DEVELOPMENT OF AN ELEVATED RAILWAY CORRIDOR FOR ENHANCING REGIONAL CONNECTIVITY AND SUSTAINABILE URBAN MOBALITY

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Abstract - *Rapid urbanization and increasing transport requirements in the Mumbai capital area (MMR) have highlighted the immediate need for effective and sustainable transit solutions. This Research Paper Presents The Ideological Design and Development of a 50-55 kilometer Elevated Rail Corridor, which Connects Alibag to Chhatrapati Shivaji Maharaj Terminus (CSMT), Including Alibag, Thal, Chodni, Agarsure, Dhokavade, Mandwa, Mumbai Central, Grant Road, Girgaon, Charani Road, Parel and after that we can get easily any local train to CSMT.*

The study uses early adjustment form, horizontal and vertical profile design, and early spatial analysis for corridor modeling and Google Earth Pro for AutoCAD Civil 3D.

The main goal of the project is to reduce the journey and increase the ratio of Alibag to Mumbai's commercial hub. The approximate travel time for the Alibag to CSMT corridor is estimated at 30 to 45 minutes, which is a significant improvement compared to the current journey to traditional railway roads of 3 to 4 hours.

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Key Word: *Google Earth Pro, AutoCAD Civil 3D, TCX Converter*

1. INTRODUCTION

The purpose of developing an elevated railway corridor between Alibag and Csmt Alibaug is considered a transformative infrastructure project for the Chhatrapati Shivaji Maharaj Terminus (CSMT) elevated railway corridor, which aims to reduce the gap between the Raigad Coast region and the movement of Mumbai in Mumbai. The main goal is to provide a high-speed, efficient, and durable transit solution to increase the demand for reliable connections between these two regions. By introducing an elevated railway system, the project aims to reduce the dependence on road-based transport, which provides a simple travel experience to passengers, tourists, and residents. Currently, major transport problems are faced in the area.

1.1. Traffic overload

The existing road network, which includes the Mumbai-Goa highway and boat services, is often overloaded, especially during the high season and the holidays.
Heavy vehicle traffic leads to delays and travel time between Alibag and Mumbai.

1.2. Limited and overwhelming public transport

Current public transport options (bus, private vehicles, Ghat) are inadequate to meet the growing demand for the computer.
Crowds and more final-meal connections on suburban networks in Mumbai are complicated.

1.3. Long and unexpected travel time

Depending on traffic and weather conditions, travel from Alibag to CSMT can be between road or boat for 2 to 4 hours via road or boat.
There is a fast and reliable transport option that ensures frequent travel time.

1.4.Environmental considerations

Heavy dependence on road transport contributes to air pollution, carbon emissions, and environmental decline.

1.5. How will this project address overload, travel time, and connection problems

a. Low travel time:The elevated railway corridor will offer high-speed connection, which will almost reduce the time of travel between Alibag and CSMT [estimated time, e.g. 90-160 minutes], despite road traffic or weather conditions.
b. Resolution of existing transport networks:
By offering a dedicated railway corridor, the project will reduce the pressure on existing roads and boat services, reduce the overload on large highways, and improve the efficiency of the overall transport network.
c. Better access and connection:
The corridor will increase the regional connection, which will integrate Mumbai with the current suburban network, metro system, and bus services, and secure the seamless multimodal transport options for passengers.
d. Continuous urban mobility:

The elevated design reduces problems with land and environmental resolution procurement, which promotes a green and durable transport solution that corresponds to urban dynamic goals.

1.6. Integration of Civil 3D and Google Earth in the project

To ensure that adjustment of adjustment, topographic analysis, and design adaptation, Autodesk Civil 3D and Google Earth Pro have been widely used during project planning and design stages: Google Earth Pro has provided satellite images, terrain data, and existing infrastructure visualization, which help identify appropriate alignment and large station sites.
Civil 3D has been used for detailed adjustment design, corridor modeling, volume calculation, and opinion work analysis, which ensures the effective use of accurate geometric design and resources.
The integration of these units has allowed realistic simulation, visual, and viability of 3D adjustments to make better decisions during studies and planning stages.
By taking advantage of these software solutions, the purpose of the project is to reduce design errors, increase coordination between teams, and optimize the construction plan in complex urban and coastal environments.

1.7. Project Background & Justification

The importance of connecting Alibag to CSMT through a high corridor Alibag, a large coastal town in the Raigad district, is often called "Goa of Maharashtra" because of the beaches and tourism capacity. Over the years, the region has seen a sufficient increase in sectors for housing, commercial, and tourism. However, a lack of direct, fast, and reliable transport connections with Mumbai the state's economic capital - has disturbed its full potential for economic integration and urban development.

1.8 Current Status of Transportation Between Alibag and CSMT

At the moment, transport options between Alibaug and Mumbai are limited, fragmented, and take time:
Road connection is the primary mode of road bar through the Mumbai-Goa Highway (NH-66) but is often crowded due to high traffic versions, ongoing expansion work on the highway, and the tourist flow. Travel time can increase by 3 to 5 hours depending on the condition of the road.
Mandwa Jetty (near Alibag) and Mumbai offer water transport through boat and Roas-Ro services, but the services are limited, depending on weather conditions, and additional surface transport from JT to Alibag is required.
Railway connection is indirect, one must first travel to pen or panel railway stations and then transfer to the suburban network towards CSMT. This multimodal approach is disabled and impractical for daily travelers.

