Study on Silos for Safe Storage of Food Grain Using Staad Pro V8i Software

Rakesh Kumar[1], Nitesh Kushwaha[2]

[1]M. Tech. Scholar, [2]Professor

Department of Civil Engineering, Millennium Institute of Technology & Science, Bhopal India

Abstract - A silo is a structure for storing bulk materials. They are commonly used for bulk storage of coal, cement, carbon black, woodchips, food products and sawdust. The design of silos to store bulk solids involves bulk materials, geometry and structural considerations.

Generally the supporting structures are said to be staging. Here 3 number of silos are taken into consideration. The design of silo also based on the density and angle of internal friction of material to be stored. In past, researchers have studied the shear behavior of Silo. the model used for the nonlinear time history analysis Considers. In this work Study on Silos for Safe Storage of Food Grain Using Staad Pro V8i Software, Comparison of Grain Storage Silo With Different Height (Silo of various height i.e. 12m, 16 m, 20m) in Seismic Zone III Using STAAD-Pro V8i Software. The structural modelling and analysis can be done using structural software-STADD PRO v8i. The structural analysis can be done using FEM method For this structure, not only considering the vertical forces (Dead load & live load) but also considering the laterals forces like wind load and Seismic loads for structural analysis and design Reinforced concrete silos are commonly used structures for large storage of different materials.

I. 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.

II. LITERATURE SURVEY

General

Sun et al. [2018] researched on thermal stress of large diameter concrete silos. Inner force calculation formula of large diameter silo wall subjected to solid load and temperature action was derived based on cylindrical shell theory with the moment. Work has been done in the field of dynamic design of silos and their behavior under earthquake.

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.

III. OBJECTIVES

The objectives of the research are outlined below:

- Study on Silos for Safe Storage of Food Grain Using Staad Pro V8i Software.

IV. METHODOLOGY

This thesis deals with relative study of behavior of silo considering different height under earthquake forces. The comparison of different height of silos under seismic forces is done. Here 3 cases are taken and same load is applied in three silos for its behavior and comparison. Preparation of geometry in STAAD PRO

