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Design And Estimation Of Bucket Elevator Tower Using Tekla Structure

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Abstract. The bucket elevator tower is a necessary supporting structure in silo structures that allows for the vertical transportation of bulk commodities like grains, cement, and other aggregates. The current research involves the design and estimation of a bucket elevator tower with the use of Tekla Structures software. The design process aims to ensure stability, durability, and safety against static and dynamic loads and also satisfaction of functional requirements. Tekla Structures supports precise 3D modeling, detailing, and clash detection to ensure accuracy of structural elements like columns, bracings, and connections. The software also supports material optimization, minimizing wastage and project cost. Load factors like wind, seismic, and operating loads are included to improve structural performance. The estimation process offers a detailed bill of materials (BOM), cost estimation, and fabrication information, allowing effective project planning and execution. This methodology provides reliability in construction, enhances productivity, and reduces errors over traditional methods. The result is a cost-efficient and structurally sound bucket elevator tower appropriate for contemporary silo use.

Keywords- Tekla Structures (2025), Silo Structures, Steel Detailing, 3D Modelling, Fabrication Planning.

I. Introduction

The bucket elevator tower plays a vital role in modern silo structures by enabling the efficient vertical transportation of bulk materials such as grains, cement, fertilizers, and aggregates. As industries continue to expand and demand higher storage and handling capacities, the need for structurally sound, reliable, and cost-effective supporting systems has become increasingly important. A bucket elevator tower not only houses the conveying mechanism but also supports dynamic operational loads, making its design a critical aspect of industrial infrastructure.

Traditionally, the design and detailing of such steel structures relied heavily on manual calculations and 2D drafting, which often led to inaccuracies, increased material wastage, and coordination issues during construction. However, with the advancement of digital tools like Tekla Structures, the approach to structural design has significantly evolved. Tekla Structures provides a comprehensive platform for 3D modeling, analysis, and detailing, allowing engineers to visualize the complete structure before fabrication. This enhances accuracy, ensures proper alignment of components such as columns, bracings, and connections, and minimizes the risk of clashes during construction.

Overall, the adoption of advanced modeling and estimation tools in the design of bucket elevator towers has transformed traditional practices into more efficient, accurate, and economical processes. This shift not only improves construction quality but also contributes to safer and more sustainable industrial operations.

In addition to geometric modeling, modern design practices also emphasize the consideration of various load conditions, including wind, seismic, and operational loads, to ensure the stability and durability of the structure. The integration of these factors within advanced software environments enables optimized material usage and improved structural performance. Furthermore, the generation of detailed bills of materials (BOM) and cost estimates supports efficient project planning, resource management, and timely execution.

II. Types Of Structures

Steel structures are broadly classified into several types based on their structural behavior and application. The most commonly used systems include steel frame structures, steel truss structures, steel arch structures, steel shell structures, steel cable and suspension structures, and composite steel structures. Each type serves a specific purpose in construction depending on factors such as span, load requirements, and architectural design. Steel frame structures are widely used in buildings due to their flexibility and strength, while truss structures are preferred for long spans and efficient load distribution. Arch and shell structures provide aesthetic appeal along with structural efficiency, whereas cable and suspension systems are ideal for very long spans such as bridges. Composite steel structures combine steel with materials like concrete to enhance performance and durability.

A typical steel structure consists of several essential components that work together to ensure stability and strength. These include beams and girders, which primarily carry loads, and columns that transfer loads to the foundation. Trusses are used for spanning large distances, while purlins support roof coverings. Bracings provide lateral stability and help resist wind and seismic forces. Gusset plates are used to connect different structural members, and ties and struts help maintain the structural integrity by resisting tension and compression forces. Roof covering or cladding protects the structure from environmental conditions. Fasteners and connections, such as bolts and welds, play a crucial role in joining the components securely. Finally, the foundation supports the entire structure and transfers loads safely to the ground.