1.9. Why an Elevated Corridor was Selected Instead of Other Alternatives

After a comprehensive viability study and evaluation of alternatives, the high corridor was chosen due to several important benefits:
a. Character corridors:
Class adjustment will require massive land acquisition, leading to high costs and significant displacement of people and businesses.
The risk of traffic disorder at crossings and security problems increased for both road users and rail passengers.
b. Underground corridor challenges:
Underground tuning will include complex geological challenges, especially near coastal areas with high water tables.
Extremely high building and maintenance costs, combined with a long project deadline.
c. The benefits of a high corridor:
Minimum over-purchase of land, as it mainly uses airspace over existing roads or dedicated corridors.
Fast construction timelines with pre-segment methods. Low disturbance in existing roads and urban settlements during construction.
Better aesthetics and urban integration with capacity for multimodal hubs in larger places.
Reduction of environmental impact, especially in organic-sensitive areas near the coast.
Benefits of the Elevated Corridor Project:
Reduced Traffic Congestion: Converting an important part of daily passengers and tourists to a dedicated railway corridor from roads and Ghats will reduce the pressure on the highways and reduce traffic stops in both Raigad and the Mumbai areas.
Boost to Urban Development & Economic Growth: Better connection will accelerate urban growth with a corridor, especially in alibag and intermediate towns. The new commercial hub, housing development, and tourism sectors are expected to emerge to promote regional economic growth.
Enhanced Travel Experience: Passengers will benefit from low travel, better safety, and modern facilities on stations and trains on the ship.
The seamless connection with the current suburban and metro system in Mumbai ensures a smooth connection experience in the final.

2. METHODOLOGY

The function that was used to design the elevated rail corridor from Alibag to Parel is based on a combination of geophysical analysis and civil engineering design techniques. The corridor includes the main stations in Alibag, Thal, Chodni, Agarsure, Dhokavade, Mandwa, Mumbai Central, Grant Road, Girgaon, Charani Road and Parel. To ensure accuracy and viability, the equipment used for data collection, design, and analysis is Google Earth Pro and AutoCAD Civil 3D.

Software Tools Used

a. Google Earth Pro-

For the first route adjustment view.

Station sites, terrain studies, and mapping of land use. Remove kml/kmz data files with suggested adjustment.

b. AutoCAD Civil 3D-

For the detailed design of adjustment, horizontal and vertical profiles. Corridor modeling, station layout design, cross-section, and volume estimate.

c. Staad pro

For the Analysis of steel truss to check the deflection.

Integration of examination data and ground technical parameters to terminate adjustment geometry.

Data Collection and Base Map Preparation The initial phase of the project included a base map preparation to help with the extensive data collection and help in the adjustment design of the elevated railway corridor between Alibag and Parel. This process used Google Earth Pro to collect spatial data and understand the existing geographical and infrastructure of the proposed corridor.

Use of Google Earth Pro Identification of start and final points.1.: The corridor begins in Alibag and ends in the parcel, covering a significant stretch of coastal and urban areas. Conspiracy of intermediate stations: The main stations were identified and marked along the proposed route, including Alibag, Thal, Chodni, Agarsure, Dhokavade, Mandwa, Mumbai Central, Grant Road, Girgaon, Charani Road, Parel

2.1. Geographic Functional Analysis

Google Earth Pro provided high-resolution satellite images to investigate: Current variations (height change, slope).

Urban settlements and densely populated areas (especially near Mumbai Central, Grant Road, and Girgaon). Natural features, such as water bodies, streams, and vegetation. Environmentally sensitive areas such as Creeks require special attention to the bridge or Viact design.

Adjustment tradition: Depending on the spatial data collected, an early passage adjustment was directly detected on the Google Earth Pro platform.

The facility was adapted to avoid dense residential areas, reduce the environmental impact, and ensure technical viability for construction.

When it was completed, the adjustment road was exported to the KML/KMZ file format, which enables spontaneous integration into the AutoCAD Civil 3D for further detailed engineering design.

2.2. Alignment Design in AutoCAD Civil 3D

Following the preliminary adjustment form in Google Earth Pro, the KML/KMZ file was imported to AutoCAD Civil 3D for detailed engineering design and for modeling elevated railway corridors from Alibag to Parel. AutoCAD Civil 3D was used to develop accurate horizontal and vertical alignment, 3D corridor modeling, and the structural cross-section required for the construction and implementation stages.

a. Implementation of kml/kmz in civil 3d

In the KML/KMZ format, the adjustment road exported from Google Earth Pro was imported to AutoCAD Civil 3D.

The adjustment points and paths were integrated and integrated with existing survey data (if available) or high-resolution satellite images, giving a realistic basic reference to design accuracy.

b. Base map construction

A base map was made by adding imported adjustments:

Survey data (from Ground Survey or Remote Sensing).

High-resolution images to imagine agricultural patterns with existing roads, buildings, water bodies, and corridors.

This base map acts as a reference to ending thehorizontal and vertical geometry for adjustment.

c. Horizontal adjustment design Horizontal alignment was designed by following standard engineering parameters:

Minimum curve radius depending on the design speed of the railway corridor.

Ensure the correct rights (Row) availability in urban crowded areas such as Mumbai Central, Grant Road, Girgaon, and Charani Road, especially.

Conflicts such as larger roads, buildings, and tools to avoid existing infrastructure.

The tangent and baskets were adjusted to maintain an even transition and ensure passenger comfort and safety.

d. Vertical adjustment design

The vertical adjustment was developed based on the area profiles drawn along the proposed route.

Upgrading data was analyzed.

2.3. Workflow of the Project

a. As We can see in Fig 1, there is no rail route from Alibag to CSMT, The below Fig Shows the Roadway to Travel from Alibag To CSMT. The Total distance is 120-130km by road ways And the time required to travel the distance is about 3-4 hours depending on the Traffic Conditions.

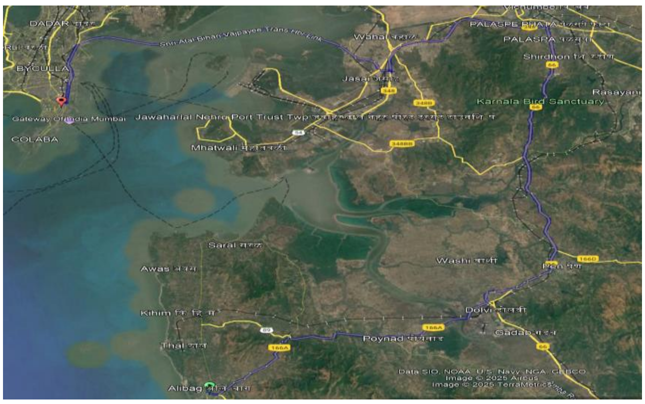


Fig 1 (Existing Road Way)

Time-consuming." The distance between these is about 110-115km. And to the time required to travel is about 2.3 - 3.5 hours.

b.On this map, a route is decided by analyzing the surface profile. The facility is planned in such a way that it passes within 1 to 2 kilometers of many densely populated villages, ensuring that residents can easily access the railway system.

