

# A Review Study on Silos for Safe Storage of Food Grain

Rakesh Kumar<sup>1</sup>, Nitesh Kushwaha<sup>2</sup>

<sup>1</sup>M. Tech. Scholar, <sup>2</sup>Professor,

<sup>1,2</sup>Department of Civil Engineering, Millennium Institute of Technology & Science,  
Bhopal, Madhya Pradesh, India

**How to cite this paper:** Rakesh Kumar | Nitesh Kushwaha "A Review Study on Silos for Safe Storage of Food Grain" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-1, December 2019, pp.531-532, URL: <https://www.ijtsrd.com/papers/ijtsrd29634.pdf>



Copyright © 2019 by author(s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



## INTRODUCTION

Silos are storage structures, capable of retaining tens of thousands of tones of different granular materials, and are vital to industry and the economy. They are, in many respects, under-appreciated by the general public due to their absence from city landscapes, usually banished to bleak industrial complexes or farms. Yet a silo disaster is a significant financial burden, both in terms of the destruction of the structure, the loss of the material stored inside and the halt in productivity at the facility. This field, therefore, merits considerable study.

## Literature Survey

### General

**J. M. Rotter [1992]** This paper presents a summary of recent research on the behaviour and design of conical steel hoppers and transition junctions in both uniformly supported and column-supported circular steel silos. The hopper in a steel silo supports the majority of the weight of the stored bulk solid and can fail in several different modes including membrane yielding and meridional rupture. The junction between the hopper, the cylinder and the skirt is termed the transition junction. It is subject to a large circumferential compression which arises from the meridional tension in the hopper and is therefore often strengthened by a ring. The transition junction can fail by elastic or plastic buckling of the ring or by plastic collapse of the hopper/cylinder/skirt/ring junction. A comprehensive picture of the behaviour and design of hoppers and transition junctions in a uniformly supported silo is presented, and several important design aspects of hoppers and transition junctions in column-supported silos are discussed.

**SUNIL R. DE SILVA [2003]** A finite element analysis has been carried out to investigate flow patterns and loads on silos either with a relatively steep hopper, or with a shallow hopper but in the presence of an insert. A Lagrangian-Eulerian approach was first adopted to simulate the material flow pattern. With the precondition that mass flow was obtained, it was then attempted to predict the loads exerted by granular materials on the walls of such silos. The load on the insert was also simulated. Techniques such as the adoption of adaptive meshes and filleting along sharp corners were applied in the analysis to overcome the difficulties usually encountered with large deformations in the FEM and

the mathematic singularity presented by the abruptness of geometry. Filleting proved to be necessary to bring down the pressure peak at the transition level. The insert took over a significant part of the loads. Comparison with the classic theories have confirmed that the loads predicted on the wall agree quite well with the theoretical results in the silo's cylinder section, but that differences exist in the hopper section; the difference is greater when the hopper is shallower. It has also shown the limitations of predicting flow patterns of granular materials with the traditional elastic-plastic model; a more advanced model is needed. Significant work has been completed in the field of designing the Silos. Most of the researchers have focused on only one of the components of Silo by using analytical and numerical methods.

**Muhammad Umair Saleem (2018)** Reinforced concrete silos and bunkers are commonly used structures for large storage of different materials. These structures are highly vulnerable when subjected to intense seismic forces. Available guidelines for analysis and design of these structures require special design skills and code procedures. Objective: The current study is aimed to elaborate the design procedures from different sources to a unified method, which can be applied to a larger class of reinforced concrete silos. In this study, analysis and design procedures are summarized and presented in a simplified form to make sure the efficient practical design applications of reinforced concrete silos. Method: Four different cases of silo design based on the type and weight of stored material were considered for the study. For each case, the silo was designed using given design procedure and modeled using FEM-based computer package. All of the reinforced concrete silos were subjected to gravity, wind and seismic forces. Results: After performing the analysis and design of different silos, the bending moment, shear force and axial forces profiles were given for a sample silo. The results obtained from the proposed design procedure were compared with FEM values for different components of silos such as slab, wall and hopper. Conclusion: The comparison of tangential and longitudinal forces, bending moments, shear forces and reinforcement ratios of different parts of silos have shown a fair agreement with the FEM model results. It motivates to use the proposed design procedure for an efficient design of reinforced concrete silos.

**Silvestri et al. [2019]** described a series of laboratory tests that featured shaking table and a silo model, which were conducted in order to obtain some experimental data to verify the proposed theoretical formulations and to compare with the established code provisions. The results indicated that in all the cases, the effective mass is indeed lower than the Eurocode specification.

