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Design And Estimation Of Metro Station Using Tekla

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Abstract- The project titled as Design and Estimation of Metro Station Using Tekla Structures-``2025 focuses on applying advanced Building Information Modeling (BIM) techniques for the efficient planning, structural design, and cost estimation of a modern metro station. The main objective of this study is to create a precise and fully integrated 3D model that enhances accuracy, constructability, and coordination throughout the project lifecycle. Using Tekla Structures, the complete structural framework of the metro station-including columns, beams, slabs, staircases, platforms, and roof trusses-is modeled with high dimensional accuracy. The software enables the automatic generation of general arrangement drawings, fabrication drawings, and material take-off reports, significantly reducing manual drafting errors and improving project efficiency. The estimation process is directly linked to the 3D model, allowing real time updates in quantity and cost calculations whenever design modifications occur. This approach enhances decision-making, reduces material waste, and ensures better cost control. The integration of BIM principles further supports clash detection, visualization, and data management, ensuring seamless coordination between design, fabrication, and construction teams. Overall, this project demonstrates that Tekla Structures is an effective digital tool for achieving higher precision and productivity in metro station projects. It provides a comprehensive solution for modeling, detailing, and estimation, thereby promoting sustainable and technology-driven infrastructure development.

Keywords-Tekla Structures, Building Information Modeling (BIM), Metro Station Design, Structural Detailing, Estimation.

I. INTRODUCTION

The rapid growth of urban populations has led to increasing demand for efficient, safe, and sustainable public transportation systems. Metro rail networks have emerged as a vital solution to reduce traffic congestion, minimize environmental impact, and improve urban mobility. A key component of these systems is the metro station, which must be carefully designed to ensure structural safety, passenger convenience, and operational efficiency.

Using Tekla Structures, engineers can create precise 3D models of metro stations, including beams, columns, slabs, and reinforcements. The software enables accurate quantity take-offs, clash detection, and efficient planning, which are essential for cost estimation and project scheduling.

This study focuses on the design and estimation of a metro station using Tekla Structures. It aims to demonstrate how BIM-based tools can enhance structural design accuracy, streamline estimation processes, and support sustainable infrastructure development in modern urban environments.

II. OBJECTIVES

The main objective of this project is to design, model, and estimate a metro station using Tekla Structures in accordance with relevant Indian Standard Codes. The project aims to develop a fully detailed 3D Building Information Model (BIM) that integrates design, detailing, and estimation processes within a single digital environment. Through this approach, the project seeks to enhance

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the accuracy, efficiency, and constructability of metro station structures.

III. STRUCTURAL DETIALS AND TYPE OF STRUCTURE:

General In this project, a Steel Framed Structure with Roof Truss System is adopted for the metro station building. The structure is designed to support heavy loads, wide roof spans, and passenger platforms. The entire modeling, detailing, and estimation are performed using Tekla Structures 2025, ensuring accuracy in fabrication, coordination, and cost control.
There are five major types of structures commonly used in civil engineering projects:

- Steel Structures
- Concrete Structures
- Composite Structures
- Precast Structures
- Special Structure

Structural components:
(i) Steel Frame (Columns and Beams)
The primary structural system of the metro station consists of steel columns and beams, designed to carry vertical and lateral loads. The framing system provides stability and supports the roof truss and platform structures. All members are modeled in Tekla Structures 2025 as per relevant Indian Standard Codes..

(ii) Roof Truss
A steel roof truss system is provided to cover large-span areas above the platforms and concourse zones. The truss ensures efficient load distribution and minimizes intermediate supports, improving passenger circulation and visibility. Tekla Structures is used for accurate modeling, detailing, and quantity estimation of truss members.

iii) Gusset Plates and Connections
Gusset plates are used at truss joints to connect members securely, transferring stresses effectively. The connections are designed as bolted or welded joints, depending on load conditions. Tekla Structures 2025 facilitates precise detailing of these components, ensuring fabrication accuracy and easy site assembly.

(iv) Purlins And Roof Sheeting
Purlins are horizontal members placed over the roof truss to support the roof sheeting. They transfer roof loads to the truss system and are typically made of steel channels or hollow sections. The purlin layout is modeled and detailed in Tekla to achieve uniform load distribution and efficient design

(v) Foundation (Base Plate & Anchor Bolts)
The steel columns and truss supports are anchored to reinforced concrete pedestals through base plates and anchor bolts, ensuring effective load transfer to the foundation. Tekla Structures 2025 is used to model and detail base plates and anchor assemblies for fabrication and erection purposes.Adsorbs heavy metals and organic pollutants.

