# Design and Comparison of Types of Silo in Koradi Power Plant

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***Abstract*:- In this recent competition of industries in India, which is being a rising nation in industries like ceramics, cement industry and textiles and power plant etc. still there is a requirement of modification of storing raw materials in the industry. Fly ash storing in silo and check stresses, bending moment and design of silo in this paper. Also done a comparison between manual load calculation for three silos and calculating results of stresses and bending moment in STAAD PRO. After both load calculation and find the stresses, bending moment of three of silos comparing and design best silo.**

**In Thermal power plant, after burning the coal more amount of ash coming in silo. This ash very useful to the construction material such as cement plant, road etc.**

**In this paper, I am comparing the three types of silo such as square, rectangular & circular. On these silo what effects (shear stresses, bending moment) takes places after applied load such as ash loading, seismic load & wind load with the help of STAAD-PRO software. Comparing these three silo by the Nagpur zone.**

## STRUCTURE CONFIGURATION

**Select silo in MAHAGENCO power plant, koradi, Nagpur Maharashtra. Here using the circular silo. Comparatively study of Varies types of silos such as circular, rectangular & square. Generally, in industrial project using the circular rcc silo & steel silo. In this comparing silo designing commonly use factor are as follows-**

| | |
|---|---|
| **Unit of fly ash** | **16 KN/CUM** |
| **Live load** | **5 KN/SQM** |
| **Zone of factor Z** | **0.10** |
| **Importance factor I** | **1.75** |
| **Response Reduction factor R** | **5.00** |
| **Density of concrete** | **25 KN/CUM** |
| **Characteristics of strength** | **25 N/SQ MM** |
| **Modulus of elasticity** | **25 KN/SQ MM** |
| **Grade of steel** | **Fe500** |
| **Density** | **78.5 KN/CUM** |
| **Modulus of Elasticity** | **200 N/SQ MM** |
| **Seismic zone** | **Zone II** |
| **Basic wind Speed** | **44 M/SEC** |

**From these basic date, types of silos analysis will be carried out with the help of STAAD-PRO software.**

***Keywords:- Circular silo, rectangular silo, Square silo, Ash load, Seismic load, Wind load.***

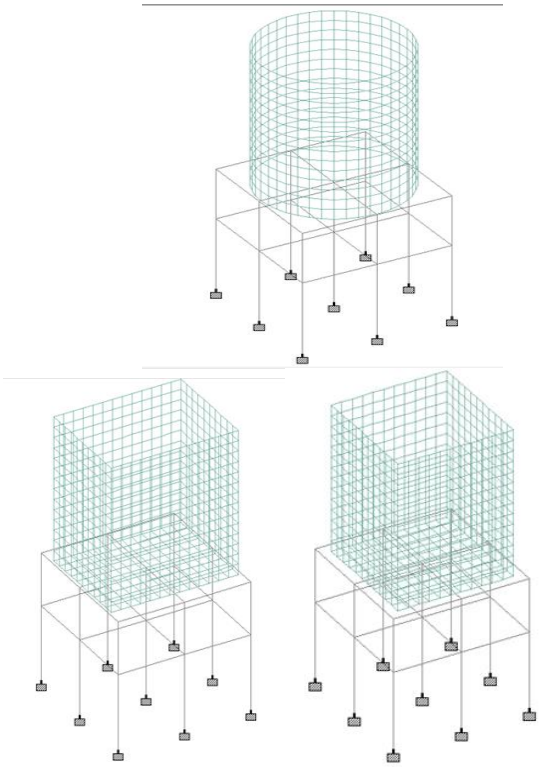
## INTRODUCTION

Reinforced concrete silo is inherently durable than steel silo. The design of silo is based on the strength design method. The design of silos is primarily governed by the type and properties of the stored material. The walls of the silos are typically subjected to both normal pressure and vertical frictional shear or traction produced by the material stored inside the silo. The magnitude and distribution of both shear and normal pressure over the height of the wall depend on the properties of the stored material and whether the silo is being filled or discharged. Design of silo considers both static & dynamic condition. Static & dynamic pressure exerted by the stored material. Other potential loads, including seismic loads, calculation of seismic load consider silo self-weight and material stored in it as a lumped mass and seismic effect of this mass is considered in design of the silo wall. At the time, rcc wall of silo casting step by step carried. In this analysis, I am taking 1M*1M span of shear wall along the length & height of silos. For the analysis, manually calculate the load (ash load, seismic load, wind load) and applied on the STAAD-PRO models.