III. Components Of Bucket Elevator

The bucket elevator tower is a steel structural system designed to support vertical conveying equipment and safely transfer loads to the foundation. Columns act as the main vertical load-bearing members, transferring loads from the structure and machinery to the ground. Beams and girders are horizontal elements that connect columns and support platforms, floors, and equipment loads. Bracings are provided to maintain lateral stability and to resist wind and seismic forces.The structure also includes platforms and ladders for easy access and maintenance of the bucket elevator system. Connections such as bolts and welds play a crucial role in holding all components together securely. Cladding or sheeting is used to protect the structure from environmental conditions like rain and dust. The foundation forms the base of the tower and safely transfers all loads

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to the soil. Additionally, special supports are provided to carry the bucket elevator equipment, including motors, pulleys, and moving buckets. All these components are accurately modeled, detailed, and estimated using Tekla Structures to ensure precision, safety, and cost-effective construction.

IV. Orientation

Orientation in steel structures refers to the correct positioning and alignment of structural members such as beams, columns, trusses, and bracings to ensure efficient load transfer, overall stability, and safety of the structure. Proper orientation enables members to perform effectively by utilizing their strong axis, thereby increasing load-carrying capacity and resistance to external forces such as wind and seismic effects.

It also plays a crucial role in maintaining structural balance and ensuring that connections between members are efficient and reliable. In addition, correct orientation simplifies fabrication and erection processes, reducing errors during construction and improving overall performance. Several factors influence the orientation of steel structures, including the direction and magnitude of loads acting on the structure, the need for structural stability, and the strong and weak axis behavior of steel sections.

Architectural layout requirements also affect how members are placed, while environmental forces such as wind and earthquakes must be considered to ensure safety. Furthermore, the design of connections and joints, along with practical considerations related to fabrication and erection constraints, significantly impact the final orientation of structural components.

V. Methodology

Fig.5.1 Methodology

VI. Planning

6.1 General Specifications:

• Type of Structure	- Tower Structure
• Total Tonnage of Structure	- 244.61 T
• Hight of structure	- 54000 mm
• Types of Base Plate	- B.P with Anchor Rod & Shear Key
• Total gross area	- 4,80,00,000 sq.mm
• Total No of Parts	- 4771 parts
• Column Profile	- ISMB600
• Column Profile	- ISMB400
• Beam Profile	- ISMB300
• Beam Profile	- ISMB200
• Total number of columns	- 6 no's
• Number of beam	- 314 no's
• Material of Steel	- IS2062
• Number of brace	-452no's
• Number of stairs	- 18no's
• Number of Purlin	- 8no's
• Number of Bolts	- 7106bolts
• Material of Steel	- IS2062
• Footing	- M30 grade

DESCRIPTION	PROFILE'S
• Main Beam	- ISMB300
• Secondary Beam	- ISMB200
• Main Column	- ISMB600
• Secondary Column	- ISMB400
• Bracing	- ISMB200
• Stringer	- ISMC250
• Steps	- PLT300*20
• Base Plate	- PLT 1000X1000X30
• 2nd Base Plate	- PLT700X700X25
• End Plate	- PLT10
• Hand Rail	- PD50*5
• Middle Rail	- PD30*3
• Stanchions	- PD48.3*3.2
• Roof Panel	- 1mm Thick Sheet