- Efficient Modeling:

Tekla Structures enabled the creation of an accurate 3D model representing all major structural components such as columns, beams, trusses, and foundations.

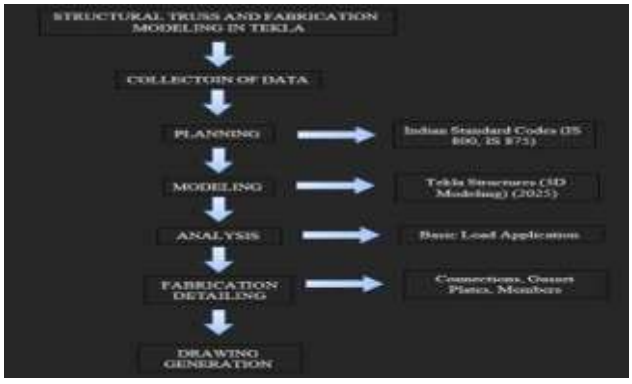
- Accurate Detailing:

Automated generation of fabrication and general arrangement drawings improved precision and reduced human errors.

- Cost and Quantity Estimation:

The estimation module provided reliable material take-offs and cost analysis directly from the model.

IV. METHODOLOGY



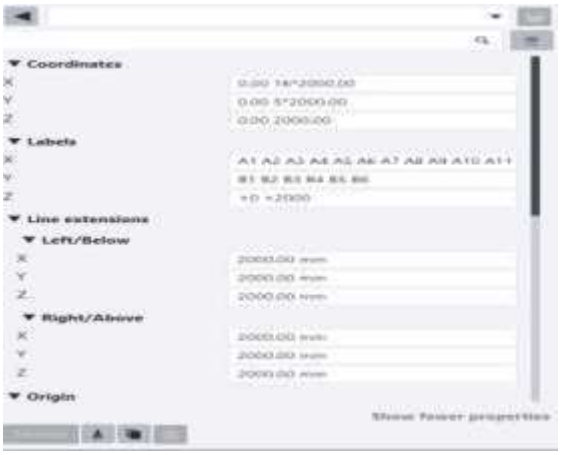


Figure 4.1 Grid Plans

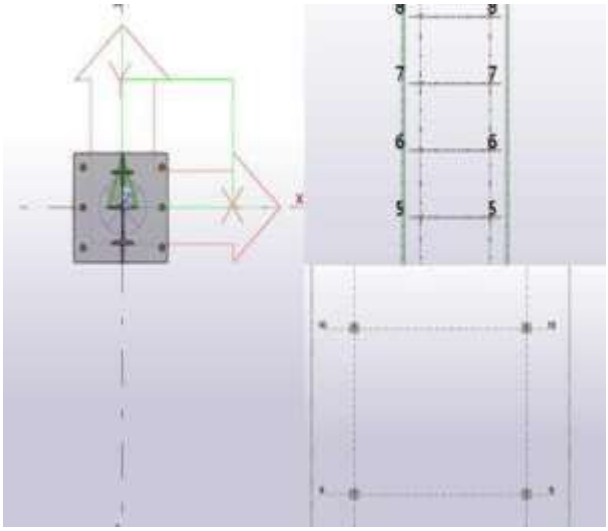


Figure 4.2Baseplate layout

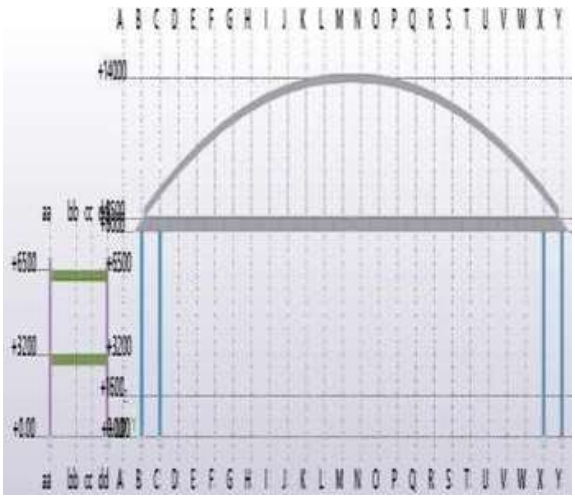


Figure 4.3 Cross section

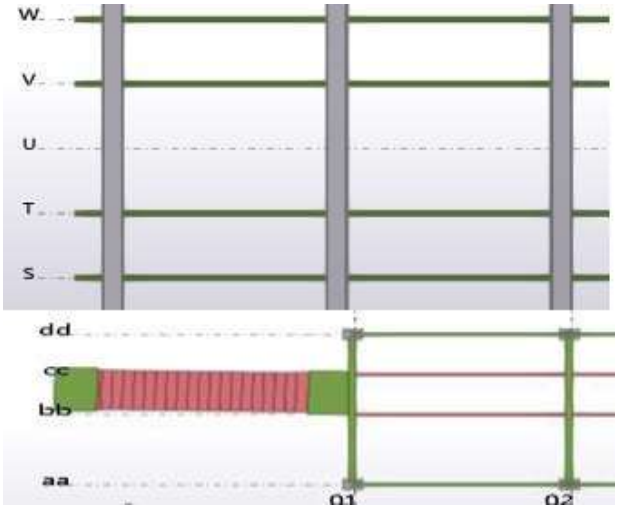


Figure 4.4 Top view

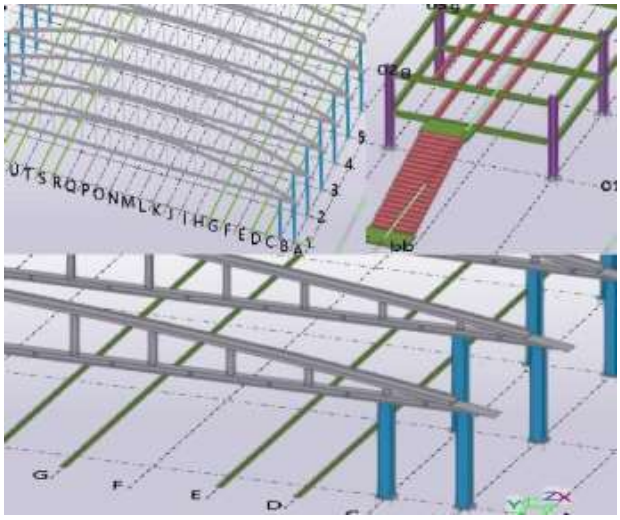


Figure 4.5 Elevation

PLAN AND DETAILS

1. Breadth& Length of Truss = 12 m x 10 m
2. Square feet of a Truss = 40′ ft x 32′ ft
3. Clear Span = 11m
4. Totalsq. ft = 12800 Sq. ft
5. Number of Panels = 10
6. One Roof Panel Size = 12m x 10m

7. Truss Rise (Depth) = 1.0m

8. Truss Rise (Depth) = 1.0m

9. Floor Levels in Model = Ground floor only

10. Support Condition = One end hinged, one end roller

11. Section Types Adopted = ISMB, ISA, RHS

12. Load Data (as applied) = Bolted and welded gusset plate connections

13. Analysis Method = D.L = 1.0Kn/m, L.L = 1.0kN/m = 2.0Kn/M

14. Analysis Method = Pin-jointedtruss, axial forces computed

V. ANALYSIS

A This project focuses on the design, modeling, and estimation of a metro station structure using Tekla Structures, an advanced Building Information Modeling (BIM) software. The work involves creating a detailed 3D model that accurately represents all major structural components such as columns, beams, slabs, staircases, and roof trusses. The modeling process follows Indian Standard Codes to ensure design safety and compliance. Tekla Structures enables the integration of design, detailing, fabrication, and estimation within a single environment, providingpreciseoutputin the form of general arrangement drawings, fabrication drawings, and quantityreports. Project demonstrates how digitalmodelingimprovescoordination, visualization, and constructability, reducing human error and project duration.

VI. ANALYSIS REPORT

The wind load The structural analysis of the metro station is carried out to determine the strength, stability, and serviceability of all major structural components under various loading conditions. The analysis ensures that the design satisfies both safety and performance criteria as per relevant Indian Standard Codes (IS 800, IS 456, IS 875, and IS 1893). The 3D model developed in Tekla Structures provides accurate member geometry, load paths, and connection details, which are further validated through structural analysis software. The applied loads include dead load, live load, wind load, seismic load, and roof load, which are distributed appropriately on structural configuration.