Silo shall be continuously disposed to ash disposal area in dense slurry form from the power plant. Silo will be provided with outlet, form this outlet shall be connected with slurry disposal stream. This silo provided in the ash handling area. Ash is considered to be collected in Electrostatic Precipitator hopper (ESP). Ash from all these ESP hopper shall be transported pneumatically under pressure to silo.

## SHAPES OF STRUCTURE

The load on silo vertical wall be evaluated according to the capacity of power plant. As per its using circular silo capacity, finding the rectangular and square silo areas and constant the heights.



METHODOLOGY

Manually calculating the ash load, seismic load and wind load with the help of IS code. These three load applied on silo models in staad pro v8i. Loading applied on the silo wall and wall converted plate wises. Theses silo structure divided one meter by one meter plate.

Ash loading calculation:-

660 MW Power Plant –
For calculation the ash collected in silo using the Janssen's theory and assuming data are as follows-

| SN | DESCRIPTION | VALUES | UNITS |
|---|---|---|---|
| 1 | Coal required for boiling water in power plant | 430 | T/Hrs |
| | **After its processing,** | | |
| 2 | Ash found in the ESP (41.2 %) =430*(41.2/100) | 177.16 | T/Hrs |
| 3 | From ESP to silo ash coming 70% =177.16*(70/100) | 124.012 | T/Hrs |
| 4 | But for safety factor taking 90% =177.16*(90/100) | 159.444 | T/Hrs |
| | For 12 Hrs, Ash found =159.44*12 | 1913.328 | T/12Hrs |
| 5 | Density of Fly Ash | 1.6 | T/CUM |
| | | 15.69 | KN/CUM |
| 6 | Diameter | 13 | M |
| 7 | Hydraulic mean radius R=D/4 | 3.25 | M |
| 8 | Angle of repose | 30 | degree |
| 9 | n=((1-sin$)/(1+sin$)) | 1 | |
| 10 | coefficient of friction between concrete wall and Fly ash = u' | 0.58 | |
| 11 | Height of silo | 14.2 | m |

For calculation of the seismic load using IS code 1893 and considering following data:-

Dead Load – 12 KN / M2
Dead Load on top of Silo – 10 KN / M2
50 % of Dead Load – Live Load
Calculation:
Area of silo – 132.732 MM2

| | | |
|---|---|---|
| W14 | | |
| = | 132.732 X 10 | |
| = | 1327.32 | KN |
| W1 TO W13 | 132.732*(10+0.4 | |
| = | ) | |
| = | 1592.784 | |
| = | 1593 | KN |
| ∑ W | | |
| = | 13 ×1598 + 1328 | |
| = | 22037 | KN |
| Fundamental Natural Period | $Ta = 0.075\ h^{0.75}$ | |
| = | $0.075 \times 14.2^{0.75}$ | |
| = | 0.548 | Seconds |

| where, | | |
|---|---|---|
| Zone factor in table 2 (IS 1893/2:2002) = | Z | 0.1 |
| Importance factor in table 6 = (IS 1893/2:2002) | I | 1.5 |
| Response reduction factor in table 7 = (IS 1893/2:2002) | R | 3 |
| Average response acceleration coefficient = for medium soil (IS 1893/2:2002) | Sa/g | 2.5 |

For calculation of wind load using IS 875 (Part-3) and assuming some data:-
Basic wind speed – 44 m/s
Terrain category – Terrain category – 2
Design Factor – Risk coefficient factor K1 – 1
Terrain & Height factor K2 – Varies with height
Topography factor K3 – 1
Cyclonic Region factor K4 – 1
Wind directionality factor Kd – 0.9
Area averaging factor Ka – 1

After assuming these data calculating the plate wise wind load and applied on the assuming types of silo. In wind load, circular silo calculations, square silo calculation and rectangular silo calculation different because wind load depends on the area of shapes.

