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CONDITIONAL ASSESSMENT OF R.C.C SILO USING VARIOUS NDT AND REPAIR TECHNIQUES.

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Abstract- *Silos are special structures subjected to many different unconventional loading conditions, which result in unusual failure modes. Failure of a silo can be devastating as it can result in loss of the container, contamination of the material it contains, loss of material, clean-up, replacement costs, environmental damage, and possible injury or loss of life. Discussion of the common or spectacular silo failures due to explosion and bursting, asymmetrical loads created during filling or discharging, large and non-uniform soil pressure, corrosion of metal silos, deterioration of concrete silos due to silage acids, internal structural collapse. Silo damage and failures from several earthquakes are also presented. Over a period of time silos will occasionally start to lean. This could be caused by an insufficient foundation, but more likely from concrete around deteriorating. Whatever the cause we may be able to strengthening them up and stabilize them for years to come using shotcrete, carbon fiber wrapping, monomer grout, corrosion inhibitor, glass fiber wrapping, and microfine cement*

Keywords*-R.C.CSilo,UltraSonicpulseVelocity,ReboundHammer,CoreCutting,STAADPRO*

I. INTRODUCTION

Silo may be classified as storage structure generally used for storing coal, cement, food grains, and other granular materials. Silos are used by a wide range of industries to store bulk solids in quantities ranging from a few tones to hundreds or thousands of tones. The term silo includes all forms of particulate solids storage structure that might otherwise be referred to as a bin, hopper, grain tank or bunker. They can be constructed of steel or reinforced concrete and may discharge by gravity flow or by mechanical means. They can be supported on columns, load bearing skirts, or they may be hung from floors. Flat bottom bins are usually supported directly on foundations. As we know that silos is the main component of the industrial plant. It plays a very vital and important role. If the silos is damaged by some means and has to be repaired or reconstructed then it can stop the production of that particular plant, so if we repair the silos it would be done very fast and in short duration of time and the cost and loss in production would be less compared to the construction of the new silos, which would take much time and boost the costing of the industry, which will result the company loses.

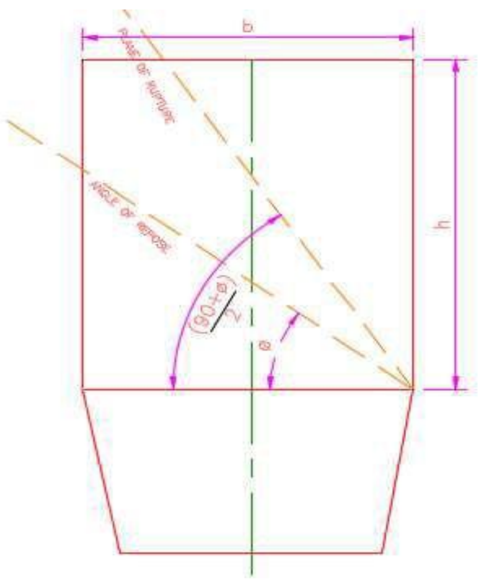


Figure-1Bunker

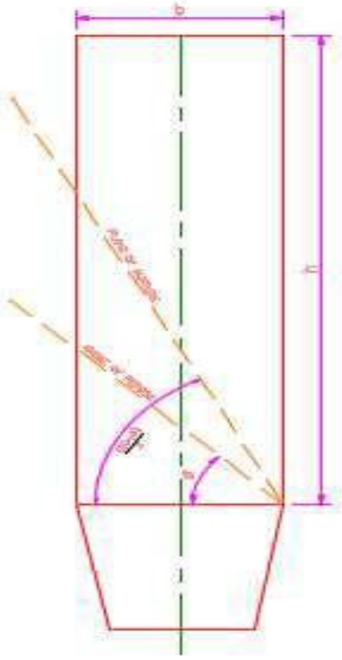


Figure-2Silo

II. MODELLING

2.1 ProblemDefinition

TherearefourmethodswhichareusedinconstructionofRCCSilo

- JanssenMethodforComputingStaticPressure,
- ReimbertMethodforComputingStaticPressure,
- Airy'sMethodforComputingStaticPressuresand
- IndianStandardcodefordesignofreinforcedconcretebinsforthestorageofgranularandpowderymaterials.