6.2 Grid Plan (PLAN @ 0)

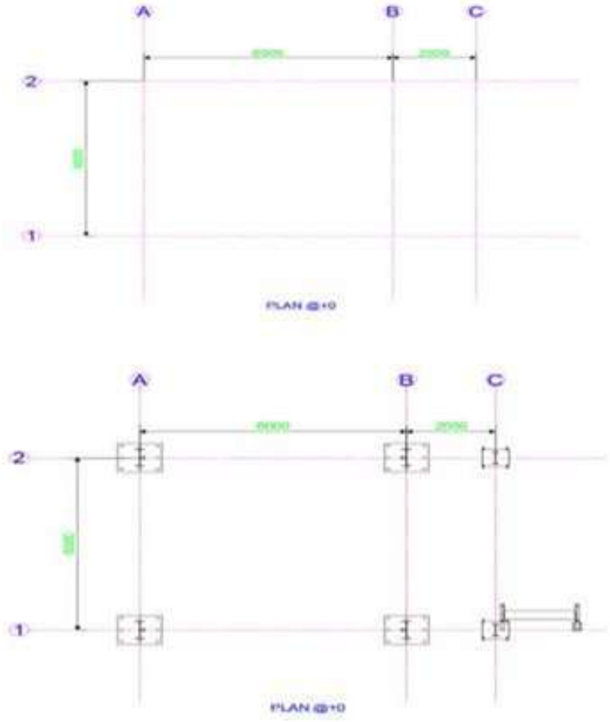

Fig.6.1 Grid Plan

6.3 GRID @ 1

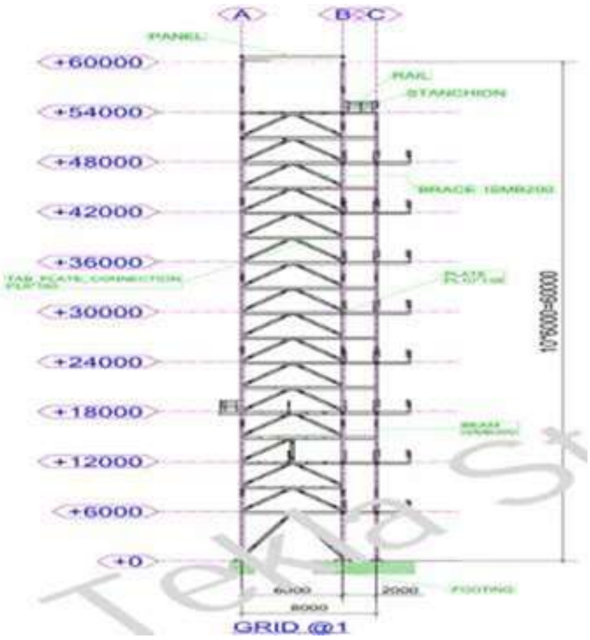

Fig.6.2 Plan @ 3000

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6.3 Grid @ 2

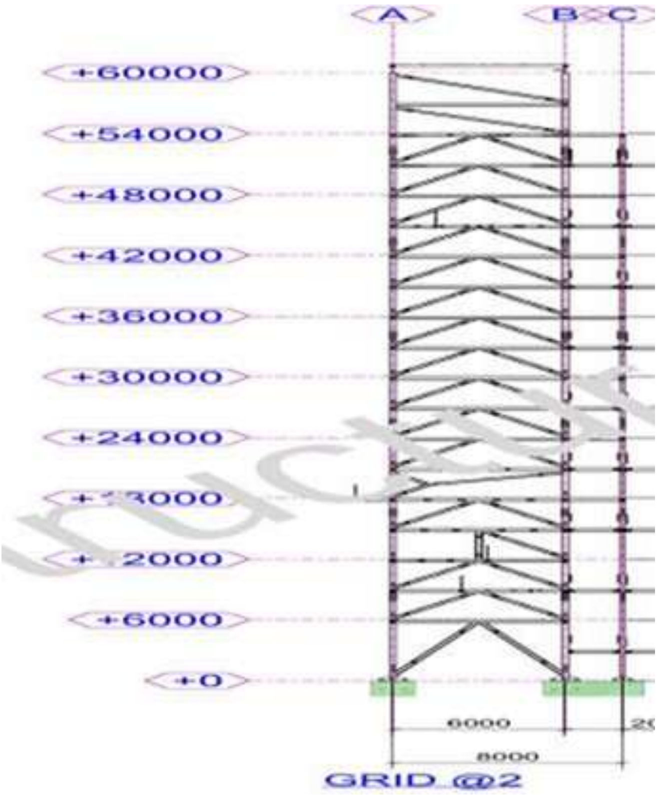

Fig.6.3 Grid @ 2

6.4 Grid @ A

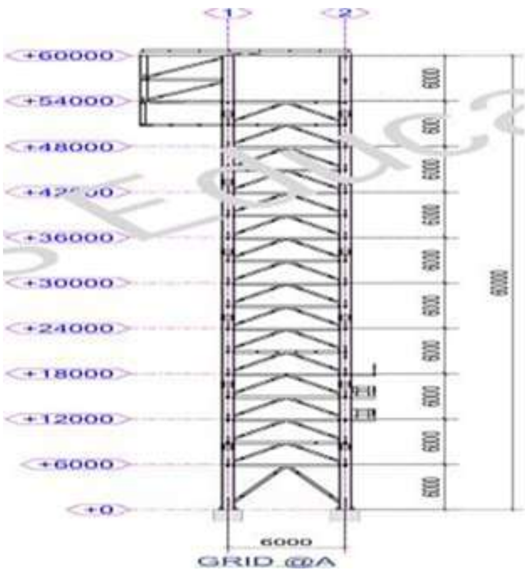

Fig.6.4 Grid @ A

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6.5 Grid @ B

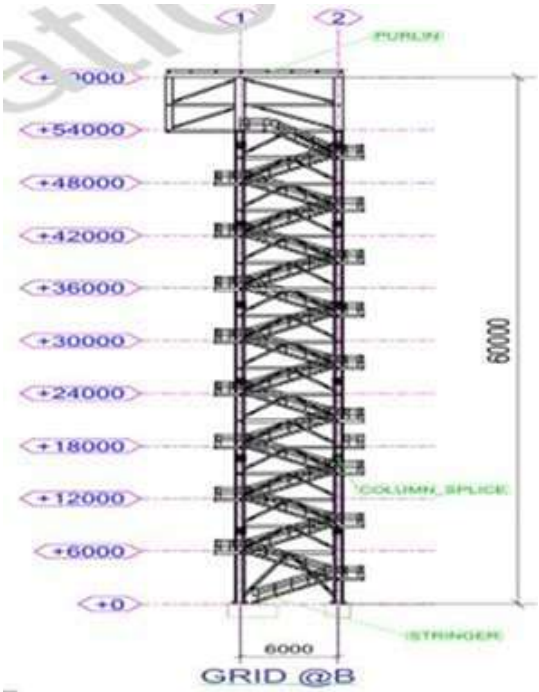

Fig.6.5 Grid @ B

6.6 3D View

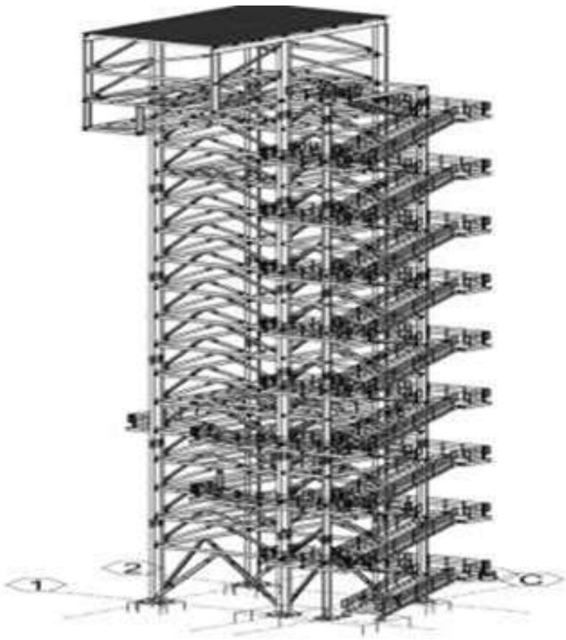

Fig.6.6 3D View

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6.7 Base Plate Detail

The base plate in a steel structure is a crucial component that connects the steel column to the concrete foundation. It distributes the column load evenly to the concrete, preventing crushing or uneven settlement. Base plates are usually made of thick steel plates and are fixed with anchor bolts for stability and alignment. They are designed based on axial load, bending moment, and shear force considerations. Grout is applied beneath the plate to ensure full contact with the foundation surface. Proper base plate design ensures structural stability, load transfer efficiency, and durability of the overall steel structure.