**Christoph Butenweg [2019]** The current study is aimed to elaborate the design procedures from different sources to a unified method, which can be applied to a larger class of reinforced concrete silos. In this study, analysis and design procedures are summarized and presented in a simplified form to make sure the efficient practical design applications of reinforced concrete silos.

**Rini Riyansi.E [2019]** In this Project, analysing, designing and comparative study on silo supporting structure using RCC and STEEL are done. The General Arrangement (GA) drawings are prepared using the 2D drawing software-AUTOCAD and the structural modelling, analysis and design can be done using structural software-STADD PRO v8i. The structural analysis can be done using stiffness matrix method and the design will be done based on IS code standards.

#### Problem Identification

Review of different papers related to the subject was done. Some problems were identified such as:-

- In past, researchers have studied the shear behavior of Silo. the model used for the nonlinear time history analysis Considers.

#### Objectives

The objectives of the research are outlined below:

- Study on Silos for Safe Storage of Food Grain.

#### CONCLUSIONS

A detailed analytical study on the different type of silos was conducted to evaluate the existing load calculation procedures and design methodologies. Silo height, diameter and unit weight of stored materials were the parameters of the study..

#### REFERENCES

- [1] Ding, S., Ji, Y., Ye, S., Rotter, J.M. and Li, Q. (2014), "Measurements of pressure and frictional tractions along walls of a large-scale conical shallow hopper and comparison with Eurocode 1991-4:2006", *Thin-Wall. Struct.*, 80, 231-238.
- [2] Drescher, A. (1991), "Analytical methods in bin-load analysis", Elsevier Science, New York.
- [3] Eurocode (2001), EN 1993-1-3, Eurocode 3: Design of Steel Structures, Part 1.3: General Rules- Supplementary Rules for Cold Formed Thin Gauge Members and Sheeting, European Committee for Standardization, Brussels.
- [4] Eurocode (2007a), EN 1991-4, Eurocode 1: Basis of Design and Actions on Structures, Part 4 - Silos and Tanks, European Committee for Standardization, Brussels.
- [5] Eurocode (2007b), EN 1993-4-1, Eurocode 3: Design of Steel Structures, Part 4.1: Steel Silos, European Committee for Standardization, Brussels.
- [6] Gallego, E., González-Montellano, C., Ramírez, A. and Ayuga, F. (2011). "A simplified analytical procedure for assessing the worst patch load location on circular steel silos with corrugated walls", *Eng. Struct.*, 33(6), 1940-1954.
- [7] Öztürk, T. and Kibar, H. (2008a), "The design parameters of storage load in the cylindrical storage structures for hazelnut", *J. Fac. Agric. Univ. Ondokuz Mayıs*, 23, 98-103.(in Turkish)
- [8] Öztürk, T., Esen, B. and Kibar, H. (2008b), "The design loads depend on the grain moisture content in a cylindrical storage structure for corn", *J. Fac. Agric. Univ. Ondokuz Mayıs*, 23, 110-115.(in Turkish)
- [9] Rejowski, K. and Ivicki, P. (2016), "Buckling analysis of cold formed silo column", *Mech. Mech. Eng.*, 20(2), 109-120.
- [10] Rotter, J.M. (2001), *Guide for the economic design of circular metal silos*, CRC Press, UK.
- [11] Rotter, J.M. (2009), "Silos and tanks in research and practice: state of the art and current challenges", *Proceedings of the International Association for Shell and Spatial Structures (IASS) Symposium, Universidad Politecnica de Valencia, September-October.*
- [12] Sanad, A. M., Ooi, J. Y., Holst, J. M. F. G. and Rotter, J. M. (2001), "Computations of granular flow and pressures in a flat-bottomed silo", *J. Eng. Mech.*, 127(10), 1033-1043.
- [13] Song, C. Y. (2004), "Effects of patch loads on structural behavior of circular flat-bottomed steel silos", *Thin Wall. Struct.*, 42(11), 1519-1542.
- [14] Tejchman, J. (2002), "Effects of wall inclinations and wall imperfections on pressures during granular flow in silos", *Kona*, 17, 125-132.
- [15] Teng, J.G. and Rotter, J.M. (1991), "The strength of welded steel silo hoppers under filling and flow pressures", *J. Struct. Eng.*, 117(9), 2567-2583.
- [16] Vidal, P., Guaita, M. and Ayuga, F. (2004), "Parametric study of the pressures of cylindrical silos with rigid wall", *ASAE Annual International Meeting, Paper Number: 044152, 1-10.*