on time and within budget. Thus, management of resources such as men, materials, machinery requires effective planning. The plan of the silos was done in AUTOCADD software.



ALL DIMENSIONS ARE IN M

Fig -2: Top view of silos



ALL DIMENSIONS ARE IN M

Fig-3: Sectional view of the silos

5. ANALYSIS IN STAADPRO

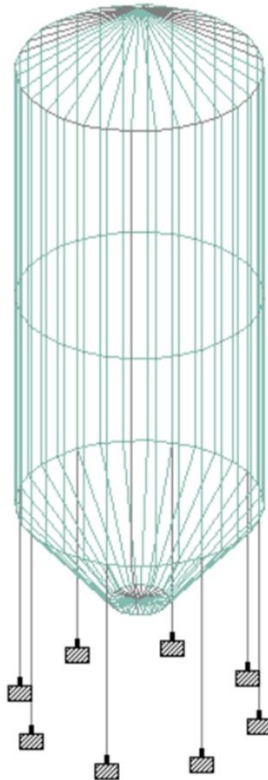


Fig-4: Nodal structure

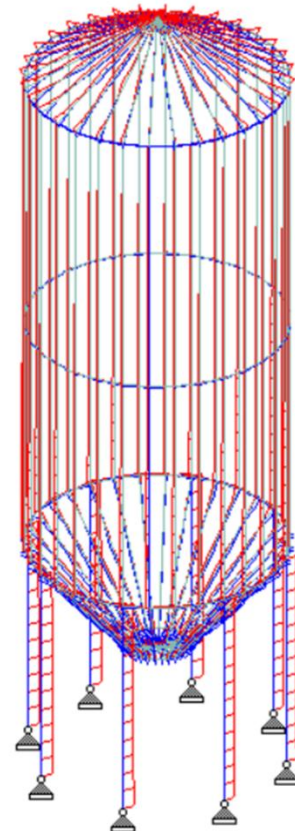


Fig-6: Shear force diagram

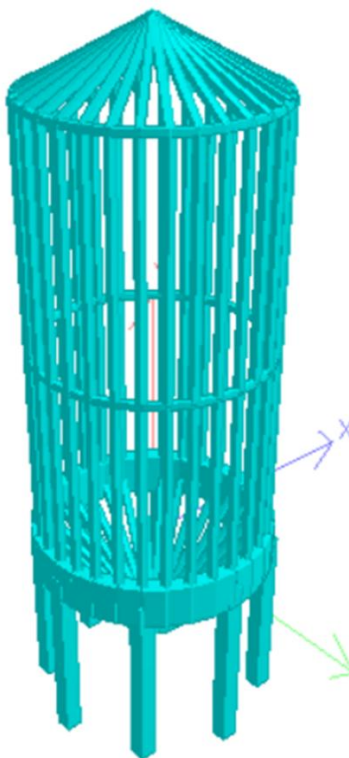


Fig-5: Rendered view

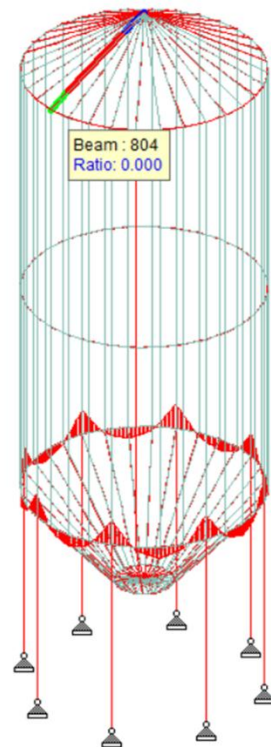


Fig-7: Deflection of beams



Fig -8: Shear force in hopper