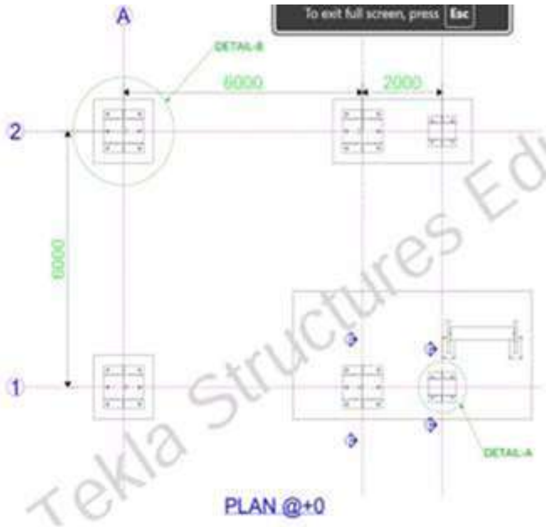

Fig.6.7 Base Plate Detail

6.8 Detail - A

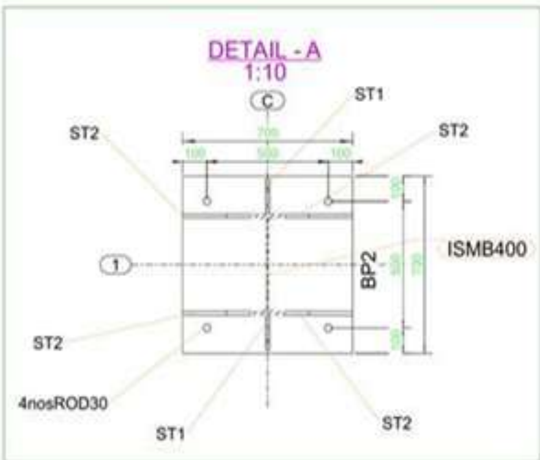

Fig.6.8 Detail - A

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6.9 Detail - B

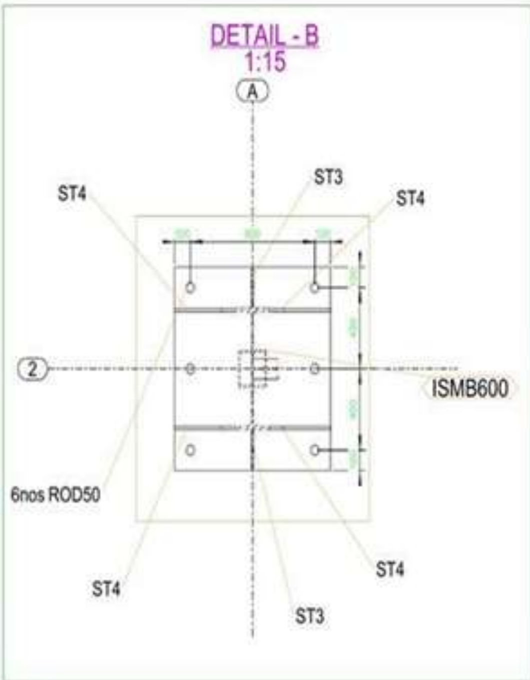

Fig.6.9 Detail - B

6.10 Section A-A

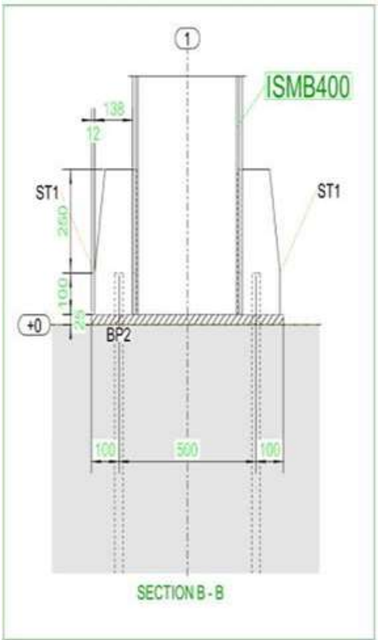

Fig.6.11 Section B-B

VII. Project Implementation

7.1 Input Of Data

The Design and Estimation of a Bucket Elevator Tower using Tekla Structure focuses on developing a precise 3D structural model with accurate dimensions for columns, beams, bracings, baseplates, and connections. Tekla facilitates detailed modeling of the tower framework, bucket elevator housing, and maintenance platforms. Critical load factors such as dead load, live load, wind pressure, and seismic effects are integrated to ensure stability and safety. The software further provides fabrication drawings, general arrangement plans, and a comprehensive bill of materials (BOM), supporting accurate estimation and efficient construction planning.

7.1.1 Grid Properties

Fig.7.1 Grid Properties

7.1.2 Column Assembly

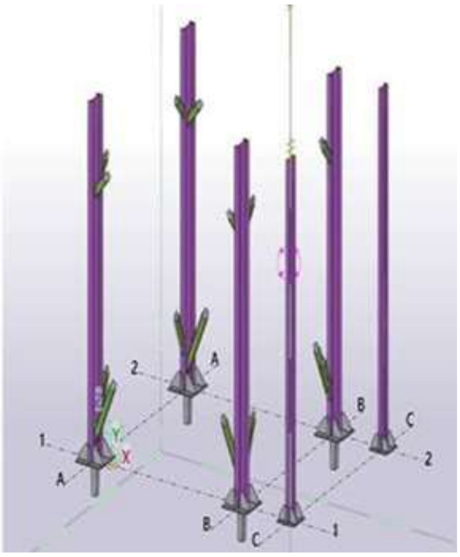