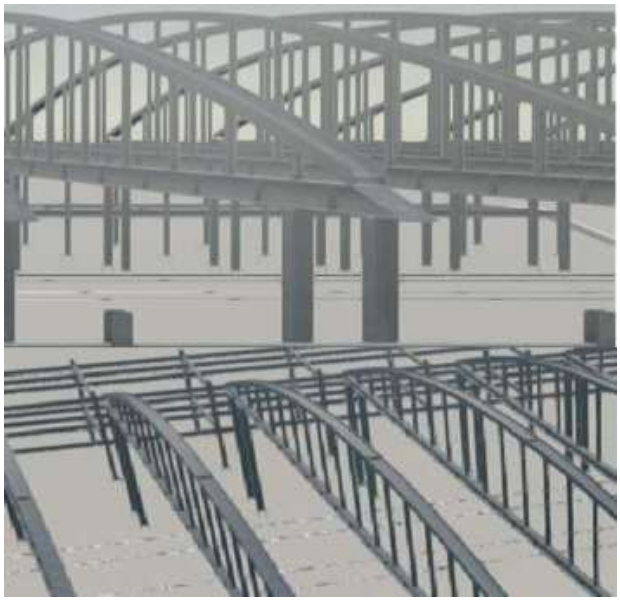


Figure 4.6 Realistic Views (Beam and Column)

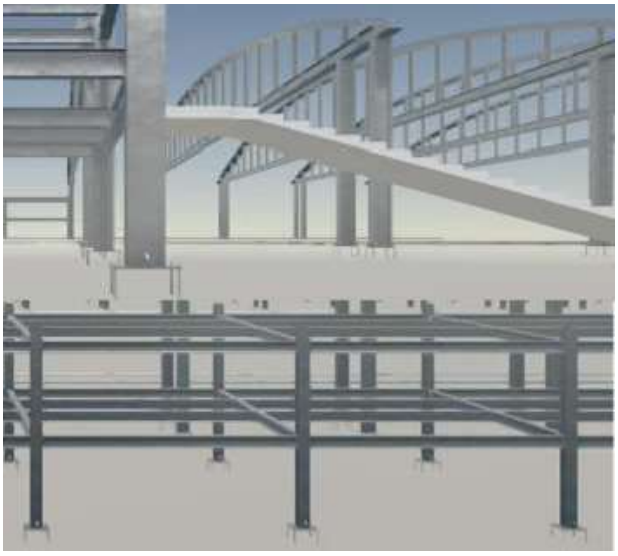


Figure 4.7 Realistic Views (Truss)

FABRICATION(STAIR CASE)

A staircase in Tekla Structures is a 3D modeled structural element that provides vertical circulation between floors. It can be reinforced concrete (RCC), steel, or composite, and is modeled accurately to reflect geometry, reinforcement, and connections for construction drawings and fabrication.

Name	Profile	Material	Grids	Part	Assembly
				position	position
Beam	UB533*312*273	S275	A-B/2-3	M1	B1
Total 541 Parts:	8.58 T, 5447.87 m				
Global coordinates:					
Start point		: X= 3167.7 mm		Y= 10000.0 m	Z= 11583.8 mm
End point		: X= 3167.5 mm		Y= -70.0 mm	Z= 11583.8 mm
Center of gravity		: X= 3170.2 mm		Y= 4965.0 mm	Z= 11613.8 mm
Top level		: +11.671			
Bottom level		: +11.571			
Local coordinates, UCS:					
Start point		: X= 3167.7 mm		Y= 10000.0 m	Z= 11583.8 mm
End point		: X= 3167.5 mm		Y= -70.0 mm	Z= 11583.8 mm
Top level		: +11.671			
Bottom level		: +11.571			
Part position		: M1			
Assembly position		: B1			
Net length		: 10070.0 mm			
Gross length		: 10070.0 mm			
Weight		: 90.12 kg			
Weight(Net)		: 90.11 kg			
Weight(Gross)		: 90.12 kg			
Volume		: 0.011 m³			
Area		: 30232.72 cm²			
Name		: ANGLE			
Material		: S275			
Finish					
Profile		: UB533*312*273			
Flange slope ratio		: 0			
Rounding radius 2 (r2)		: 4.5 mm			
Rounding radius 1 (r1)		: 7.0 mm			
Plate thickness (t)		: 0.0 mm			
Width (b)		: 75.0 mm			
Height (h)		: 75.0 mm			

Beam Inquire (Purlin Beam)