2.2 AllDataisGivenbyUSHTAINFINITY.

- Fy=250n/mm2
- Fck=M25
- C/CDiameterofsilo=16m
- Heightofsilo=52.5m
- Densityoffilledmaterial=1350kg/m3(IS4995,PART1-1974,Table1)
  AngleofRepose ⌀=25degree
- InternalDiameterAboveConeLevel=16m
- ExternalDiameterAboveConeLevel=16.7 m
- InternalDiameterBelowConeLevel=15.3m
- ExternalDiameterBelowConeLevel=16.7m
- WallThicknessAboveConeLevel=350mm
- WallThicknessBelowConeLevel=700mm

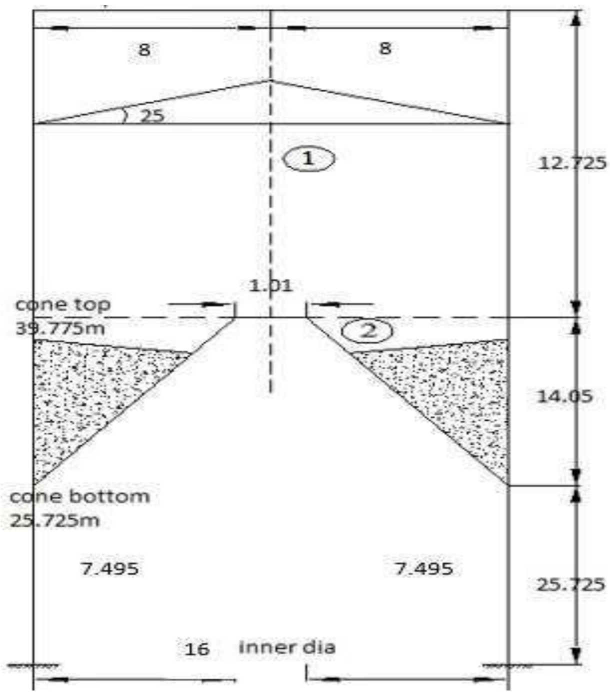


Figure-3dimensionofSilo

2.3 FlowChartofDesignProcess

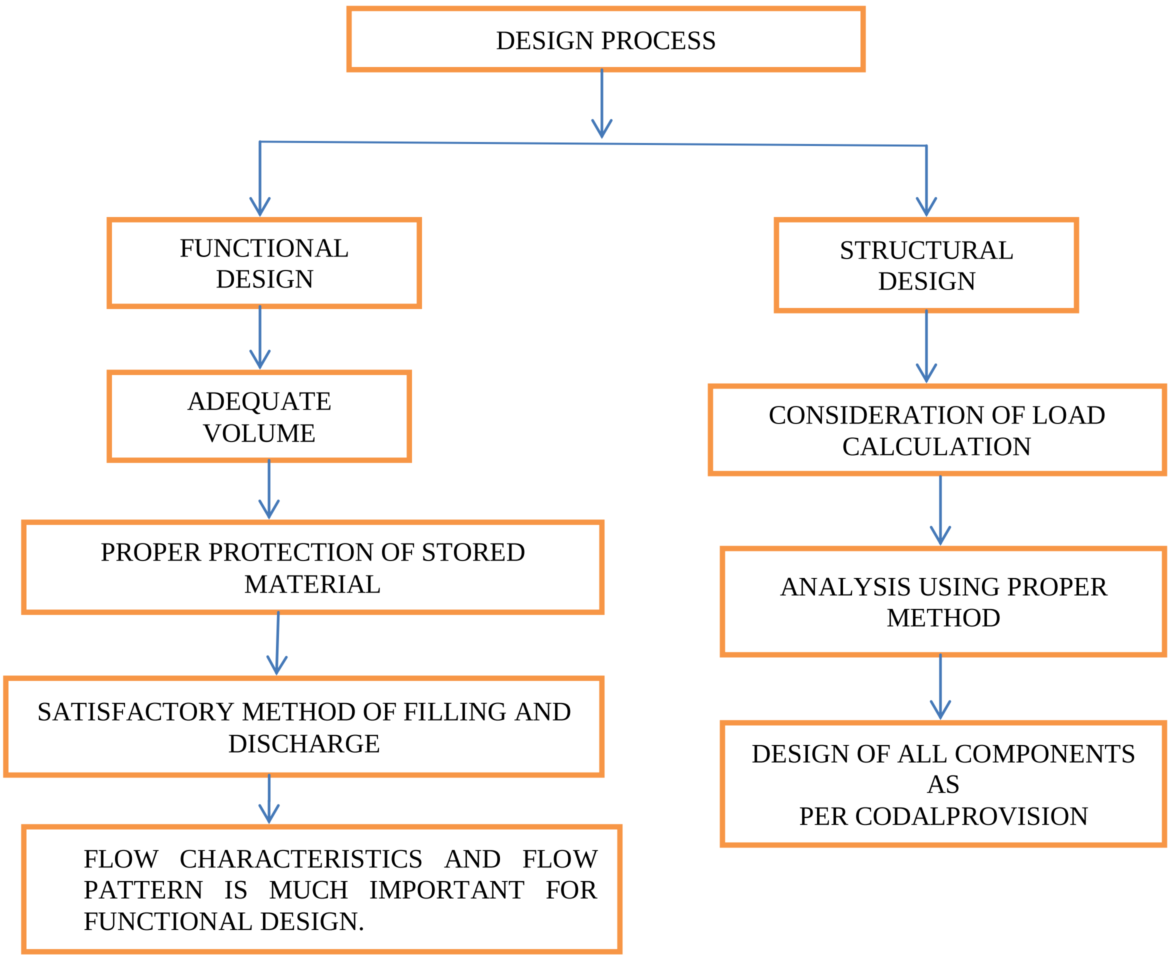


Figure-4 Flow chart of design process

2.4codesandstandards

To Help Ensure Safety And Better Quality Silo And Bunker Structures, Several Countries Have Already Adopted Codes And Standards For Silo And Bunker Design And Construction. Few Of Them Are As Below:

I.S 4995- 1974: CRITERIA FOR DESIGN OF REINFORCED CONCRETE BINS FOR THE STORAGE OF GRANULAR AND POWDERY MATERIALS.

Part 1. GENERAL REQUIREMENTS AND ASSESSMENT OF BIN LOADS.
Part 2. DESIGN CRITERIA

CH 302: "INSTRUCTION FOR DESIGN OF SILOS FOR GRANULAR MATERIALS" Silo Code In The United States