Fig.7.2 Column Assembly

7.1.3 Bucket Elevator Tower

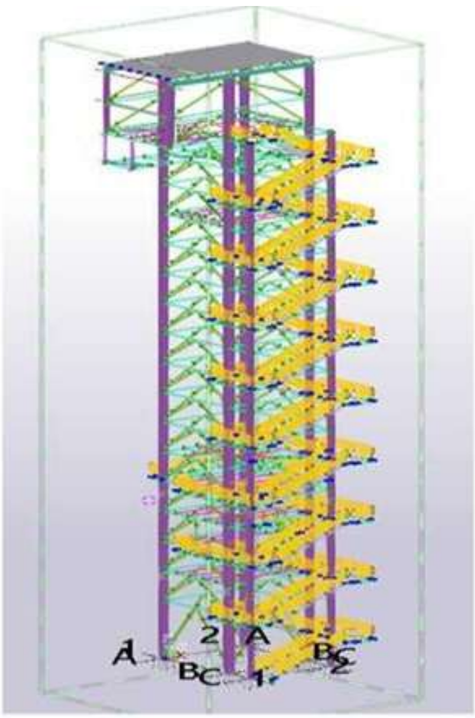

Fig.7.3 Bucket Elevator Tower

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VIII. Estimation

8.1 Bill Of Materials

A Bill of Materials (BOM) is a comprehensive list of all materials, components, and parts needed to manufacture, fabricate, or assemble a product or structure. It acts like a shopping list + assembly guide for engineers, fabricators, and procurement teams. Peltier devices, which convert temperature differences into electrical power, offer an innovative method to harness the heat generated from MSW combustion. These devices operate by utilizing the thermal gradient between the hot and cold sides, with the heat from the incinerator being absorbed on the hot side and the cold side dissipating into the surrounding environment. Although the efficiency of Peltier devices is lower compared to conventional power generation technologies, their ability to generate electricity from waste heat makes them an ideal solution for small scale and localized applications, particularly in areas with limited access to large scale infrastructure.