Name	Profile	Material	Grids	Part	Assembly
				Position	Position
COLUMN	C356*368*	S275	A/1	P1	C1
Global coordinates:					
Start point		: X= 0.0 mm		X= 0.0 mm	Z= 0.0 mm
End point		: X= 0.0 mm		Y= 0.0 mm	Z= 10000.0 mm
Center of gravity		: X= 0.0 mm		Y= -0.0 mm	Z= 5015.0 mm
Top level		: +10.000			
Bottom level		: +0.030			
Local coordinates, UCS:					
Start point		: X= 0.0 mm		Y= 0.0 mm	Z= 0.0 mm
End point		: X= 0.0 mm		Y= 0.0 mm	Z= 10000.0 mm
Top level		: +10.000			
Bottom level		: +0.030			
Part position		: P1			
Assembly position		: C1			
Net length		: 9970.0 mm			
Gross length		: 9970.0 mm			
Weight		: 613.53 kg			
Weight(Net)		: 613.60 kg			
Weight(Gross)		: 613.53 kg			
Volume		: 0.077 m³			
Area		: 130565.96 cm²			
Name		: COLUMN			
Material		: S275			
Finish					
Profile		: UC356*368*129			
Flange slope ratio		: 0.14			
Rounding radius 2 (r2)		: 0.0 mm			
Rounding radius 1 (r1)		: 14.0 mm			
Flange thickness (t)		: 16.0 mm			
Web thickness (s)		: 8.9 mm			
Width (b)		: 140.0 mm			
Height (h)		: 400.0 mm			

Column Inquire

FABRICATION INQUIRE

Name	Profile	Material	Grids	Part	Assembly
				position	position
PLATE	PL30*500	IS2062	A1-A2/B2	2	2
Total 516 Parts:	62.41 T, 530.73 m				
Global coordinates:					
Start point		: X= 32467.8 mm		Y= 2360.7 mm	Z= 515.0 mm
End point		: X= 32467.8 mm		Y= 1360.7 mm	Z= 515.0 mm
Center of gravity		: X= 32557.2 mm		Y= 2110.7 mm	Z= 385.8 mm
Top level		: +0.530			
Bottom level		: +0.000			
Local coordinates, UCS:					
Start point		: X= 32467.8 mm		Y= 2360.7 mm	Z= 515.0 mm
End point		: X= 32467.8 mm		Y= 1360.7 mm	Z= 515.0 mm
Top level		: +0.530			
Bottom level		: +0.000			
Part position		: 2			
Assembly position		: 2			
Net length		: 1028.5 mm			
Gross length		: 1028.5 mm			
Weight		: 120.96 kg			
Weight(Net)		: 120.96 kg			
Weight(Gross)		: 121.11 kg			
Volume		: 0.015 m³			
Area		: 11198.52 cm²			
Name		: PLATE			
Material		: IS2062			
Finish					
Profile		: PL30*500			
Flange slope ratio		: 0			
Rounding radius 2 (r2)		: 0.0 mm			
Rounding radius 1 (r1)		: 0.0 mm			
Plate thickness (t)		: 0.0 mm			
Width (b)		: 30.0 mm			
Height (h)		: 30.0 mm			

Fabrication Inquire

Connection 144	(Code: , Number: 967)		
Number of secondaries	: 1		
Primary part	: 4849369		
Secondary parts	: 4815041		
Origin [mm]	: x = 11995.55	y = 0.00	z = 9850.00
Position type:	: Collision plane		

End Plate Inquire

Connection 1047 (Code: , Number: 795)			
Number of secondaries	: 1		
Primary part	: 4849369		
Secondary parts	: parts		
Origin [mm]	: x = 12000.00	y = 0.00	z = 0.02
Position type	: Middle		

BASE PLATE INQUIRE

Single Bolt assembly Info:		
Name:	BOLTM20*55-8.8XOX	
Diameter:	20.0 mm	
Length:	55.0 mm	
Weight:	344.8 g	
Edge distance:	29.5 mm	
Hole Tolerance:	2.0 mm	
Assembly type:	Site	
Bolt structure:	10111	
Thread in material:	Yes	
Slotted hole X:	0.0 mm	
Slotted hole Y:	0.0 mm	
Connect assemblies:	A0(?) ->	
Connected parts:	a0(?)->	
Number of parts:	1	
Contents:		
Standard:	Size [mm]	Qty. Name:
Bolts		
8.8XOX	20.0 x 55.0	1 BOLTM20*55-8.8XOX
Nuts		
GR8-HEX	20	1 NUTM20-GR8-HEX
GR8-HEX	20	1 NUTM20-GR8-HEX
Washers		
FLAT-E	20	1 WASHERM20-FLAT-E
FLAT-E	20	1 WASHERM20-FLAT-E