Silo Details

Case- I Diameter = 6 m

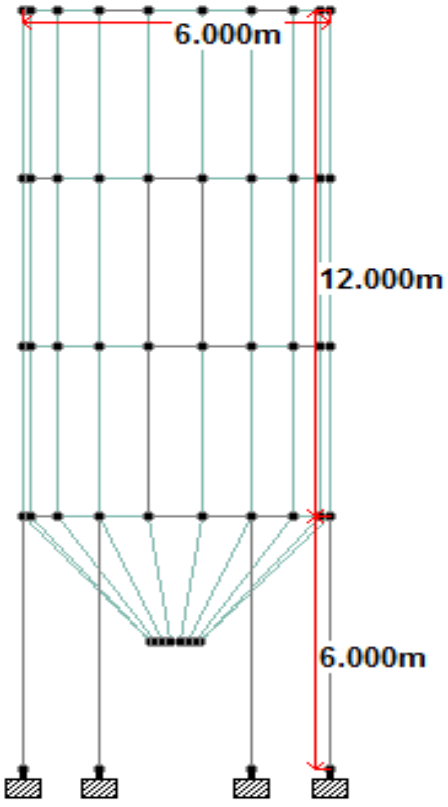
Height = 12 m

Seismic Zone = 3

Grain = Wheat

Grain Density = 790 kg/ cum

Angle of Repose = 28 degree



Case – II Diameter = 6 m

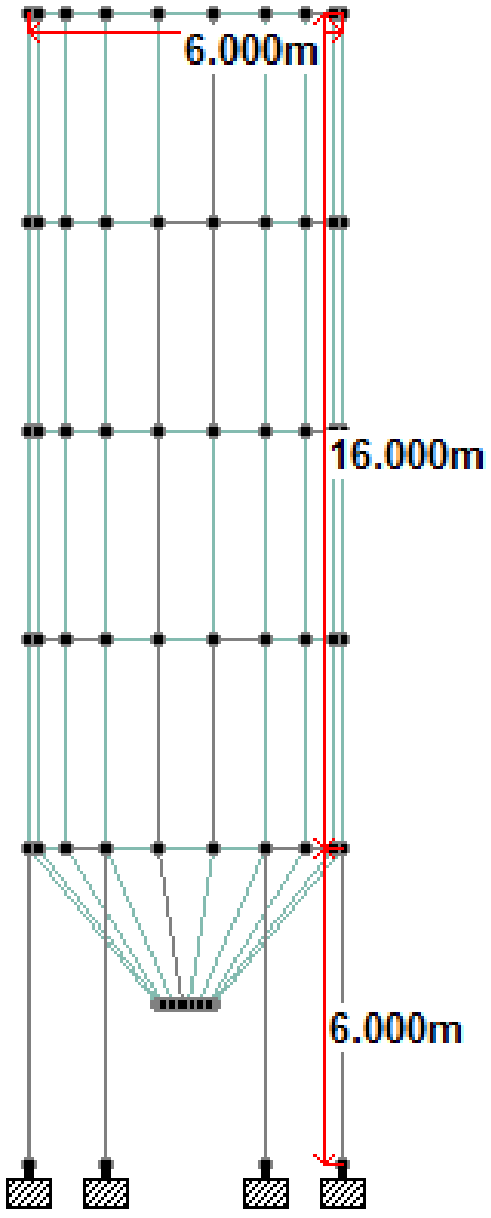
Height = 16 m

Seismic Zone = 3

Grain = Wheat

Grain Density = 790 kg/ cum

Angle of Repose = 28 degree



Case III Diameter = 6 m

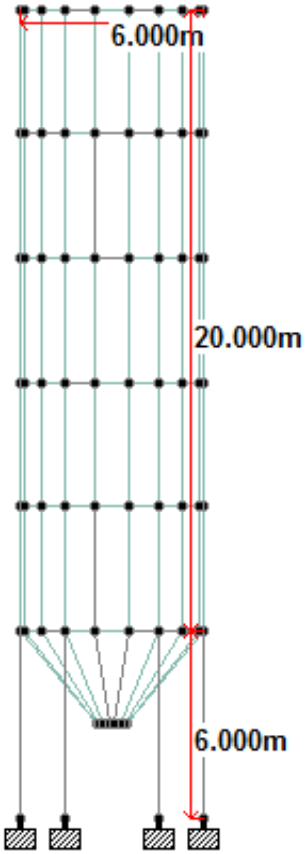
Height = 20 m

Seismic Zone = 3

Grain = Wheat

Grain Density = 790 kg/ cum

Angle of Repose = 28 degree



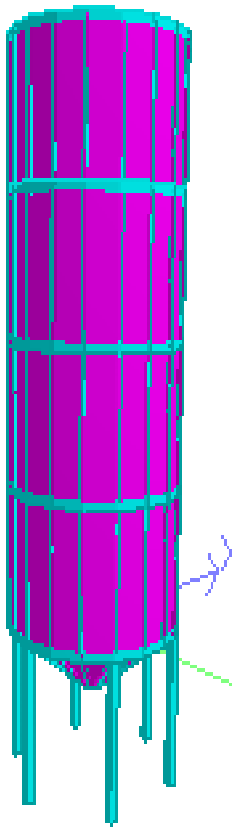


Fig 4.4 Silo (Dia = 7m & Ht = 17.6m)

V. RESULTS

5.2.1 Displacement Comparison Graph Silo Max X

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Displacement in X Direction (in mm)	5.806	6.711	7.775