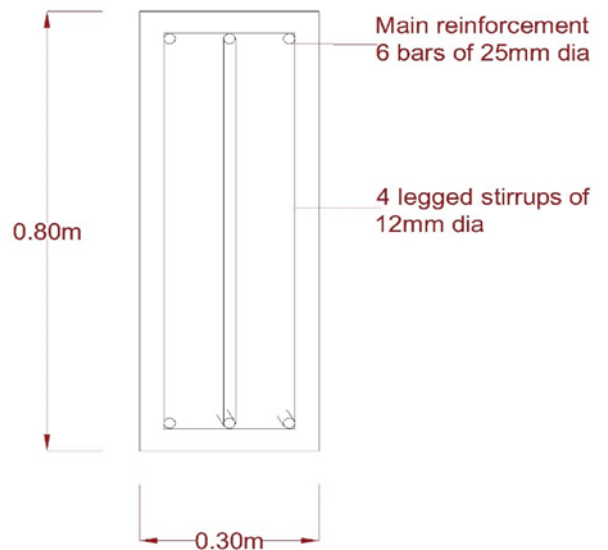


Fig-10: Ring beam Reinforcement details

6. DESIGN

6.1 DESIGN OF DOME SLAB

Size of slab: 4.2 m diameters
 Rise of the dome: 1.15 m
 Thickness of the slab: 120 mm
 Grade of Concrete used: M20.
 Grade of Steel used: Fe415.

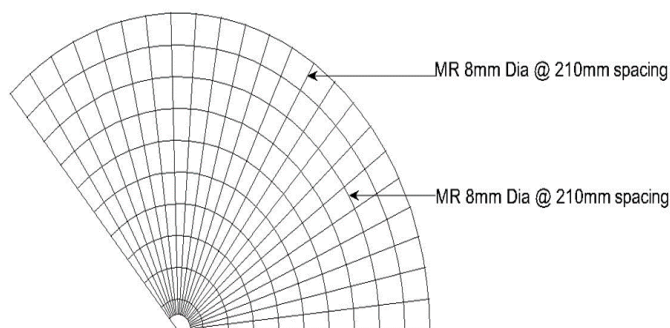


Fig-9: Dome Reinforcement details

6.2 DESIGN OF RING BEAM

Beam Dimension: 0.80m X 0.30m
 Grade of Concrete used: M20.
 Grade of Steel used: Fe415.
 Clear cover: 20mm

6.3 DESIGN OF CYLINDRICAL WALLS

Diameter of the wall: 4.2 m
 Height of the wall: 8.35 m
 Thickness of the wall: 120 mm
 Grade of Concrete used: M20.
 Grade of Steel used: Fe415.