LOAD CASES AND COMBINATION

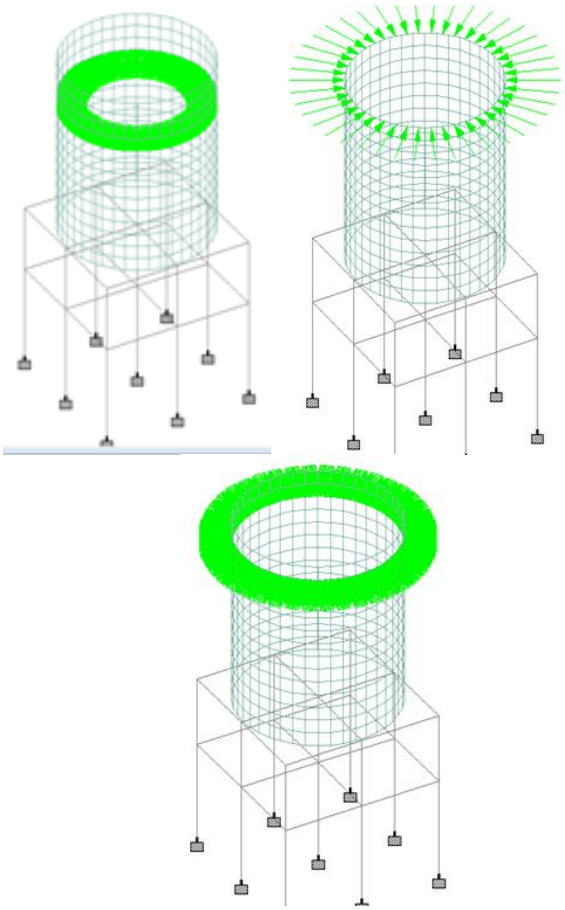
Mainly in this analysis three load cases are used are as follows:-

1. Ash load
2. Seismic load
3. Wind load

How to the load combination taken are shown below:-

| Plates Nos Layer wise | Ash load | Seismic load | Wind load |
|---|---|---|---|
| 1 | Ash loading 1 | Seismic load 14 | Wind load 14 |
| 2 | Ash loading 2 | Seismic load 13 | Wind load 13 |
| 3 | Ash loading 3 | Seismic load 12 | Wind load 12 |
| 4 | Ash loading 4 | Seismic load 11 | Wind load 11 |
| 5 | Ash loading 5 | Seismic load 10 | Wind load 10 |
| 6 | Ash loading 6 | Seismic load 9 | Wind load 9 |
| 7 | Ash loading 7 | Seismic load 8 | Wind load 8 |
| 8 | Ash loading 8 | Seismic load 7 | Wind load 7 |
| 9 | Ash loading 9 | Seismic load 6 | Wind load 6 |
| 10 | Ash loading 10 | Seismic load 5 | Wind load 5 |
| 11 | Ash loading 11 | Seismic load 4 | Wind load 4 |
| 12 | Ash loading 12 | Seismic load 3 | Wind load 3 |
| 13 | Ash loading 13 | Seismic load 2 | Wind load 2 |
| 14 | Ash loading 14 | Seismic load 1 | Wind load 1 |

