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Analysis and Design of RCC Silo for Storage of 2000 ton using E-Tabs Software

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***Abstract:-T*he research article looks in to Design and analysis of RCC silo to store granular material. Up to 2000 ton, by using the BS-8110 recommendation and Etabs software, And for better understanding of the structural behavior during loading. Also to showcase the loading capacity & design charts, 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.**

.And the selected silo is located in Sudan as case study with circular walls. For storing agricultural Martials.

Keywords—RCC silo t; concrte design ; analysis of silo;; etabs software ; storage design

I. INTRODUCTION

.Silos are storage structure which can be concrete or steel structure with many types depending the storage volume and the martials type, this article reveals the structural behavior during loading , the loading capacity, classification of silos lastly the load path in structure. Considering its location in Sudan & to store 2000 ton barely by using etab.
Some of the types can be Bunker silos, Bag silos Sand and salt silos lastly fabric silos. And they can be cylindrical or square shaped. Depending on the storage and the loading capacity determined.

II. LITERATURE REVIEW

- , the silo is essential in the agricultural, industrial, and military domains. People used to keep items in bins that were constructed by guesswork until the 1960s. Andrew W. Jenike's 1960s study laid the groundwork for the bin design. Traditional approaches' silos are insufficient owing to the implementation of simplistic solutions in complicated settings (Wojcik et al., 2003). Earthquakes frequently cause damage to silos and/or their collapse, causing not only huge financial losses but also fatalities. For example, after the 2001 earthquake in El Salvador, three people died as a consequence of a silo failure (Mendez 2001).
- It +6 is difficult to calculate and understand the loads of solids on the walls and interior of such buildings. As a result, silos and bunkers disintegrate much faster than other industrial equipment. Defecting a part can lead to deformation or deformation, which is unpleasant, but does not affect safety or operation. In some cases, failures lead to complete collapse of the structure, leading to discontinuation of use and death (Carson 2000). In the last 50 years, many attempts have been made to encode the inductive force of a solid acting on a silo wall. The German Standard DIN 1055 Part 6 "Design loads for buildings: Loads in silo bins" was established through rigorous testing by the researchers (Pieper et al., 1964), who published the first code to offer useful instructions to design engineers estimating silo loads. This standard was initially published in 1964, and it has been considerably altered and republished twice since then, in 1987 and 2005.
- Based on a basic model presented by various researchers (Rotter 1986, 2001). Some of the complexity arises due to different methodologies adopted by different researchers, this can be treated using action assessment class (AAC), in association with patch loads. Many applications require knowledge of the pressures happening in silos and other types of containers packed with powders or bulk materials (Schulze 2021):

A. *Methdology:*

I. ***Properties of the structure :-***

Width	Height	Length
12 M	51 M	12 M

II. The selected approach in this article through E-tabs software for analysis and the design sheets too. Statically choosing about (1500-2000) ton of storage and considering non earthquake behavior duo to SUDAN geographic features.

III. According to the weight of the silo seismic loads and horizontal the center mass is increased as the load being transferred to the soil with cylindrical design.

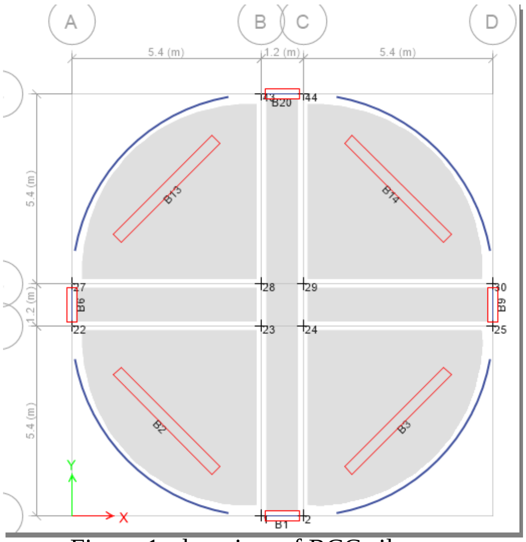

Figure 1-plan view of RCC silo.