ACI- 313: "RECOMMENDED PRACTICE FOR DESIGN AND CONSTRUCTION OF CONCRETE BIN" Silo Code In The United States.

IS 456-2000: "PLAIN AND REINFORCED CONCRETE -CODE OF PRACTICE"

IS 875-1987-**PART 1 (DEAD LO ADS — UNIT WEIGHTS OF BUILDING MATERIALS AND STORED MATERIALS)**: "CODE OF PRACTICE FOR DESIGN LOADS (OTHER THAN EARTHQUAKE) FOR BUILDINGS AND STRUCTURES"

IS 875-1987-**PART 2 (IMPOSED LOADS):** "CODE OF PRACTICE FOR DESIGN LOADS (OTHER THAN EARTHQUAKE) FOR BUILDINGS AND STRUCTURES"

IS 875-1987-**PART 3 (WIND LOADS)**: "CODE OF PRACTICE FOR DESIGN LOADS (OTHER THAN EARTHQUAKE) FOR BUILDINGS AND STRUCTURES"

2.5LoadConsideration

The principle loads for silo and bunker design come from action of the stored material loads or forces from other sources including; dead load, equipment load wind, floor and roof live loads; seismic loads; forces from thermal effects and forces applied at restrain of attached items..

DeadLoad

LiveLoad

EquipmentLoad

WindLoad(IS875:1987,PART-3)

TemperatureEffect(IS:4995-1974,PART-2)(CL.5.8,pg.17)

EarthquakeLoad(IS1893:2002)(PART1)

.