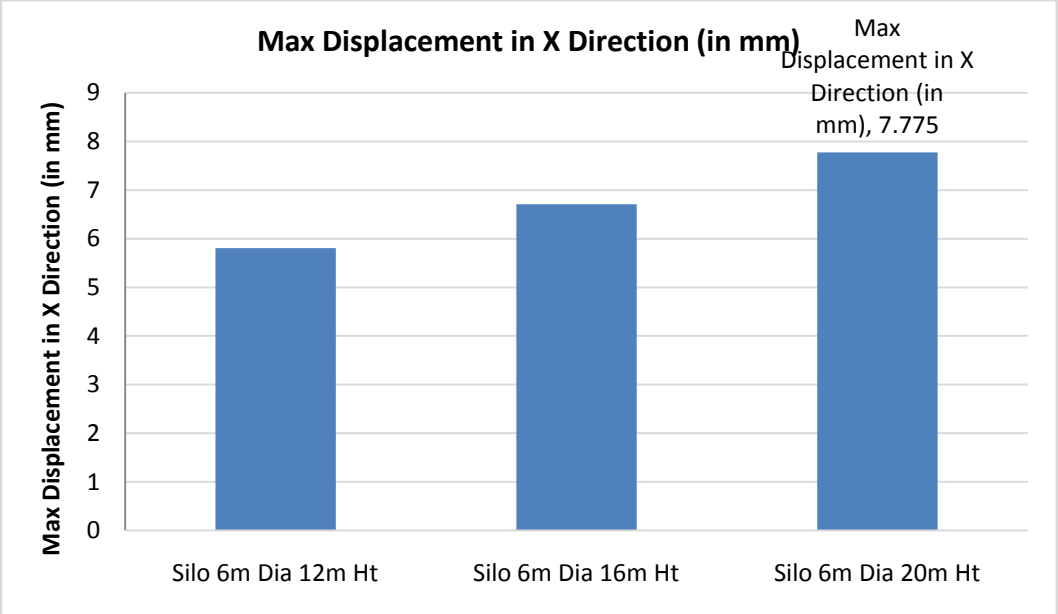


FIG. 5.1 Max Displacement in X Direction (in mm)

5.2.1 Displacement Comparison Graph Silo Max Y

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Displacement in Y Direction (in mm)	0.095	0.137	0.186

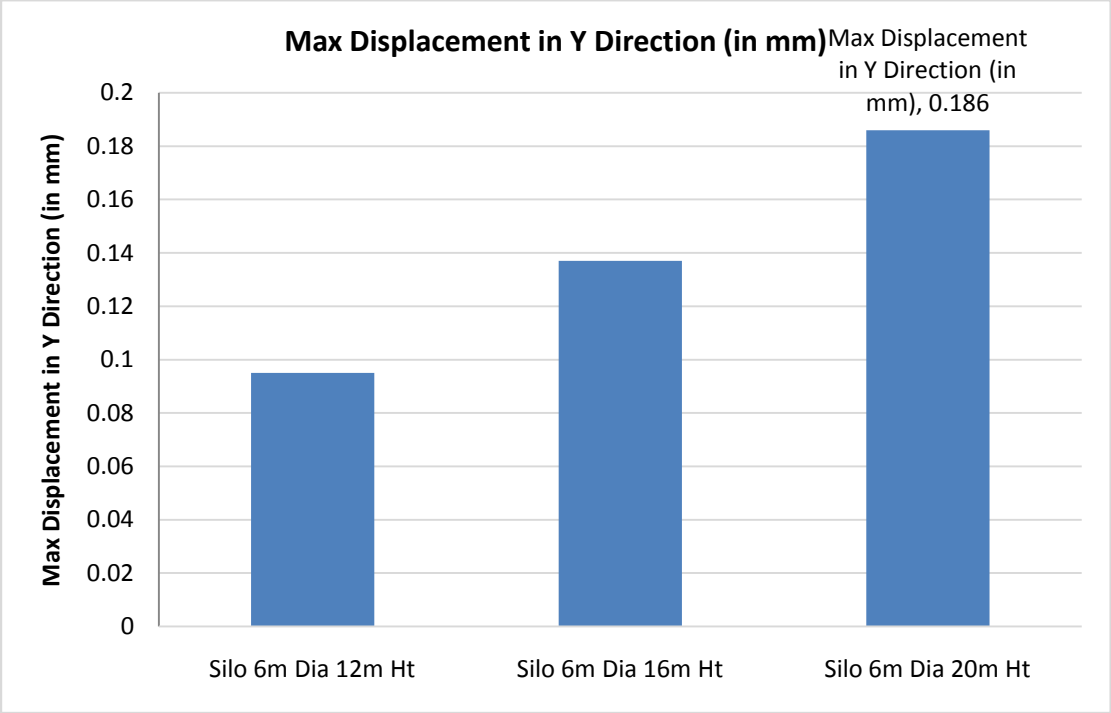


FIG. 5.1 Max Displacement in Y Direction (in mm)

5.2.1 Displacement Comparison Graph Silo Max Z

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Displacement in Z Direction (in mm)	5.806	6.711	7.775