8.1.1 Material List

TEKLA STRUCTURES MATERIAL LIST FOR CONTRACT No:1000 Page: 1
TITLE: Trimble Solutions*** Date: 02.10.2025

Size	Grade	Qty.	Length(mm)	Area(m²)	Weight(kg)
1500*1500	M30	2	1500	13.5	8100.0
1500*1500	M30	1	3500	25.5	18900.0
			6500	52.5	35100.0
3000*1500	M30	1	6000	63.0	64800.0
			6000	63.0	64800.0
RLL80*80*10	IS2062	502	125	0.0	1.5
			62750	21.6	738.9
ISMB200	IS2062	64	2190	1.6	52.9
ISMB200	IS2062	64	795	0.6	19.2
ISMB200	IS2062	64	627	0.5	15.2
ISMB200	IS2062	58	2688	2.0	65.0
ISMB200	IS2062	58	710	0.5	17.2
ISMB200	IS2062	58	595	0.4	14.4
ISMB200	IS2062	18	1470	1.1	35.5
ISMB200	IS2062	12	968	0.7	23.4
ISMB200	IS2062	10	5970	4.4	144.3
ISMB200	IS2062	8	995	0.7	24.1
ISMB200	IS2062	7	3490	2.6	84.4
ISMB200	IS2062	7	1468	1.1	35.5
ISMB200	IS2062	4	4470	3.3	108.1
ISMB200	IS2062	4	4468	3.3	108.0
ISMB200	IS2062	4	4348	3.2	105.1
ISMB200	IS2062	4	3968	3.0	95.9
ISMB200	IS2062	4	1969	1.5	47.6
ISMB200	IS2062	4	1170	0.9	28.3
ISMB200	IS2062	4	1055	0.8	25.5
ISMB200	IS2062	2	2972	2.2	71.9
ISMB200	IS2062	2	2830	2.1	68.4
ISMB200	IS2062	2	1875	1.4	45.3
ISMB200	IS2062	2	1660	1.2	40.1
ISMB200	IS2062	2	633	0.5	15.3
ISMB200	IS2062	2	629	0.5	15.2
ISMB200	IS2062	2	534	0.4	12.9
ISMB200	IS2062	2	510	0.4	12.3
ISMB200	IS2062	2	509	0.4	12.3
ISMB200	IS2062	2	428	0.3	10.3
ISMB200	IS2062	2	378	0.3	9.1
ISMB200	IS2062	1	5545	4.1	134.1
ISMB200	IS2062	1	5349	4.0	129.3
ISMB200	IS2062	1	5332	4.0	128.9
ISMB200	IS2062	1	5252	3.9	127.0
ISMB200	IS2062	1	5029	3.7	121.6
ISMB200	IS2062	1	4362	3.2	105.5
ISMB200	IS2062	1	4069	3.0	98.4
ISMB200	IS2062	1	3649	2.7	88.2
ISMB200	IS2062	1	3511	2.6	84.9
ISMB200	IS2062	1	3485	2.6	84.3

Fig.8.1 Material List

IX. Conclusion

The design and estimation of a bucket elevator tower using Tekla Structures highlights the importance of modern structural modeling software in achieving precision, efficiency, and safety in engineering design. The bucket elevator tower is a vital structure that facilitates the vertical transportation of materials such as grains, cement, and aggregates in industrial plants. Through Tekla Structures, the project incorporates advanced 3D modeling and structural analysis to ensure accurate design of components like beams, columns, and bracing systems. The software's capability to produce fabrication and general arrangement drawings, along with detailed material lists, minimizes human error and enhances execution speed. Additionally, Tekla enables the integration of various load conditions, including wind, seismic, and self weight effects, ensuring structural stability and safety. The estimation process optimizes material usage, reduces waste, and ensures cost-effectiveness.