III. RESULTS

AssignedPlateProperties

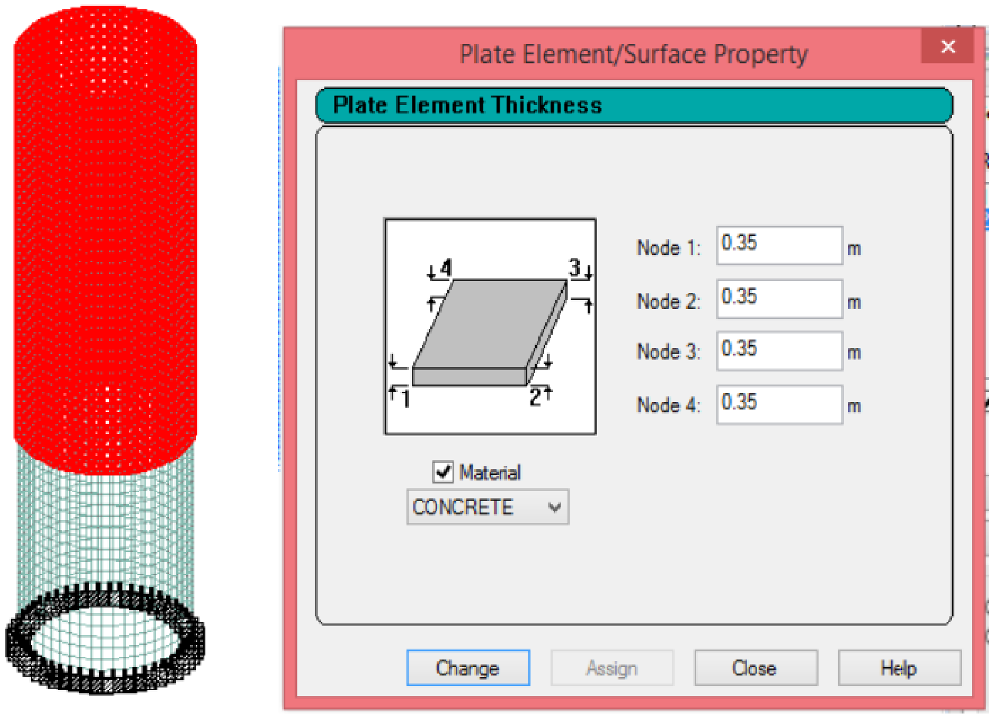


Figure-5 Wall Thickness above Cone Level

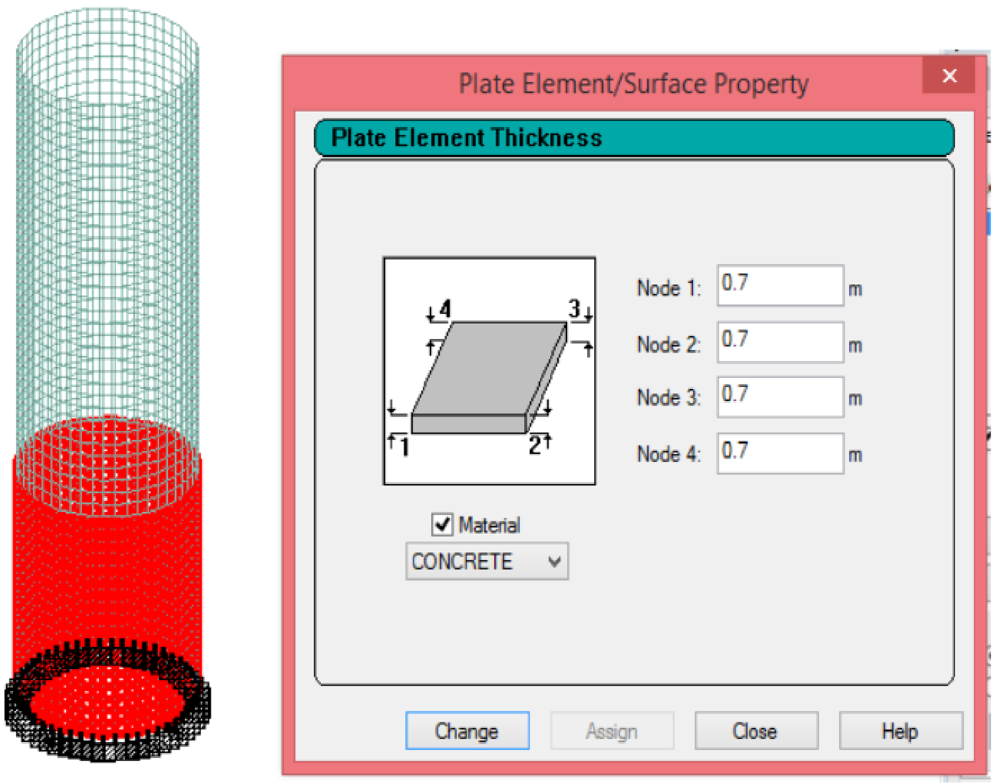
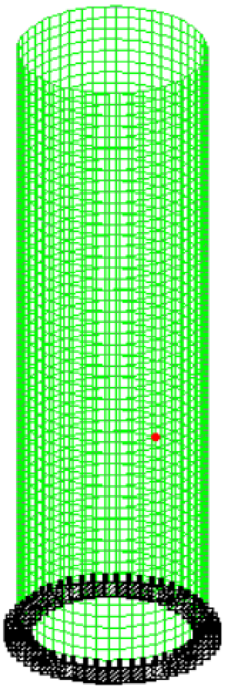


Figure-6 Plate Thickness below Cone Level

DisplacementResults



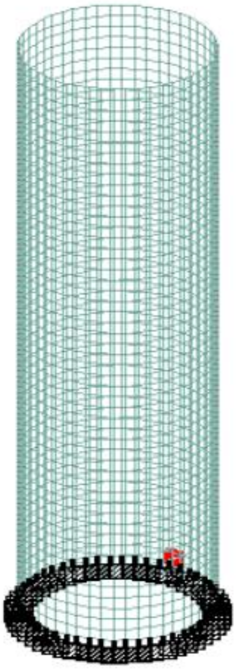
SILO FINAL DESIG...