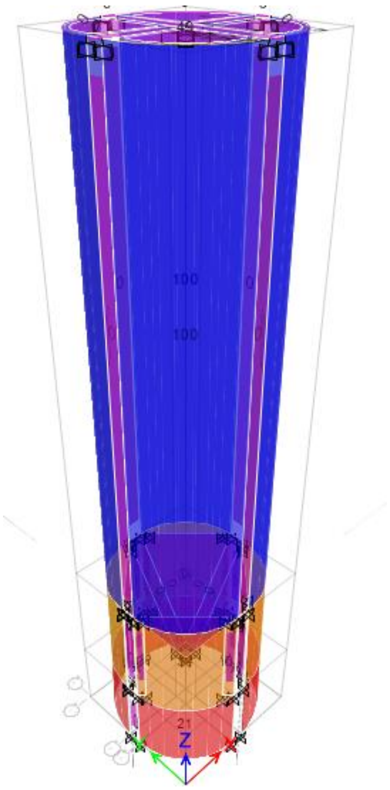

Figure 2 vertical plan view of RCC silo

As per EUROCODE, the loads on silo vertical wall be evaluated according to slenderness of silo determined according to the following types which given in Table 2.

Table 2: Silo classification

SR. NO.	Types Of Silo	Condition
a	Slender silo	2 < hc /dc
b	Intermediate slenderness silo	1 < hc /dc < 2
c	Squat silo	0.4 < hc /dc < 1
d	Retaining silo	hc /dc < 4

Figure 3-silo classification

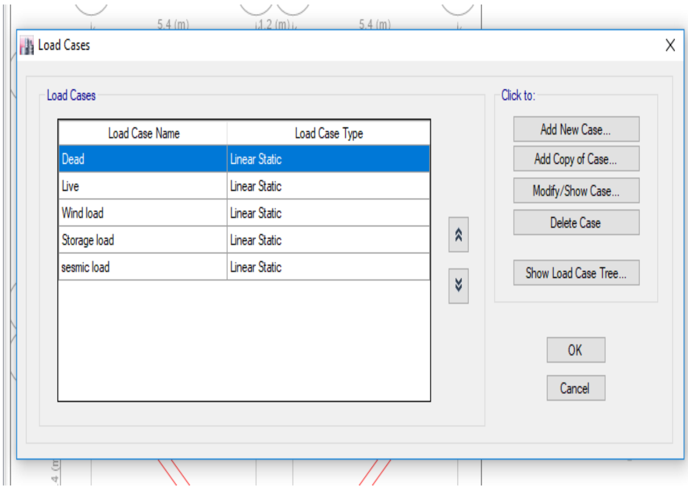

Figure 4 loads on RCC structure

Table 4.4 - Load Combinations

Name	Load Case/Combo	Mode	Scale Factor	Type	Auto
Comb1	Dead		1.4	Linear Add	No
Comb1	Live		1.6		No
Comb1	Modal	1	1		No
Comb1	Live		1		No
Comb1	Dead		1		No

Figure 5 loads combinations

.After defining loads and choosing the limit state design method for analyzing model in E-tabs, then assigning those loads and have better understanding of the model behavior in resisting horizontal pressure and vertical axial force acting towards it. And forecasting its dereliction reaction and its maximum loads capacity. All those steps ware made

III. RESULTS .

.After doing the steps above we concluded that the structural behavior of loading depends on the height of silo, and the weight capacity of its content and a key factor of its failure is loading and footing type if not matched, below are results of this thesis

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3 Analysis Results

This chapter provides analysis results.

3.1 Structure Results

Table 3.1 - Base Reactions

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	0	0	19410.9429	116593.9942	-116064.0316	0	0	0	0
Live	0	0	0	0	0	0	0	0	0
Wind load	0	0	0	0	0	0	0	0	0
Storage load	0	0	16896.5645	101508.8829	-100978.5609	0	0	0	0
sesmic load	0	0	0	0	0	0	0	0	0
Comb1	98.2565	80.1945	46586.2629	277099.0034	-275212.9591	927.0276	0	0	0

Figure 6- analysis results on loads

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Figure 7- silo classification.