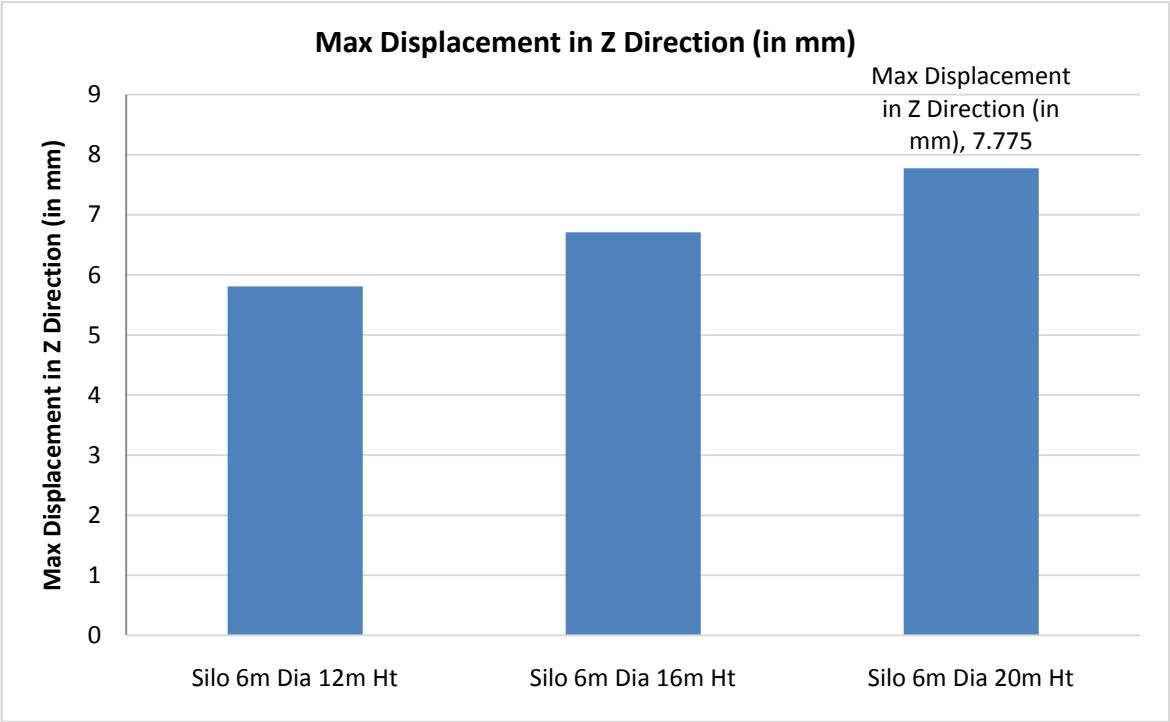
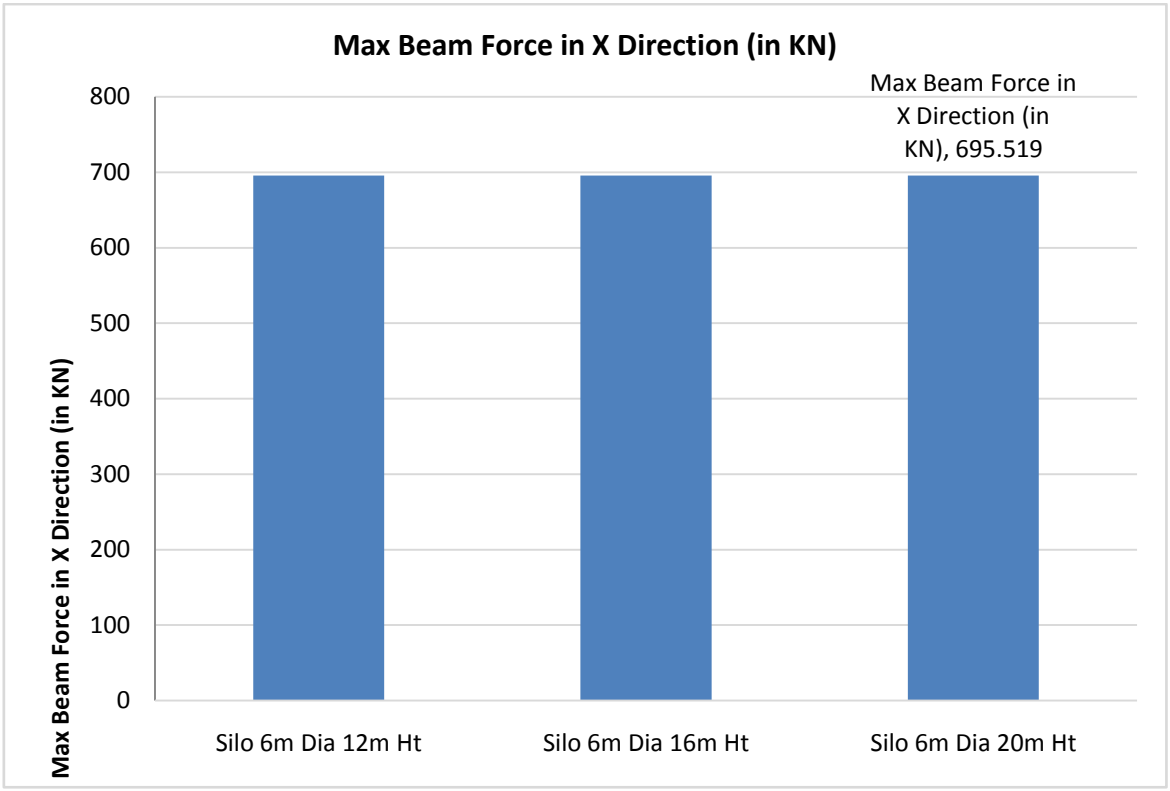