Bolt Inquire

Weld(Number: 0)		
Logical weld: No		
Connected parts:	Main part:	Secondary part:
Part position:	M0(8)	M0(7)
ID:	5377210	5378133
Name:	BEAM	BEAM
Grade:	IS2062	IS2063
Workshop Weld		
Continuous Edge Weld		
Weld Properties:	Above line:	Below line:
Size:	3	3
Weld type:	Fillet	Fillet
Actual length:	100 mm	0 mm
Length:	0 mm	0 mm
Pitch:	0	0
Increment amount:		
Angle:	0	0
Contour:	None	None
Finish:	None	None
Root face:	0	0
Root opening:	0	0
Throat thickness:	0	0
Cross section area:	9 mm2	0 mm2
Weld volume, total:	900 mm3	
Welding process type:	None	
Electrode classification:	None	
Electrode strength:	0	
Electrode coefficient:	0	
NDT inspection level:	None	

Weld Inquire

MATERIAL LIST

Tekla Structures		MATERIAL		LIST		DRGP***
Client :DRG BUILDER						**1**
Contract :DRG PROJ NAME						30.10.2025
Site	:DRG ADDRESS					11:24:03
Phase	:1		:			DRGMOD***
Qty.	**Profile**	**Grade**		**Length**	**Area (m²)**	**Weight(kg)**
26	UB533*312*273	S275		28572		7592.0
26	UB533*312*273	S275		28477		7566.1
26	UB533*312*273	S275		28047		7612.6
26	UB533*312*273	S275		27875		7565.3
				293722	6961.2	788735.3
				4		
1	CHS219.1*6	S275		25711		803.8
				25711		803.8
104	UC356*368*129	S275		7974		1016.3
				829296	1774.7	105691.0
48	UB406*178*54	S275		7200		380.6
8	UB406*178*54	S275		7152		378.1
8	UB406*178*54	S275		7146		377.7
				459966	6800.8	24315.5
8	SECTION-A75	S275		70000		393.5
				560000		3147.7
48	UC254*254*89	S275		6980		613.3
				335040	5022.	29437.5

					6		
8	UC305*305*97	S275		6980			665.5
				5584	1000.0		5324.4
8	UC305*305*118	S275		6980			812.1
				5584	1011.1		6497.1
192	SECTION-A75	S275		60000			337.3

Tekla Structures MATERIAL LIST Job No: DRG P***

Client :DRG BUILDER
Contract :DRG PROJ NAME
Site :DRG ADDRESS
Phase :1 Lot :

Page: 3
Date: 30.10.2025
Time: 11:24:03
By : DRG MOD***

Qty.	Profile	Grade	Length	Area(m²)	Weight(kg)
26	ROD200	S275	1000	0.7	234.3
26	ROD200	S275	961	0.6	225.7
			50981	34.1	11959.1
256	D16	S275	566	0.0	0.8
			144019	7.3	209.9
816	D20	S275	557	0.0	1.3
			231764	14.8	527.6
64	PLT20*550	S275	550	0.6	67.5
			35200	41.5	3039.5
104	PLT10*515.6	S275	529	0.6	31.4
			54974	58.9	2225.1
1248	PLT35*140	S275	502	0.2	19.3
			626371	230.4	24038.1
104	PLT16*335.6	S275	369	0.3	15.5
			38334	28.1	1615.8
52	PLT10*100	S275	280	0.1	4.0
			14560	5.7	205.7
1216	L150*100*10	S275	260	0.1	4.9
			316160	163.9	5956.5
624	PLT10*100	S275	200	0.0	1.4

Tekla Structures MATERIAL LIST Job No: DRG P***

Client :DRG BUILDER
Contract :DRG PROJ NAME
Site :DRG ADDRESS
Phase :1 Lot :