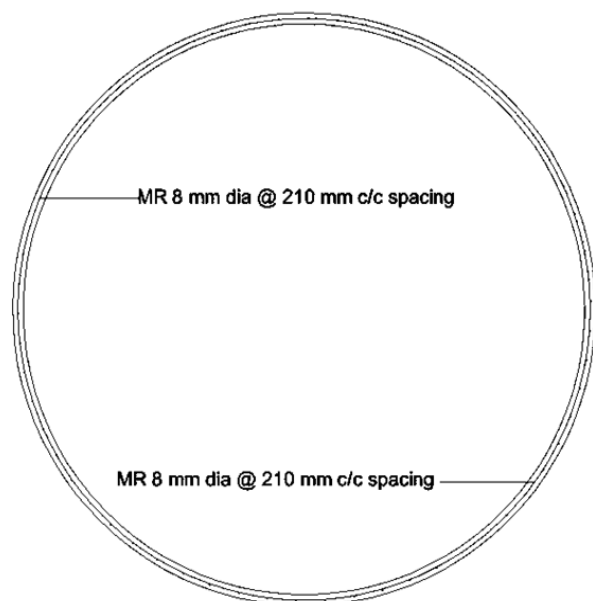


Fig-11: Cylindrical wall Reinforcement details

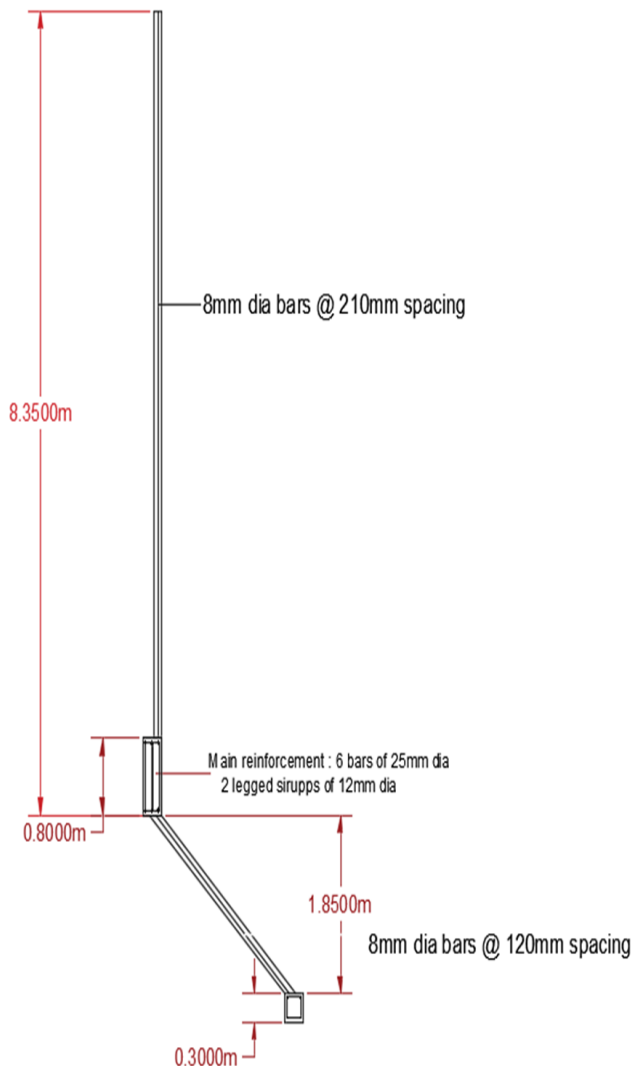


Fig-12: Reinforcement details in sectional view

6.4 DESIGN OF COLUMN

Column Dimension: 300mm x300mm.

Grade of Concrete used: M20.

Grade of Steel used: Fe415.

Clear cover: 20mm

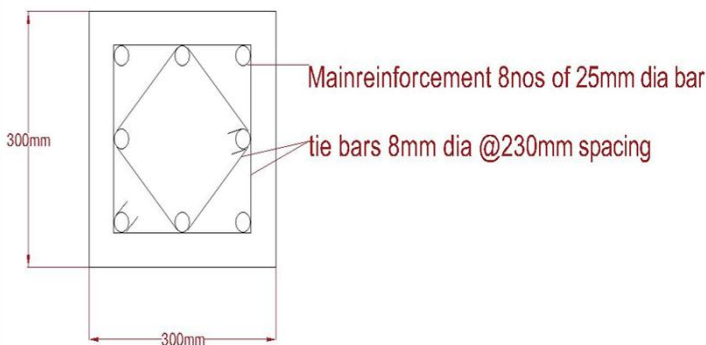


Fig-13: Column Reinforcement details

6.5 DESIGN OF FOUNDATION

Safe Bearing Capacity (S.B.C) =225 KN/m².

Type of footing = Raft footing

Total load on Foundation = 352 tons.

Column Dimension: 300mm x300mm.

Grade of Concrete used: M20.

Grade of Steel used: Fe415.

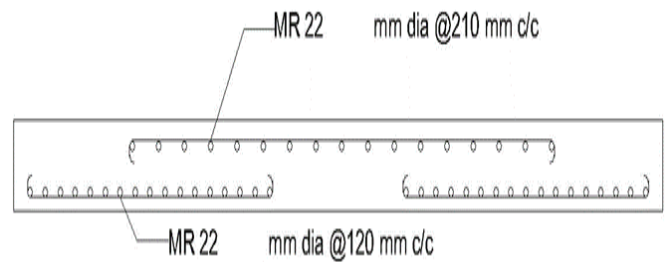


Fig-14: Raft Reinforcement details

7. CONCLUSIONS

The planning of the silo is done using AUTO CAD and it is analyzed for all the load combinations such as dead load, live load with respective Indian Standard codes IS 456:2000, IS 4995:1974(part 1 and 2)and IS 875-1987(part 1,2,4) using STAAD Pro. The design forces and moments are considered as per the STAAD Pro results for the design of the structures such as dome slab, ring beam, hopper, column and footing. It has been shown that the members chosen are safe to carry the expected design loads.

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