3.3 Modal Results

Table 3.4 - Modal Periods and Frequencies

Case	Mode	Period sec	Frequency cyc/sec	Circular Frequency rad/sec	Eigenvalue rad²/sec²
Modal	1	0.028	35.851	225.2555	50740.0393
Modal	2	0.028	35.851	225.2555	50740.0393
Modal	3	0.028	35.851	225.2555	50740.0393
Modal	4	0.028	35.851	225.2555	50740.0393
Modal	5	0.025	39.263	246.6948	60858.3346
Modal	6	0.025	39.263	246.6948	60858.3346
Modal	7	0.025	39.263	246.6948	60858.3346
Modal	8	0.025	39.263	246.6948	60858.3346
Modal	9	0.023	44.267	278.1359	77359.5861
Modal	10	0.023	44.267	278.1359	77359.5861
Modal	11	0.023	44.267	278.1359	77359.5861
Modal	12	0.023	44.267	278.1359	77359.5861

Figure 8- Model reaction upon loads.

Table 3.2 - Story Forces

Story	Load Case/Combo	Location	P kN	VX kN	VY kN	T kN-m	MX kN-m	MY kN-m
Story3	Dead	Top	-717.6291	0	0	0	-4305.7744	4305.7744
Story3	Dead	Bottom	717.6291	0	0	0	4305.7744	-4305.7744
Story3	Live	Top	0	0	0	0	0	0
Story3	Live	Bottom	0	0	0	0	0	0
Story3	Wind load	Top	0	0	0	0	0	0
Story3	Wind load	Bottom	0	0	0	0	0	0
Story3	Storage load	Top	-717.6291	0	0	0	-4305.7744	4305.7744
Story3	Storage load	Bottom	717.6291	0	0	0	4305.7744	-4305.7744
Story3	sesmic load	Top	0	0	0	0	0	0
Story3	sesmic load	Bottom	0	0	0	0	0	0
Story3	Comb1	Top	-1722.3098	-0.5974	-0.4875	-14.6184	-10338.0655	10339.0139
Story3	Comb1	Bottom	1722.3097	0.5974	0.4876	14.6187	10329.6519	-10328.7032
Story2	Dead	Top	-2207.8311	0.0487	0.1971	0.1883	-13177.7512	13271.7141
Story2	Dead	Bottom	1921.5117	0.0487	0.1971	0.1883	11459.8347	-11553.7976
Story2	Live	Top	0	0	0	0	0	0
Story2	Live	Bottom	0	0	0	0	0	0
Story2	Wind load	Top	0	0	0	0	0	0
Story2	Wind load	Bottom	0	0	0	0	0	0
Story2	Storage load	Top	-1385.2596	0.0487	0.1971	0.1883	-8242.3218	8336.2846
Story2	Storage load	Bottom	1098.9401	0.0487	0.1971	0.1883	6524.4053	-6618.3681
Story2	sesmic load	Top	0	0	0	0	0	0
Story2	sesmic load	Bottom	0	0	0	0	0	0
Story2	Comb1	Top	-5298.7947	0.1168	0.473	0.4515	-31626.6027	31852.1139
Story2	Comb1	Bottom	4611.6281	0.1168	0.4731	0.4521	27503.6036	-27729.1142

Figure 9-Story results.

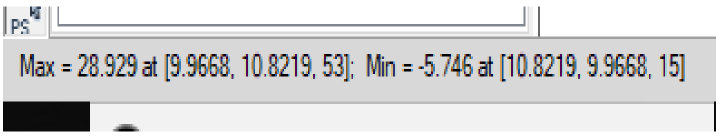

Figure 10- max-min values of moment.

.and the following result shows that the model is fit for containing loads up to 20,000 ton perfectly. And its structural behavior so we can even add-up more than this slightly

A. *Recommendations & discution:-*

Based on the result above and the outcoming strucural result we can coculoud that silos are more than concrete struture with capacity of loading but also a great storage and can contain up to 20000 ton of weight aduqtely if being costructrd cearfully. And more safescitiated based on loading , filling , draining , slope of drainage and defiliction measurment by the BS8110-1997 design recommendation and more sutibale for soil geography in SUDAN with capacity for more and taller height .

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