Fig 2 (Proposed Rail Route)

The graph represents the Elevation Of the Surface from Alibag to Thal and the distance is about 50-55 km.

Fig 3 (Graph of Proposed Route)

c. In Fig 4, specific areas were selected for project work to extract contour data. This data will help determine the area profile and estimate the resources and efforts required for adjustment design.

Fig 4 (Creating Path on google earth)

d. Fig 5 shows the converting coordination from Google Earth and converting height data to COGO points, which are later imported into AutoCAD, Civil 3D for further adjustment of adjustment and surface modeling.

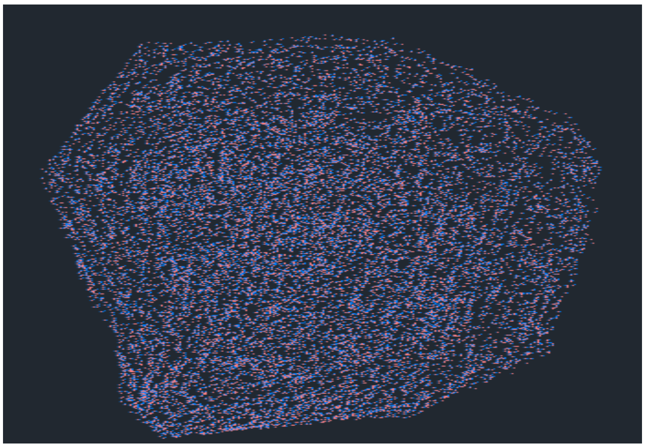


Fig 5 (Cogo Points)

Steps to Extract Contour Points from Google Earth and Convert to COGO Points for Civil 3D:

1. Google Earth Pro Open- Start Google Earth Pro on your computer.

Navigate in the project area (eg Alibag to CSMT corridor).

2. Mark and extract elevation points- Use the "Add Placemark" tool to mark specific places with adjustments where you want to remove the height data. For each point, be aware of latitude, longitude, and height (shown in the right corner or placement properties). You can also create a path with adjustments and test points.

3. Export marked points- After marking all the points, go to the panel and right-click on the folder or placemark. Click "Save Location" and export the file to KML or KMZ format.

4. Convert kml/kmz to CSV (optional but useful)

Use online converters or software tools (such as QGIS or Global Folders) to convert KML/KMZ to CSV, including latitude, longitude, and height values.

This CSV file can then be formed to match the civil 3D requirements.

5. Import data to AutoCAD Civil 3D- Open AutoCAD Civil 3D.

Use COGO points or point groups to import coordination data: Go to the home tab> Ground Data Panel> Points> Make Import Points.

Select the CSV file or input that includes Northing, Easting, and height values.

Specify the correct point file format (usually pnezd = point number, Northing, Easting, height, details).

6. Make the surface from Coago Points

After importing points, make a tin surface:

Home -tab> Create ground data> Surfaces> Surfaces.

Add COGO points imported to the surface as point groups.

Civil 3D will automatically produce shapes in the surface style based on points and settings.

e. This figure shows the surface in AutoCAD Civil 3D, which provides the necessary surface data such as the height of the area, contour lines, and ground profiles. This surface data adjustment is important for the design, vertical profile form, and structural analysis of elevated rail corridors.

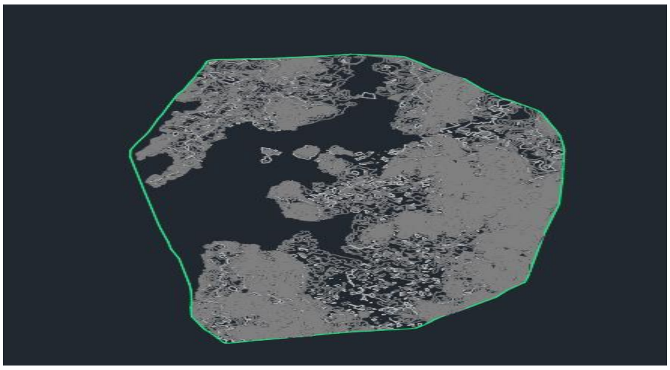


Fig 6 (Surface On Civil 3D)

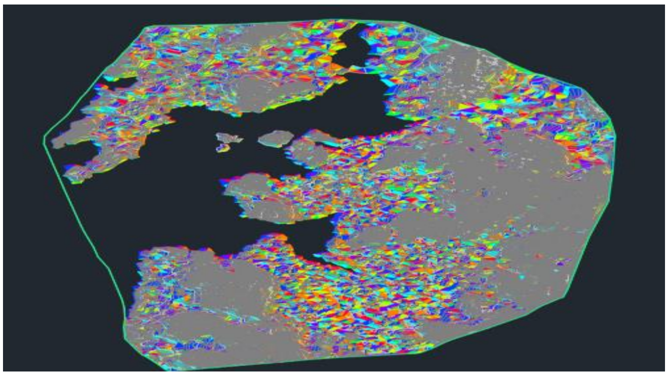


Fig 7 (Direction Surface)