How to applied load on silo structure as shown in figure:-



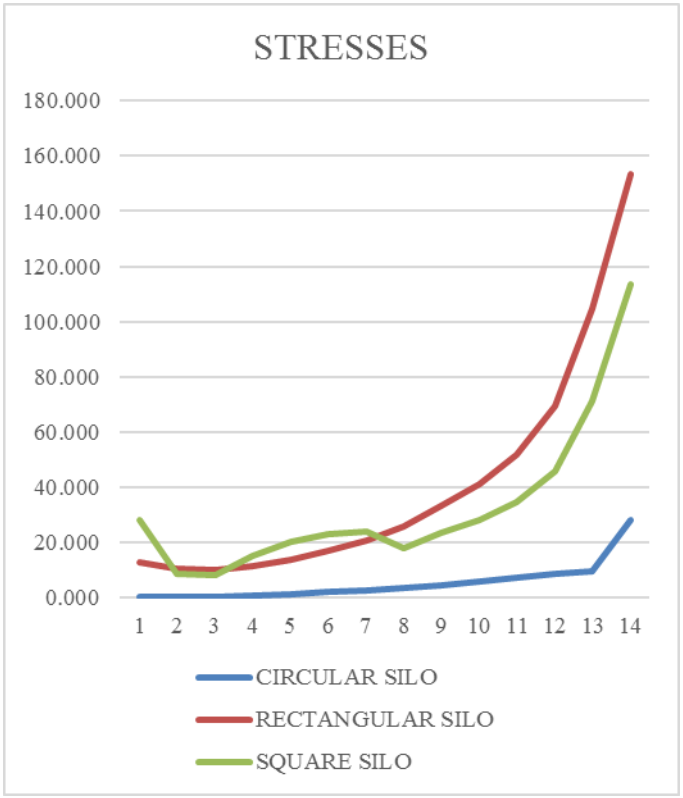
LOADING TYPES – ASH LOAD, SEISMIC LOAD, WIND LOAD

## RESULTS

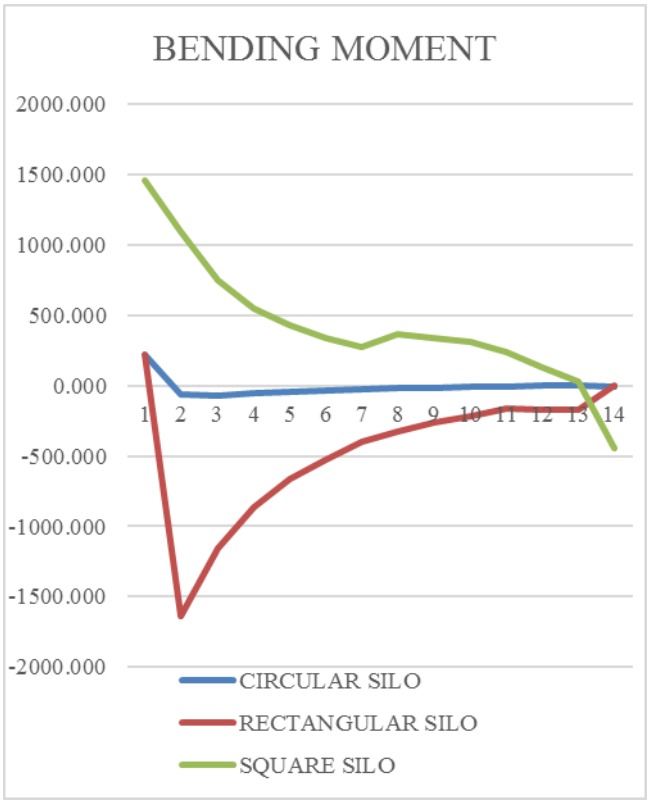
In these analysis, the different result of stress and bending moment during comparison of three types of silos in staad pro software. It is concluded that, the change of silo shapes various results of stresses and bending moment. Again in this paper software based results balanced.

After applying the ash loading, seismic load and wind load coming the stresses and Bending Moment are as follows:-

| PLATES NOS | CIRCULAR SILO | RECTANGULAR SILO | SQUARE SILO |
|---|---|---|---|
| 1 | 0.492 | 12.811 | 28.130 |
| 2 | 0.116 | 10.507 | 8.389 |
| 3 | 0.322 | 10.234 | 8.174 |
| 4 | 0.760 | 11.457 | 15.325 |
| 5 | 1.326 | 13.725 | 20.270 |
| 6 | 2.004 | 16.838 | 23.010 |
| 7 | 2.739 | 20.735 | 23.832 |
| 8 | 3.620 | 25.646 | 18.058 |
| 9 | 4.681 | 33.361 | 23.386 |
| 10 | 5.834 | 41.017 | 28.367 |
| 11 | 7.124 | 51.626 | 34.785 |
| 12 | 8.793 | 69.285 | 45.611 |
| 13 | 9.519 | 104.770 | 71.099 |
| 14 | 28.166 | 153.353 | 113.468 |