FIG. 5.1 Max Displacement in Z Direction (in mm)

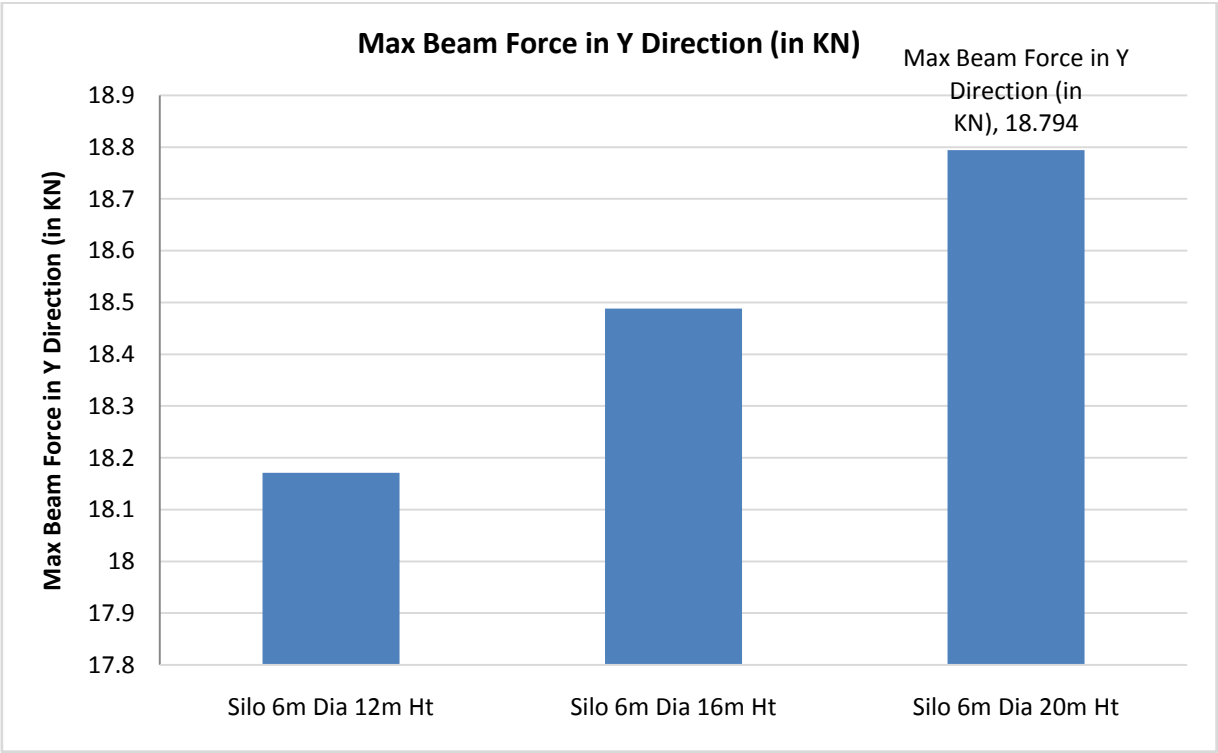
5.2.2 Comparison of Max Beam Force in X Direction (in KN) at different Height of Silos

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Beam Force in X Direction (in KN)	695.519	695.519	695.519