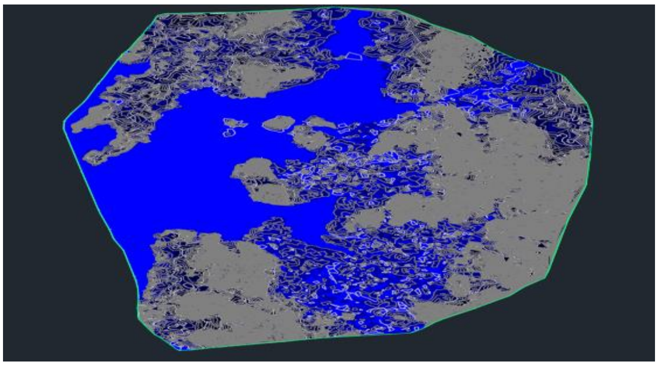


Fig 8 (Elevation Surface)

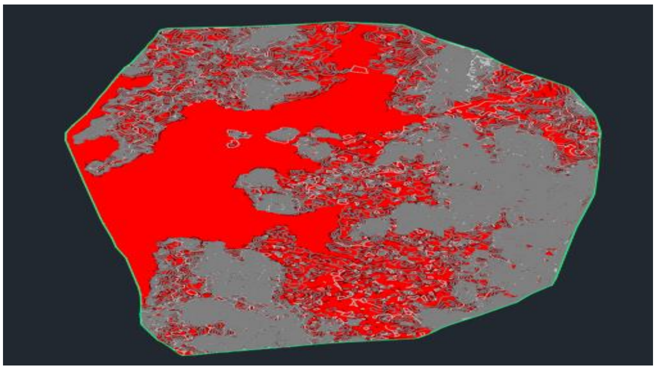


Fig 9 (Slope Surface)

In Fig7, Fig 8, Fig 9 in these there Direction, Elevation, amd Slope are shown by the Colour in civil 3d software.

Directions Table

Number	Minimum Direction	Maximum Direction	Color
1	N0 00' 00"E	N2 41' 50"E	
2	N2 41' 50"E	N17 50' 07"E	
3	N17 50' 07"E	N33 05' 17"E	
4	N33 05' 17"E	N48 46' 04"E	
5	N48 46' 04"E	N63 03' 27"E	
6	N63 03' 27"E	N77 17' 13"E	
7	N77 17' 13"E	S89 05' 58"E	
8	S89 05' 58"E	S76 19' 10"E	
9	S76 19' 10"E	S61 56' 11"E	
10	S61 56' 11"E	S47 38' 35"E	
11	S47 38' 35"E	S33 00' 53"E	
12	S33 00' 53"E	S18 06' 58"E	
13	S18 06' 58"E	S2 32' 15"E	
14	S2 32' 15"E	S0 00' 00"W	
15	S0 00' 00"W	S0 38' 12"W	
16	S0 38' 12"W	S16 09' 05"W	
17	S16 09' 05"W	S31 00' 30"W	
18	S31 00' 30"W	S44 25' 20"W	
19	S44 25' 20"W	S56 30' 52"W	
20	S56 30' 52"W	S68 23' 30"W	
21	S68 23' 30"W	S79 40' 01"W	
22	S79 40' 01"W	N89 15' 07"W	
23	N89 15' 07"W	N79 17' 44"W	
24	N79 17' 44"W	N67 53' 22"W	
25	N67 53' 22"W	N55 55' 18"W	
26	N55 55' 18"W	N43 38' 20"W	
27	N43 38' 20"W	N29 17' 25"W	
28	N29 17' 25"W	N15 00' 34"W	
29	N15 00' 34"W	N0 02' 12"W	

Direction Table 1

Elevations Table

Number	Minimum Elevation	Maximum Elevation	Area	Color
1	−21.85	−0.48	21283701.31	
2	−0.48	0.00	400992689.48	
3	0.00	0.48	55462187.90	
4	0.48	0.98	62280397.43	
5	0.98	1.26	40585002.05	
6	1.26	1.69	62173800.54	
7	1.69	2.00	43600306.19	
8	2.00	2.44	53514506.34	
9	2.44	2.93	47866986.94	
10	2.93	3.42	36064520.61	
11	3.42	4.12	41224431.16	
12	4.12	5.09	48382440.22	
13	5.09	6.26	50922426.37	
14	6.26	7.55	54935411.82	
15	7.55	8.97	56255089.83	
16	8.97	10.41	47647555.13	
17	10.41	12.30	54229403.71	
18	12.30	14.31	48028886.65	
19	14.31	16.91	43606679.12	
20	16.91	20.88	47891224.47	
21	20.88	26.81	51608949.13	
22	26.81	34.74	47659755.64	
23	34.74	46.52	53126764.84	
24	46.52	63.26	53827887.06	
25	63.26	88.77	55405065.21	
26	88.77	121.45	47093341.88	
27	121.45	187.06	51601403.25	
28	187.06	410.61	43860042.41	

Elevation Table 2

Slopes Table				
Number	Minimum Slope	Maximum Slope	Area	Color
1	0.00%	0.13%	407901989.63	
2	0.13%	0.28%	73148982.83	
3	0.28%	0.41%	65858266.02	
4	0.41%	0.52%	66070483.70	
5	0.52%	0.64%	62243045.35	
6	0.64%	0.74%	62163931.90	
7	0.74%	0.86%	57912003.45	
8	0.86%	0.98%	53867868.89	
9	0.98%	1.12%	51665660.70	
10	1.12%	1.27%	53158211.31	
11	1.27%	1.44%	51713944.53	
12	1.44%	1.62%	47675074.78	
13	1.62%	1.84%	47596982.08	
14	1.84%	2.10%	44772464.92	
15	2.10%	2.39%	44708350.05	
16	2.39%	2.75%	39546884.07	
17	2.75%	3.20%	40142969.89	
18	3.20%	3.75%	42175781.79	
19	3.75%	4.45%	40138535.36	
20	4.45%	5.37%	40061674.41	
21	5.37%	6.76%	40149875.52	
22	6.76%	8.83%	50366043.39	
23	8.83%	11.78%	50416823.87	
24	11.78%	15.93%	51638980.86	
25	15.93%	21.52%	49667080.43	
26	21.52%	30.62%	48211352.87	
27	30.62%	376.53%	36887934.47	