All | Summary

	Node	L/C	Horizontal X mm
Max X	4101	101 1.5(DL +	31.225
Min X	4126	101 1.5(DL +	-31.225
Max Y	5101	101 1.5(DL +	0.000
Min Y	2451	101 1.5(DL +	3.324
Max Z	4138	101 1.5(DL +	-1.961
Min Z	4113	101 1.5(DL +	1.961
Max rX	5088	101 1.5(DL +	-0.317
Min rX	5063	101 1.5(DL +	0.317
Max rY	5006	101 1.5(DL +	9.773
Min rY	5021	101 1.5(DL +	-9.773
Max rZ	5076	101 1.5(DL +	-5.049
Min rZ	5051	101 1.5(DL +	5.049
Max Rs	2451	101 1.5(DL +	3.324

Figure-7 Displacement Result

Maximum Permissible Limit for Displacement in X Direction is $\frac{L}{500}$ **= 105 mm.** Actual Displacement in X Direction is 31.225 mm. So, Designed Silo is safe for Displacement



SILO FINAL DESIGN - Plate Center Stress:

Shear, Membrane and Bending | Summary | Princi

	Plate	L/C	Shear SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2
Max Qx	10211	101 1.5(DL +	0.000	-3.606	-32.804
Min Qx	10215	101 1.5(DL +	-0.000	-3.606	-32.804
Max Qy	9903	101 1.5(DL +	0.000	0.811	1.621
Min Qy	10253	101 1.5(DL +	0.000	-9.906	-53.453
Max Sx	8607	101 1.5(DL +	-0.000	-0.755	11.875
Min Sx	10253	101 1.5(DL +	0.000	-9.906	-53.453
Max Sy	5255	101 1.5(DL +	0.000	0.008	0.152
Min Sy	8501	101 1.5(DL +	0.000	-1.630	-23.239
Max Sx	10254	101 1.5(DL +	-0.000	-9.906	-53.453

Figure-8 Stress Result

Take one load combination which is **1.5(DL+LL+TL)** and it gives the stress results at all the plates. Choose one plate having maximum stress which is **-53.453N/mm2.**

Crack-Width (IS: 4995-1974, PART-2) (CL.5.10.1, pg.18)

$$\mathbf{Wcr} = \mathbf{10^{-6}} * \left(\mathbf{4} + \frac{\rho * \varnothing'}{\boldsymbol{Po}}\right) * \boldsymbol{\sigma sa} * \{\mathbf{1} - \left(\frac{\mathbf{6}}{\boldsymbol{Po * \sigma sa}}\right)^{\mathbf{2}}\}$$

wcr = maximum (95 percent probability) crack-width in cm
ρ = a factor depending on the bond characteristics of steels. (0.09 for plain bars and 0'05 for deformed bars),
⌀ ′ = diameter of reinforcing bar in cm,

$\mathbf{P_0}$ = As/Act = geometric percentage of the tensile reinforcement with respect to the concrete area in tension,

As = area of tensile reinforcement per unit height of wall cm'/m

Act = concrete area in tension per unit height of wall cm2/m [sectional area of unit height of wall for tension members (entire section under tension) or half the sectional area below the neutral axis of unit height of wall for flexural members (neutral axis within the section),

σsa = actual steel stress under permanently acting loads in kg/cm2 ,

Table-1Differentvaluestofindcrack-width

ρ	0.05
⌀′	20cm
As	2417cm^2/m
Act	3500cm^2/m
σsa	534.5kg/cm^2
Wcr	**0.0029**

From Given Stress Correlate this stress with crack width from IS 4995 PART 2, and find the crack width and it should be less than 0.02 cm.

IV. CONCLUSION

- The study gives functional understanding and guidelines of design of Structural components of RCC silo structure.
- Design of all the elements of on the basis of IS 4995-1974 (part I, II) it gives the correct pressure variation along bin depth.
- By preparing the spread sheets, we can save time and long iterative manual Procedure and get exact result of our input value

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