Page: 4
Date: 30.10.2025
Time: 11:24:03
By : DRG MOD***

Qty.	Profile	Grade	Length	Area(m²)	Weight(kg)
			124800	25.2	857.2
192	PLT12*250	S275	135	0.1	2.9
			25920	13.6	559.5
32	PLT12*200	S275	111	0.0	1.0
			3552	1.5	58.4
32	PLT15*200	S275	108	0.0	2.2
			3456	1.5	70.0
4	PLT2000*375.7	C30	6573	34.1	5571.3
			26293	136.2	22285.1
4	PLT150*1200	C30	3200	6.3	969.1
			9800	25.2	3876.6
4	PLT250*1200	C30	3200	7.0	1615.2
			8800	27.9	6460.9
		Totals:		14536.8 m²	1717419.1 kg

Tekla Structures MATERIAL LIST Job No: DRG P***

Client :DRG BUILDER
Contract :DRG PROJ NAME
Site :DRG ADDRESS
Phase :1 Lot :

Page: 2
Date: 30.10.2025
Time: 11:24:03
By : DRG MOD***

Qty.	Profile	Grade	Length	Area(m²)	Weight(kg)
			1152000	0.0	68753.5
128	UB406*178*60	S275	5452	6.9	345.6
			714276	1068.3	41468.2
96	UB406*178*54	S275	5950	6.5	313.8
24	UB406*178*54	S275	5949	6.5	313.8
			713948	1056.6	37658.1
26	ROD200	S275	5398	3.4	1314.1
26	ROD200	S275	5393	3.4	1313.3
26	ROD200	S275	5341	3.4	1300.7
26	ROD200	S275	5340	3.4	1300.1
26	ROD200	S275	5219	3.3	1269.6
26	ROD200	S275	5218	3.3	1268.0
26	ROD200	S275	5001	3.2	1216.4
26	ROD200	S275	4967	3.2	1213.4
26	ROD200	S275	4690	3.0	1140.5
26	ROD200	S275	4674	3.0	1136.8
26	ROD200	S275	4298	2.7	1043.1
26	ROD200	S275	4291	2.7	1038.8
26	ROD200	S275	3824	2.4	926.4
26	ROD200	S275	3796	2.4	926.6
26	ROD200	S275	3255	2.1	787.1
26	ROD200	S275	3216	2.1	779.2
26	ROD200	S275	2567	1.7	625.5
26	ROD200	S275	2556	1.6	617.5
26	ROD200	S275	1847	1.2	442.7
26	ROD200	S275	1813	1.2	434.6
			2151310	1374.8	522302.9
26	PLT10*547.1	S275	1470	1.7	65.3
26	PLT10*547.1	S275	1425	1.7	63.1
			75277	87.4	3330.4

Name	Profile	Material
ANCHOR ROD	D20	S275
Total 144 Parts:	77.20 T, 1723.84 m	
Global coordinates:		
Start point		: X= 0.0 mm
End point		: X= 12000.0 mm
Center of gravity		: X= 6000.0 mm
Top level		: +10.000
Bottom level		: +9.700
Local coordinates, UCS:		
Start point		: X= 0.0 mm
End point		: X= 12000.0 mm
Top level		: +10.000
Bottom level		: +9.700
Part position		: F
Assembly position		: SP

Base Plate and Anchor Bolt

Future Scope

The proposed modeling and estimation methodology can be extended to large-scale transportation infrastructure. Integration with real-time scheduling, cost optimization, and sustainability modules can further improve the overall efficiency of metro project execution.

V. CONCLUSION

The study on the Design and Estimation of a Metro Station using Tekla Structures (2025) demonstrates the practical application of Building Information Modeling (BIM) in structural design and cost analysis. The project effectively integrates architectural, structural, and MEP disciplines within a unified digital platform, ensuring precision and coordination throughout the design and estimation processes. The 3D parametric modeling in Tekla Structures enabled accurate representation of all primary components, including columns, beams, slabs, staircases, and roof trusses. The software's compliance with Indian Standard Codes such as IS 456:2000, IS 800, and IS 875 ensured that the design adhered to safety and serviceability criteria. Load combinations were applied systematically to analyze the structure under dead, live, and seismic conditions. Automated estimation tools in Tekla facilitated the extraction of material quantities, bar bending schedules, and bill of materials directly from the model, minimizing human errors and improving cost accuracy. The integrated model based documentation enhanced the efficiency of drawing preparation and reduced design conflicts. Furthermore, the BIM- based coordination improved interdisciplinary collaboration and minimized structural inconsistencies during design review. The study concludes that Tekla Structures significantly enhances accuracy, time efficiency, and constructabilityin metro station design projects.

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