Slope Table 3

In Table 1, Table 2, Table 3 the data of the direction, elevation, slope data is shown in the civil 3d software.

f. Steps to Convert COGO Points into a Surface and get elevation, slope, and direction table in Civil 3D:

1. Make a new tin surface
Home tab> Create ground data panel> Surface> Surface.
2. Select the tin surface type.
Give it a name and style (controls 1 m and 5m, etc.).
Click OK.
3. Add logo points to the surface
Expand surfaces in the Professor tab> Your Definition of Surface Name> Definition.
Right-click Point Group> Add.
Select your point group that includes your COGO points.
Click OK.
Now your surface has originated from the COGO points! You should see the Figure and High Data display.

g. Analysis of slope, height, and direction on the surface

1. Slope analysis
Go to the Prosector tab, expand the surfaces, and right-click on the surface.
Select the Surface Properties> Analysis tab.
In the type of analysis, select the slope.
Determine the number of areas (eg 5).
Click on the race analysis.
Apply a surface style showing the slope area.
This will color the slopes on your surface.
2. Height Analysis
Steps similar to slope analysis, but choose the height of the analysis type.
Game analysis to display the high tape with color boundaries on the surface.
You can show the most important and easy form of better clarity.
3. Direction (aspect) analysis
In the type of analysis, select the instructions.
This slope shows the face (aspect).
It is useful to determine the contact with water flow or sunlight in the area.

h. Create a slope, height, and directional table

1. Surface slope/height table
NOTE TABE> Add Label> Surface> Sloper / Height / Spot Elevation Label.
Click on the surface and then add labels to the points or areas you want.
2. Surface analysis table
Tab> Table Panel> Add Surface Celebration Table.
Choose the surface.
Choose slope, height, or guideline.
Keep the table on the drawing. It will show the reach, the color code, and the details.

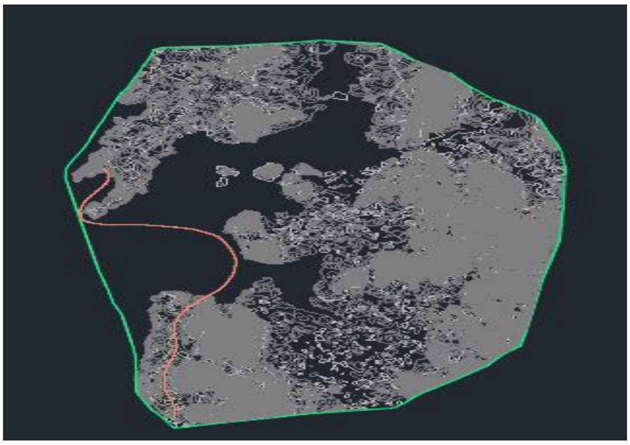


Fig 10 (Proposed Alignment)

Fig 11 (Graph of surface alignment)

i. Steps for Rail Alignment After Surface Creation in Civil 3D

1. Make horizontal adjustment
Go to the Home tab> Create a Design Panel> Adjustment> Create Layout Adjustment.
Give the adjustment a name (eg Alibag-CSMT corridor).

Choose rail as an adjustment type (or center line).
Enter the design criteria if necessary (speed, radius, super locations).
Use the setup toolbar:
Draw the touch (straight lines).
Add reduction (spiral or circular curves).
Make sure the adjustments are considering the custom route:
Area (by surface).
Less acquisition of land.
Bypass the populated areas or environmentally sensitive areas.
2. Analyze and optimize horizontal adjustment
Use the profile view to check how the horizontal adjustment interacts with the area.
Adjust the baskets, ready and tangent:
Speed limitation (eg, minimum radius for speed of 80-120 km/h).
Station site.
The availability of land.
3. Create vertical adjustment (profile)
Home -Tab> Go to Profile and Section View> Create Surface Profiles.
Choose your horizontal alignment and surface (tin).
Draw the profile view (longitudinal section).
Add a design profile on the current reason:
Use the profile setup tool to create characters, vertical curves, and gradients.
Maintain acceptable maximum grade (usually 1% -1.5% for railways).
Plan advanced classes:
For bridges, viaducts, and tunnels (eg Thal to Alibag requires tuning).
4. Corridor modeling (optional for 3D visualization)
Go to the corridor> Create the corridor.
Select adjustment, profile, and mounting (cross section of rail section).

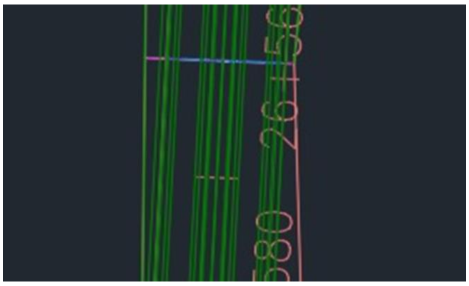
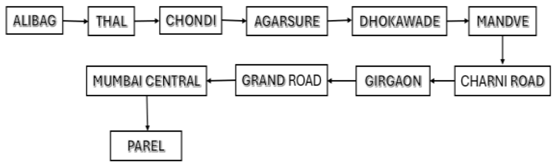


Fig 12 (Corridor)

j. Steps in Civil 3D Corridor Creation (with Values):
1. Horizontal alignment
Make a midline adjustment for 50.3 km
Maintain a minimum curve radius of 500 meters
Station sites marked in series:
Example:
Alibag (0 km), Thal (5 km), Chodni (9 km), etc.