References

1. N. Yashaswini, Raju. B and A. Purushottham, Design and optimization of bucket elevator through finite element analysis, International Journal of Mechanical Engineering Volume 2, Issue 9, 2014.
2. Hemlata H. Mulik, Bhaskar D. Gaikwad, Design of Sugar Bucket Elevator and Roller Conveyor Chain for 20 Tonnes per Hour Capacity, International Journal of Engineering Trends and Technology, Volume 20 Number- I, 2015.
3. Snehal Patel, Sumant Patel, Jigar Patel, A Review on Design and Analysis of Bucket Elevator, International Journal of Engineering Research and Applications Vol. 2, Issue 5, 2012.
4. F. J. C. Rademacher, ―Non-Spill Discharge Characteristics of Bucket Elevators, Powder Technology, Volume 22, Issue 10, 2014.
5. Edward Yin, Onumus Muvengei, John Kihiu, Kenneth Njoroge, Failure Analysis on Conveyor Chain Links of a Central Bucket Elevator, IOSR Journal of Mechanical and Civil Engineering Volume 13, Issue 4 Ver. VII (2016), PP 56-63.
6. Ghazi Abu Taher, Yousuf Howlader, Md. Asheke Rabbi, Fahim Ahmed Touqir, ―Automation of Material Handling with Bucket Elevator and Belt Conveyor, International Journal of Scientific and Research Publications, Volume 4, Issue 3, 2014.
7. Kulkarni Digambar Rangnathrao, Prof Swami M.C, Mr. Shinde, ―Experimental Analysis of Bucket Elevator Chain Breakdown‖, International Research Journal of Engineering and Technology Volume: 05 Issue: 05 | 2018.
8. Tushar S Hingve, Y.A.Kharche, N.A Kharche, Diagnosis for the failure of sprocket and chain drive, International Research Journal of Engineering and Technology,2017, 2394-8280.
9. Sunil Tukaram Shinde, Shailesh S Pimpale, ―Modal Analysis and Material Optimization of Elevator Bucket, International Journal of Engineering science Volume 6 Issue No. 7, 2015.
10. Swapnil P. Deokar, Prof. Ashish Lagad, Prof. S.S Kelkar, ―FEA and Optimization of Elevator Bucket, International Engineering Research Journal Page No 975-980, 2015.
11. Snehal Patel, Sumant Patel, Jigar Patel, ―Productivity Improvement of Bucket Elevator by Modified Design, International Journal of Engineering Technology and Advanced Engineering, Volume 3, Issue 1, 2013.
12. A. Göksenli, I.B. Eryürek, Failure analysis of an elevator drive shaft, Engineering Failure Analysis 16 (2009) 1011–1019, Volume 13, 2013.

13. Rusinski E, Harnatkiewicz P, Bobyr B, Yakhno, Caterpillar drive shaft damage causes analysis, Architecture Civil Mechanical Engineering 2008; VIII(3):117 29.
14. Mile Savkovic a, Milomir Gašic, Miodrag Arsic, Radovan Petrovic, Analysis of the axle fracture of the bucket wheel excavator, science Engineering Failure Analysis 18 (2011) 433–441, 2011.
15. Krishnakumar and Arockia Selvakumar, ―A Review of failure analysis found in industrial roller chain, International Journal of Engineering Technology and Advanced Engineering, Volume 3, Issue 1, 2015.
16. Koster, K.‖Centrifugal discharge of bucket elevators, International Journal of Modern Engineering Research, Volume 3, Issue 1, 2015.
17. Koster, K.‖Development and state of the art in heavy duty bucket elevators with central chains‖, part 2 [entwicklung und stand der technik von hochleistungsbecherwerken mit zentralkette - teil 2].
18. Kruggel-Emden, H., Sudbrock, F., Wirtz, S., Scherer, V, Experimental and numerical investigation of the bulk behaviour of wood pellets on a model type grate, Granular Matter 14(6), 681-693 (2012).
19. Jagtap M. D., G. B. D., and P. P. M., ―Study of Roller Conveyor Chain Strip under Tensile Loading, International Journal Of Modern Engineering Research, vol. 4, no. 5, pp. 61–66, 2014.
20. U. Singh, M. K. Singh, and M. Singh, ―Failure Analysis of Bridle Chain Used for Hoisting in Mines, International Journal Of Modern Engineering Research vol. 4, no. April, pp. 38–45, 2013.