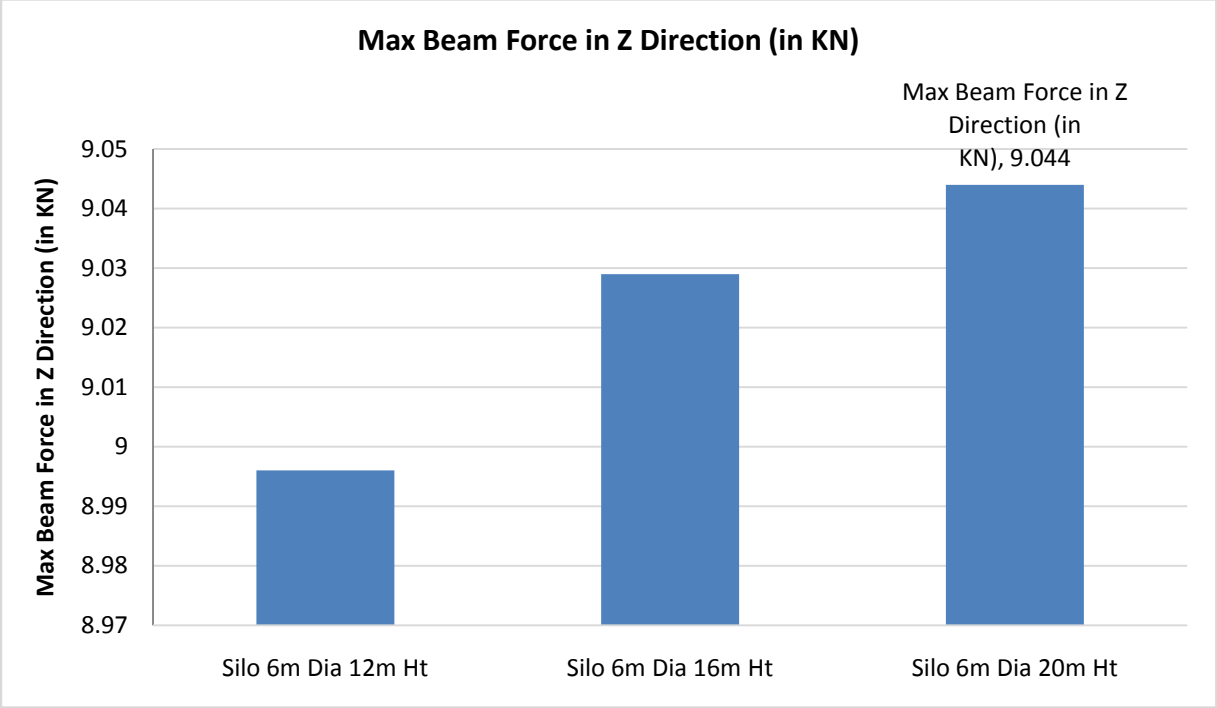
5.2.2 Comparison of Max Beam Force in Y Direction (in KN) at different Height of Silos

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Beam Force in Y Direction (in KN)	18.171	18.488	18.794



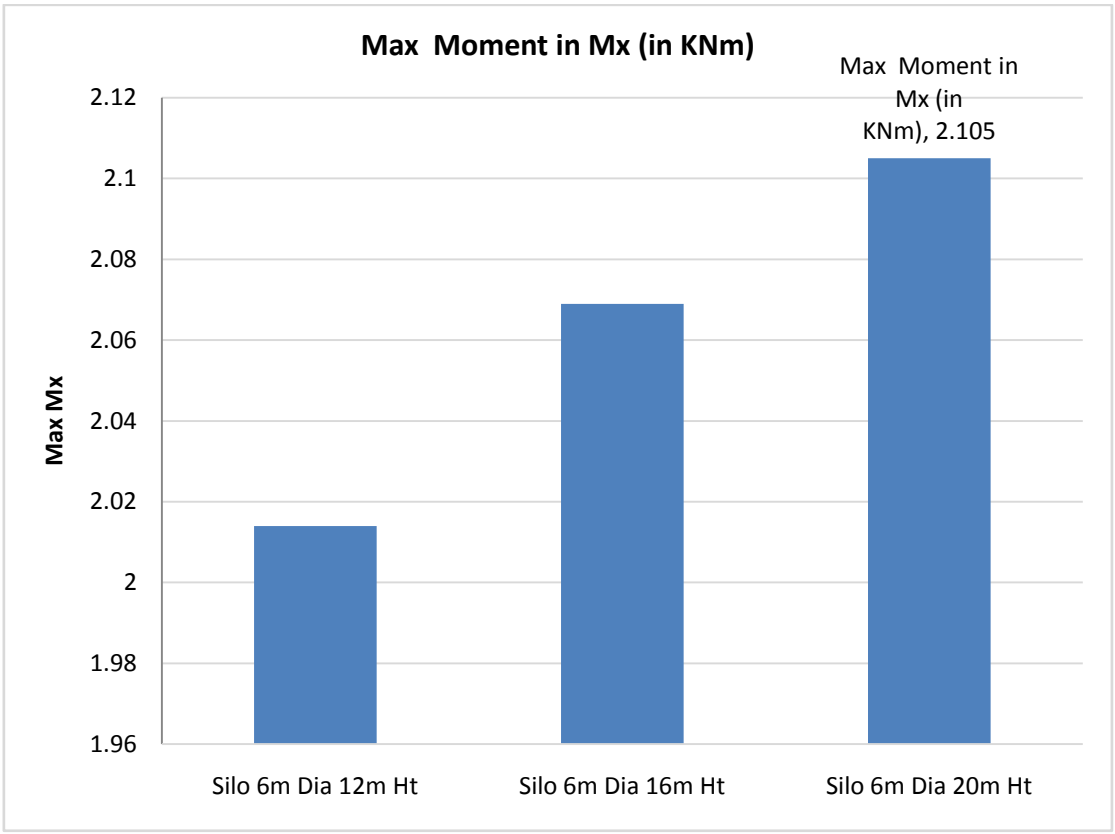
5.2.2 Comparison of Max Beam Force in Z Direction (in KN) at different Height of Silos