The label station points with adjustment for reference in profile and corridor construction.
2. Vertical adjustment (profile)
Remove the surface profile from the tin surface
Design Vertical Adjustment:
Maximum shield: 1.0% - 1.5%
Crest/SAG curves on the change in the slope
The tunnel section (if applied) requires zero shield or soft slope
Factor in height difference design for pierce
3. Overall (specific cross-section)
Railway Disc tracks (ballast-free)
Cover plate: 8-10 meters wide
Pier cap supportive tires
Pier shaft: 8 meters to 20 meters height
Ohe -het backing: 5.5 m
Walk for maintenance if necessary: 0.75 m on each side
4. Corridor modeling
Use adjustment as a baseline
Use vertical profile
Design Speed Is 80-120Km.

k. Stations location



l.Time Required to Travel this distance

Segment	Distance (km)	Run Time (min)	Dwell Time (min)	Total Time (min)
Alibag → Thal	6	4	0.5	4.5
Thal → Chodni	5	3.5	0.5	4
Chodni → Agarsure	4	3	0.5	3.5
Agarsure → Dhokavade	5	3.5	0.5	4
Dhokavade → Mandwa	6	4	0.5	4.5
Mandwa → Mumbai Central	15	10	0.5	10.5
Mumbai Central → Grant Road	2	1.5	0.5	2
Grant Road → Girgaon	1.5	1	0.5	1.5
Girgaon → Charni Road	1	1	0.5	1.5
Charni Road → Parel	8	5.5	-	5.5

m. Assembly

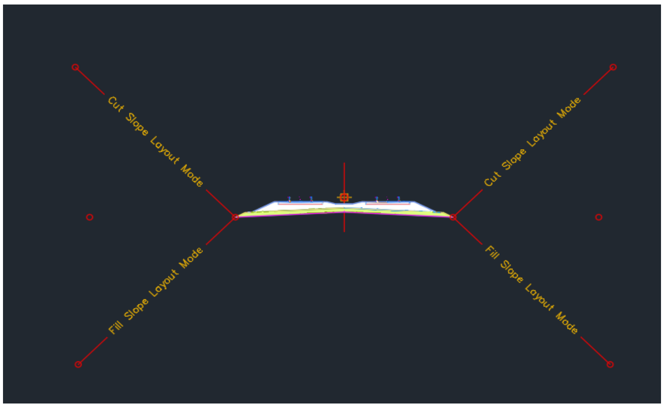


Fig 13 (Assembly of rail)

In these Fig Assembly is created in the civil 3d software for double track .

3. TRUSS Bridge

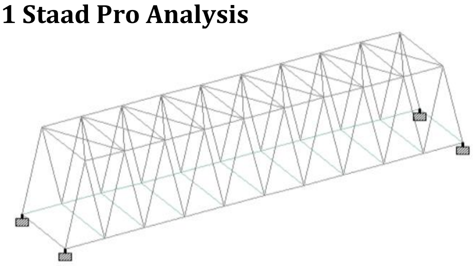
IS 2062 E450 steel used in railway steel bridge steel truss provide:

- High yield strength
- Good ductility
- Excellent weldability
- Corrosion resistance (especially in marine zones)

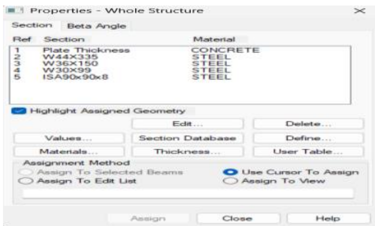
Steel Grades Used (India – IRS Standards)

Member Type	Force Type	Steel Section	Steel Grade
Top Chord	Compression	W44 X 335	IS 2062 E450
Bottom Chord	Tension	W36 X 150	IS 2062 E450
Diagonals	Tension/Compression	W30 X 99	IS 2062 E450
Cross Bracings	Shear/Tension	ISA 90×90×8	IS 2062 E450