| PLATES NOS | CIRCULAR SILO | RECTANGULAR SILO | SQUARE SILO |
|---|---|---|---|
| 1 | 221.780 | 218.772 | 1461.856 |
| 2 | -59.253 | -1636.380 | 1091.621 |
| 3 | -68.252 | -1156.920 | 746.228 |
| 4 | -55.132 | -861.780 | 552.629 |
| 5 | -45.632 | -666.484 | 430.611 |
| 6 | -36.657 | -528.372 | 343.020 |
| 7 | -28.357 | -399.826 | 272.585 |
| 8 | -20.759 | -322.079 | 363.678 |
| 9 | -14.754 | -263.983 | 341.084 |
| 10 | -9.075 | -220.114 | 312.564 |
| 11 | -4.521 | -159.521 | 236.678 |
| 12 | -1.037 | -172.177 | 125.064 |
| 13 | 1.258 | -170.036 | 30.340 |
| 14 | -3.141 | 2.174 | -448.593 |




## CONCLUSION

In manual calculation of load circular silo is very easy. Value of these loading is very less.

Applied the loading in staad pro v8i is very easy in the circular silo comparative other silos and load combination also very easy.

Stress and bending moment value very low of circular silo and near same value of rectangular and square silo.

But in literature surveys, more storage capacity in rectangular silo and square silo.

The power tool for computerized structural engineering STAAD Pro is the most popular structural engineering. Analysis & multi material design prepare 3D finite model of silo in STAAD.

## REFERENCES

[1] SUVARNA DILIP DESHMUKH, RATHOD S. T. 'comparison of design and seismic behavior of rcc silo' international journal of science and research (ijsr) issn (online): 2319-7064 index Copernicus value (2013): 6.14 | impact factor (2013): 4.438 volume 4 issue 5, may 2015 www.ijsr.net.

[2] DHARMENDRA H. PAMBHAR1, PROF. SHRADDHA R. VANIYA2. 'design and analysis of circular silo (r.c.c) for storing bulk matrials' international journal of advance research in engineering, science & technology(ijarest), issn(o):2393-9877, issn(p): 2394-2444, volume 2,issue 5, may-2015, impact factor: 2.125.

[3] ER. AMIT BIJION DUTTA 'study of failures in silos' volume:2. issue :11. nov 2013-issn no 2277-8160

[4] JEAN-PIERRE BIRAT 'scientific research takes place in silos' mat'eriaux & techniques 102, 501 (2014)c_ edp science, 2014. Doi: 10.1051. mattech 2014040. www.mattach-journal.org.

[5] HANS E. VON WACHENFELT A,*, N. CHRISTER NILSSON A, GO¨RAN I. €OSTERGARD B, N. ANDERS OLOFSSON B, J. MARIE KARLSSON B ' design criteria for structural design of silage silo walls', research paper journal home page: www. elsevier.com/locate/issn/15375110.

[6] N. KRISHNA RAJU 'advanced reinforced concrete design' IS: 456-2000 2nd edition.

[7] S. RAMAMRUTHAM 'design of reinforcement concrete structures' eleventh edition 2011.

[8] Dr. SUDHIR K JAIN (IIT kanpur) 'Explanatory Examples on Indian Seismic code IS 1893 (Part I)' Document no. IITK-GSDMA-EQ21-V2.0 (Load calculation of seismic load )

[9] Dr. N. M. BHANDARI, Dr. PREM KRISHNA, Dr. KRISHEN KUMAR (IIT ROORKEE) 'An Explantory Handbook On Proposed IS 875 (part 3) Wind Loads Building and Structures'. Document No. IITK-GSDMA-Wind06-V3.0 (Load calculation of Wind load )