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Beam Force in Z Direction (in KN)	8.996	9.029	9.044



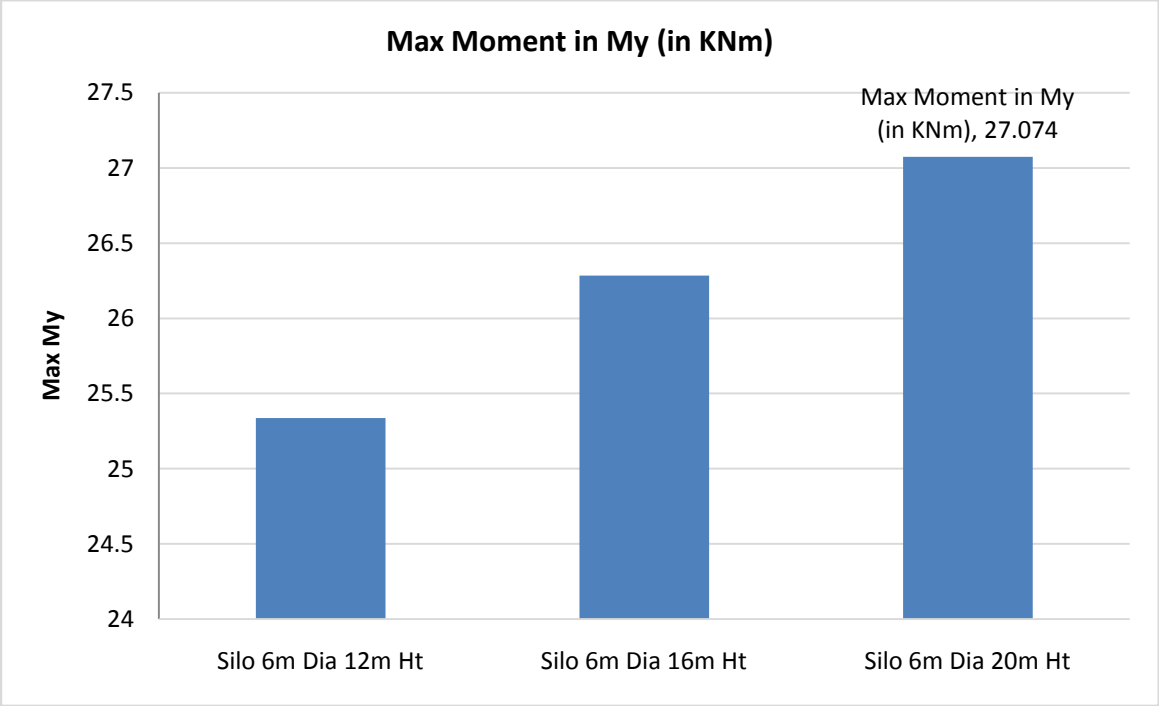
5.2.2 Comparison of Max Moooment in X Direction (in KN-m) at different Height of Silos

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Moment in Mx (in KNm)	2.014	2.069	2.105