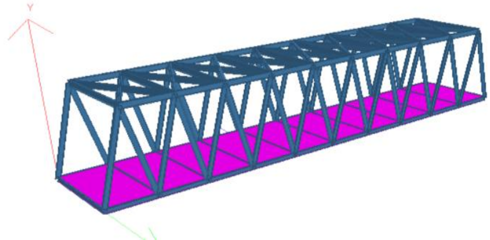
3.1 Staad Pro Analysis



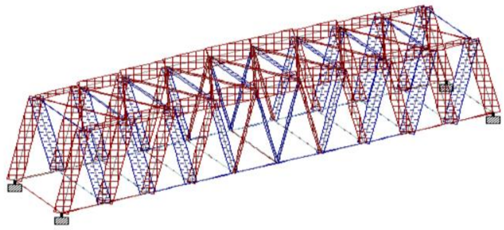
80M SPAN STEELTRUSS



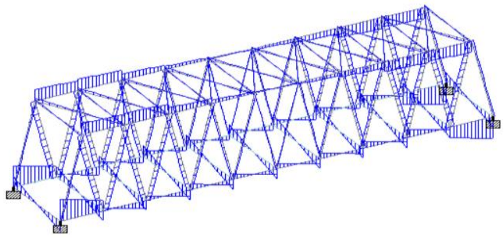
STEEL PROPERTIES DEFINE



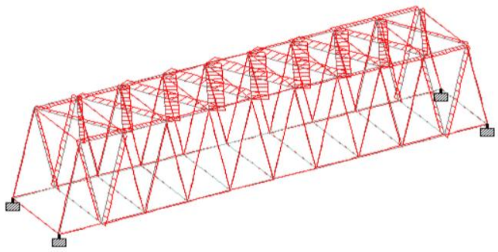
RENDER VIEW



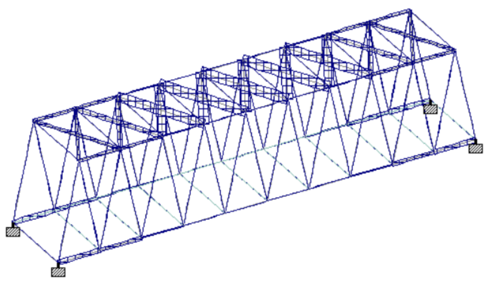
AXIAL FORCE



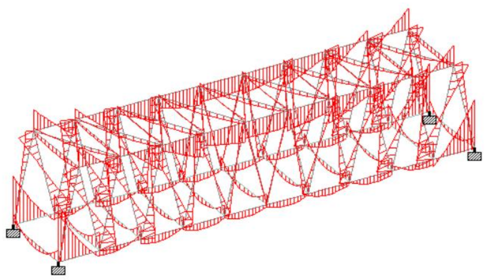
SHEAR-Y



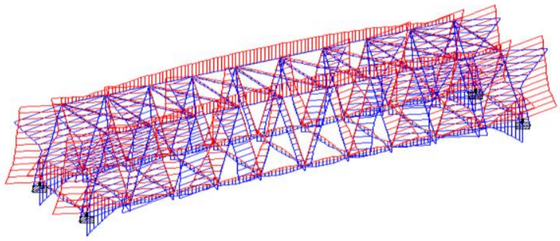
SHEAR-Z



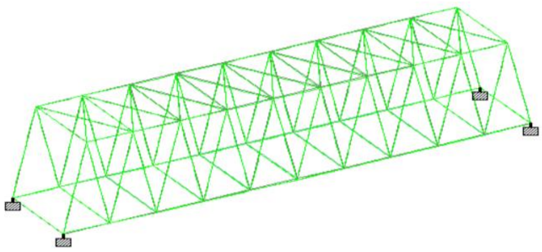
TORSION



BENDING-Z



BENDING STRESS



Deflection

4. Costing of the project

4.1 Rail Work

a- TRACK WORK 50KM

Component	Quantity	Rate (INR)	Amount (INR Cr)
Rails (60 kg/m)	~6,000 MT	₹90,000/MT	₹ 540
PSC Sleepers	83,000 units	₹ 2,500	₹ 20.75
Ballast (if any)	150,000 m³	₹800/m³	₹ 12.00

b- Electrification, Signaling, Misc.

Component	Estimated Cost (INR Cr)
Electrification	₹10 Cr/km × 50 km = ₹500
Signaling + Control	₹5 Cr/km × 50 km = ₹250
Contingency & Misc.	10% of total

c- STATIONS (11 STATIONS)

Type	Cost per station	Total (INR Cr)
Medium Stations	₹15–20 Cr	₹180 Cr (avg)

d- Grand Total Estimation

Component	Cost (INR Cr)
Trackwork	₹ 573
Stations	₹ 180
Electrification & Signal	₹ 750
Misc + Contingency	₹ 650
Total	☑ ₹7,703 Crore

Therefore, Total Cost For Track Work, Electrification, Signaling, Misc,Sations (11 Stations Is Rs7,703 Crores.
And The Cost Per Km Is = 7,703 / 50
Rs 154.03 Crore /Km

4.2 Estimation and Costing for 15 km Warren Truss Railway Bridge

(Material: IS 2062 E450 BR Grade Steel)

a- Dimension

Sr. No.	Particulars	Unit	Value
1	Length of Marine Bridge	km	15 km
2	Span Length	m	80 m
3	Width of Deck (Double Track + Walkway)	m	14 m
4	Number of Spans	-	188 spans
5	Steel Weight per Span	Tonnes	840 Tonnes
6	Total Steel Weight for 15 km	Tonnes	1,57,920 Tonnes
7	Unit Rate of Fabricated Steel (incl. erection)	₹/Tonne	₹ 95,000

b- Detailed Cost Estimation

Sr. No.	Description	Quantity	Rate	Amount (₹)
1	Structural Steel Fabrication & Erection	1,57,920 Tonnes	₹95,000/Tonne	₹ 1,50,02,40,000
2	Bearings (5% of Steel Cost)	Lump Sum	5% of ₹1,500 Cr	₹75 Crores
3	Erection, Barges & Heavy Cranes (7%)	Lump Sum	7% of ₹1,500 Cr	₹105 Crores
4	Protective Coating (Marine Paint) (3%)	Lump Sum	3% of ₹1,500 Cr	₹45 Crores
5	Contingency & Miscellaneous (5%)	Lump Sum	5% of ₹1,500 Cr	₹75 Crores

c- Total Estimated Project Cost

Description	Amount (₹)
Base Steel Fabrication Cost	₹1,500 Crores
Additions (20% total)	₹300 Crores
Grand Total	₹1,800 Crores

d- Steel Consumption & Cost per Unit

Particulars	Value
Steel per Span	840 Tonnes
Cost per Span	₹7.98 Crores
Steel per km	10,500 Tonnes
Cost per km	₹99.75 Crores

4.3 Estimation and Costing for 1 Pier (including piles + pile cap + pier)

(Material: M40 concrete, Fe500 steel, marine zone)

a. Dimemsion of pier

Item	Value
Number of Piles per Pier	6 piles (1.2 m dia, 30 m long)
Pile Cap Size	6.5 m × 4 m × 2 m
Pier Column	2.5 m dia, 15 m height
Concrete Grade	M40
Reinforcement Grade	Fe500
Exposure Condition	Severe (Marine Zone)
Labour + Machinery Rates	CPWD Standard + Marine Correction

b. Quantity Calculation

Component	Unit	Quantity
Excavation	m³	6 piles × (1.5×1.5×30) = 405 m³
Concrete for Piles	m³	6 piles × (π/4 × 1.2² × 30) = 204 m³
Concrete for Pile Cap	m³	6.5×4×2 = 52 m³
Concrete for Pier	m³	(π/4 × 2.5²) × 15 = 73.63 m³
Total Concrete	m³	204 + 52 + 73.63 = 329.63 m³
Reinforcement (overall)	kg	150 kg/m³ × 329.63 ≈ 49,445 kg = 49.44 Tonnes
Water Stop (for joints)	m	Perimeter of pile cap: 2(6.5+4) = 21 m

c. Estimation and Cost Table for 1 Pier

Sr. No.	Description	Quantity	Unit Rate (₹)	Amount (₹)
1	Excavation (Marine, under bentonite)	405 m³	₹600/m³	₹ 2,43,000
2	Pile Concrete M40 (pumped)	204 m³	₹8,000/m³	₹ 16,32,000
3	Pile Cap Concrete M40	52 m³	₹8,000/m³	₹ 4,16,000
4	Pier Shaft Concrete M40	73.63 m³	₹8,500/m³ (height)	₹ 6,25,855
5	Reinforcement (Fe500, Cut+Bent+Placed)	49.44 Tonnes	₹85,000/Tonne	₹ 42,02,400
6	Water Stop Joint (PVC strip)	21 m	₹300/m	₹ 6,300
7	Machinery (Crane, Tremie, Pumping)	Lump Sum	₹ 3,50,000	₹ 3,50,000
8	Labour + Supervision	Lump Sum	₹ 2,00,000	₹ 2,00,000
9	Miscellaneous (Bentonite, Tools, Formwork)	Lump Sum	₹ 2,00,000	₹ 2,00,000

d. Total Estimated Cost for 1 Pier:

Particular	Amount (₹)
Subtotal	₹ 78,75,555
Add 10% Contingency (marine environment risk)	₹ 7,87,555
Grand Total for 1 Pier	≈ ₹86.63 Lakhs

Now For Total 15 km Bridge:
Number of Piers = 188 Spans → ~188 Piers
Total Cost:
188×86.63 Lakhs=₹162,86,44,000=₹1,628.64 Crores
(Thus, approx ₹1,630 Crores for pier work of entire marine bridge)

4.4 Estimation and Costing: Labour, Workers, and Machinery

a. Labour and Worker Cost

Sr. No.	Type of Labour/Worker	No. of Persons	Rate per Day (₹)	Working Days (Approx.)	Total Cost (₹)
1	Site Engineers / Supervisors	15	2,000	600	1,80,00,000
2	Structural Steel Fitters / Welders	70	1,600	600	6,72,00,000
3	Masons (Concrete Workers)	40	700	600	1,68,00,000
4	Crane Operators (Heavy Marine Cranes)	8	2,500	600	1,20,00,000
5	Tremie Operators / Marine Concreting	12	1,200	600	86,40,000
6	Bar Benders (Steel Fixers)	25	800	600	1,20,00,000
7	Electricians / Mechanical Technicians	5	1,800	600	54,00,000
8	General Helpers / Unskilled Labour	100	600	600	3,60,00,000
9	Safety Officers (Marine Specialization)	5	2,000	600	60,00,000

Total Labour and Worker Cost = ₹172.04 Crores

b. Machinery Requirement and Cost

Sr. No.	Type of Machinery	No. of Units	Rental Cost per Month (₹)	Duration (Months)	Total Cost (₹)
1	Floating Marine Cranes (150–300T)	4	25,00,000	18	18,00,00,000
2	Piling Rigs (Marine)	6	15,00,000	12	10,80,00,000
3	Batching Plant (90 m³/hr)	2	4,00,000	18	1,44,00,000
4	Barges for Material Transportation	6	7,00,000	18	7,56,00,000
5	Gantry Cranes	4	5,00,000	18	3,60,00,000
6	Hydraulic Jacks and Stressing Equipment	10	2,00,000	12	2,40,00,000
7	Welding Generators, Cutting Machines	Lump Sum	—	—	15,00,000
8	Marine Survey Boats with DGPS	2	3,00,000	18	1,08,00,000

Total Machinery Rental and Operation Cost = ₹440.3 Crores

c. Grand Total (Labour + Machinery)

Particulars	Amount (₹)
Labour and Skilled Worker Cost	₹172.04 Crores
Machinery Rental and Operation	₹440.30 Crores
Grand Total	612.34 Crores

d. Time Duration and no. of labour and machine Required

Item	Quantity / Value
Total Labour Per Day	280–300 persons
Total Major Machinery Units	~50–55 Units
Project Construction Period	24–26 months (2 years)
Total Cost for Labour + Machines	**₹612.34 Crores**

Therefore, Total Cost of the Project is
1)Track Work, Electrification, Signalling, Misc, Stations (11 Stations) = ₹7,703 Crore
2)15 Km Warren Truss Railway Bridge = ₹1,800 Crore
3) Total Costing For Pier = ₹1,630 Crore
4): Total Cost of Labour, Workers, And Machinery = ₹612.34crore
Total Cost = 1+2+3+4 = ₹11,745.34 Crore

5. 3D Design in Civil 3D

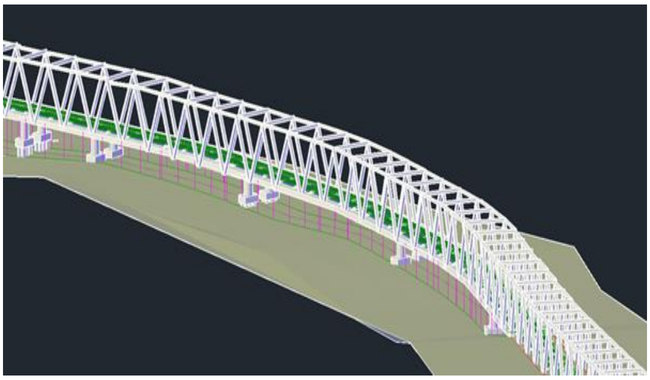


Fig 14 (3D View In Civil 3D)

This final figure showcases a comprehensive 3D model of the railway bridge project created using Autodesk Civil 3D software. The visualization includes critical structural elements such as piers, the Warren Truss bridge framework, rail components (tracks and sleepers), and the terrain surface modeled accurately to reflect real-world topography.

Conclusion:

1-Low travel time:
The elevated railway corridor will reduce the current travel time from Alibag to CSMT, which will greatly improve regional connection.

2-Technically possible design:
Using devices such as AutoCad Civil 3D, Staad.Pro and Google Earth Pro, a strong design with 80 meters Spain Warren Treas Bridge and Marine Pile Foundation developed to meet coastal and urban challenges.

3-Strategic infrastructure development:
With 11 strategically located stations, the Commutor plant increases, integrates multimodal transport options and supports future urban expansion.

4-Future scalability:
The system is designed to allow upgrading to metro or high-speed technologies, ensuring that it is favorable for future transport requirements.

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