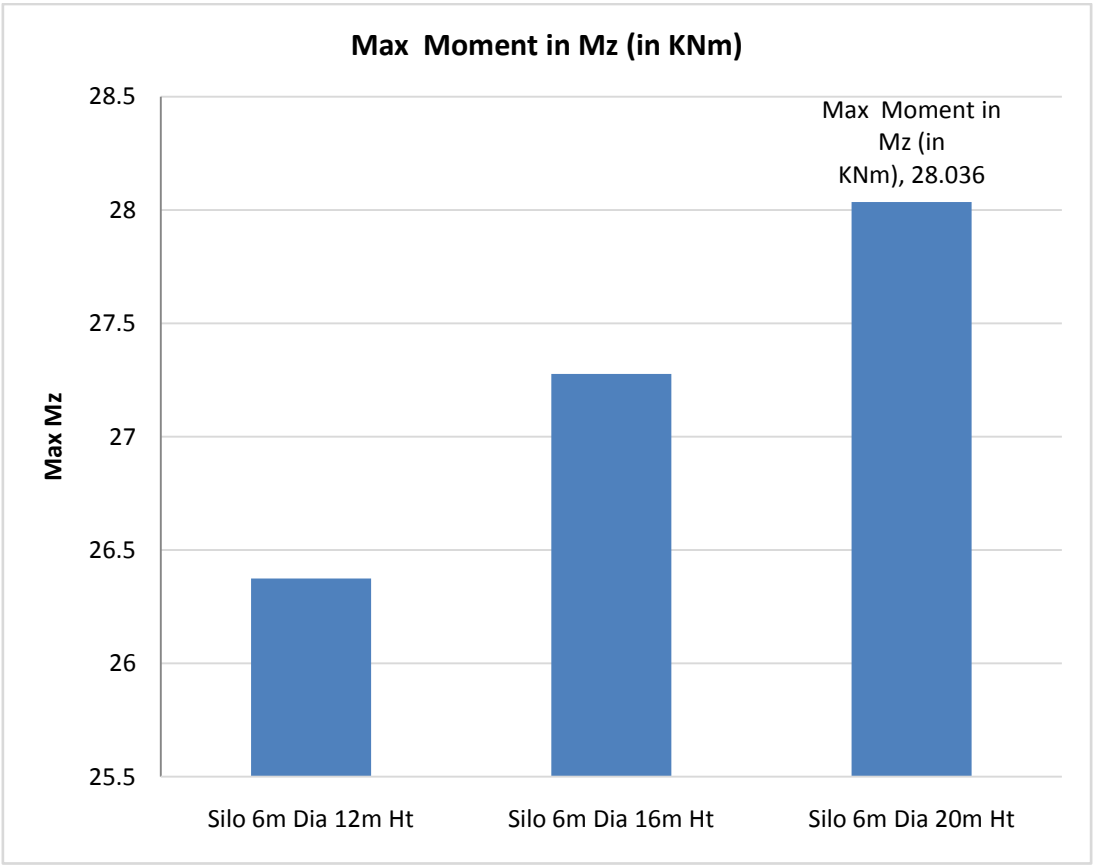
5.2.2 Comparison of Max Moooment in Y Direction (in KN-m) at different Height of Silos

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Moment in My (in KNm)	25.337	26.284	27.074



5.2.2 Comparison of Max Moooment in Z Direction (in KN-m) at different Height of Silos

	Silo 6m Dia 12m Ht	Silo 6m Dia 16m Ht	Silo 6m Dia 20m Ht
Max Moment in Mz (in KNm)	26.374	27.277	28.036



VI. CONCLUSIONS

Findings of the project can be concluded as below:

1. Silo of various height i.e. 12m, 16 m, 20m show max displacement of 5.806mm, 6.711mm, 7.775mm respectively.
2. Silo of various height i.e. 12m, 16 m, 20m show max beam forces of 695.519 KN for all conditions.
3. Silo of various height i.e. 12m, 16 m, 20m show max beam moments of 26.374KNm, 27.277KNm, 28.036KNm respectively.

REFERENCES

[1] Briassoulis, D. (2000), "Finite element analysis of a cylindrical silo shell under unsymmetrical pressure distributions", Comput. Struct., 78(1), 271-281.

[2] Brown, C.J., Lahlouh, E.H. and Rotter, J.M. (2000), "Experiments on a square planform steel silo", Chem. Eng. Sci., 55(20), 4399-4413.

[3] Carson, J.W. (2015), "Limits of silo design codes", Pract. Period. Struct. Des. Constr., Article number 04014030.

[4] Carson, J.W. and Craig, D. (2015), "Silo design codes: their limits and inconsistencies", Procedia Eng., 102, 647-656.

[5] 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.

[6] Drescher, A. (1991), "Analytical methods in bin-load analysis", Elsevier Science, New York.

[7] 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.

[8] Eurocode (2007a), EN 1991-4, Eurocode 1: Basis of Design and Actions on Structures, Part 4 - Silos and Tanks, European Committee for Standardization, Brussels.

[9] Eurocode (2007b), EN 1993-4-1, Eurocode 3: Design of Steel Structures, Part 4.1: Steel Silos, European Committee for Standardization, Brussels.

[10] 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.