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Analysis and Design of Precast Reinforced Concrete Slab Tracks on Non-Ballasted Foundations using STAAD Pro

Aniket Rahate[1], Hemant Dahake[2]
[1]P.G. Student, [2]Assistant Professor, Department of Civil Engineering, G. H. Raisoni University, Anjangaon Bari, Maharashtra, India

Abstract: Formation of the usual route includes a large number of excavation materials, the formation of the base layer, the underlying layer, the ballast layer and the sleeping rays. This is optimal for a large period of forming the track. In this case, as the gap is limited to 212 meters, to reduce the cost and efficient use of resources available near the site, a specific structure is formed, as well as the gauge. Also, the land robot has to be made less optimized. With this method of forming the track, regular routine work in the industry does not depend, and also consumes less time and resources used. In this proposed work, railroad roads for specific SPAN stretch on existing road levels must be developed as on the rail load details provided by the industry.
Keywords: non ballast, track

I. INTRODUCTION

A relatively new ballast – the less plate of the walkway or continuous concrete gauge is applied worldwide on an increase in scale for high-speed rail lines. For example, more than 4000 km plates for high-speed lines are planned in China in the near future. This development is due to the fact that the plate track has a number of advantages over the Balelno track. Some structural advantages: higher longitudinal and lateral constant stability, impossibility of railroad barricading and lower susceptibility to differential calculations. Operational benefits of the plate are: lower maintenance (reduced 70 – 90% compared with the chatter), resulting in higher availability and the possibility of longer tenure – which is important for high-speed connections, preventing ballast particles from foaming at high speed, as well as increasing passenger comfort, as well as security, thanks to the high stability of the track and better alignment. The disadvantages are high initial investment costs and reduced vibration and noise absorption, which can also lead to structural damage at an early stage.

Almost all constructions of modern gauge panels are based on the principle of relatively flexible continuous or segmented concrete slab over a rigid substructure. Since many high-speed lines are built in flat areas of the delta with relatively weak subclasses (Germany, the Netherlands, Sweden, Japan, Korea, China), often massive and cost-intensive improvement of soil are needed, especially to increase the speed of a critical train. According to the German school, based on the static highway construction, the reference layer, with a thickness of about 0.3 m, must have a substantial bearing rigidity, with the youth module of at least 120MN/m2, and the waterfront below should be a minimum module of 60MN/m2. In this case, it may also be applied incoherent block structures without flexion rigidity, and are excluded the differential settlement. The applied design of the track have reinforcements in the neutral axis so as to control the width of the cracks in place of the concrete casting in the plate.

II. REVIEW OF LITERATURE

This article discusses the mechanical properties of steel reinforced concrete prefabricated tracks on a non-occult, looper-plastic foundations. In order to understand the behavior of the plates, the analysis of FEM was performed for discrete and continuous systems. Firstly, the full-size plates without a foundation, including solid and hollow specimens (with a 30% weight reduction) were tested under a focused static (Monmonic) load line, and load-deflecting curves were removed. Then, FEM for the zero basis of stiffness have been tested with experiments that were in a good contract. Initial results include the effects of multiple parameters on cracking load, Ultimate Load, and absorption of energy plates placed on the Pelelno-plastic foundations, including the width of the plate, concrete tensile strength and load factor. (M. Madhkhan et al 2011).

Taken into account the mechanical properties of the floor slabs on the foundation with nonlinear rigidity. Initially, the cracking stages were tested in the FEM models, and it was known that the track plate had unilateral flexural behaviour. Secondly, the experimental full-scale models were made, and the accuracy of the tests was tested by comparing FEM loaded erection curves with

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preliminary studies and validation of cracks and end loads with those that are obtained from the experiments. Finally, the impact of multiple parameters on cracking and Ultimate loads and the absorption of energy by steel fibers of reinforced plates have been researched by examining the real behavior of the plate lanes on elastic foundations before and after cracking. Steel fibers have increased compression and flexible strengths as well as plasticity and energy absorption. The width of 2.5 m was the optimum width and the fracture pattern changed to that width. (M. Madhkhan et al 2013).

The constituent model for material nonlinear analysis of Steel® BRE reinforced concrete slabs, supported on the soil, was developed. Taken into account the potential of absorption of energy, which ensures the Reinforcement® BRE in the constituent relations. Plasticity theory is used to combat elpedia-plastic behavior of concrete. The Smearedcrack model is used to reproduce concrete cracking behavior. Soil-linear behavior is modeled by springs on orthogonal directions to the plate. Loss of contact between the stove and soil is taken into account. Model performance is evaluated using experimental research results (J.A.O. Barros et al 2001).

III. ANALYSIS

The analysis of non ballasted track is analyzed in STAAD-PRO and consider the length as 210 m, height as 2.05 m and the gauge is to be standard, broad and narrow gauge.

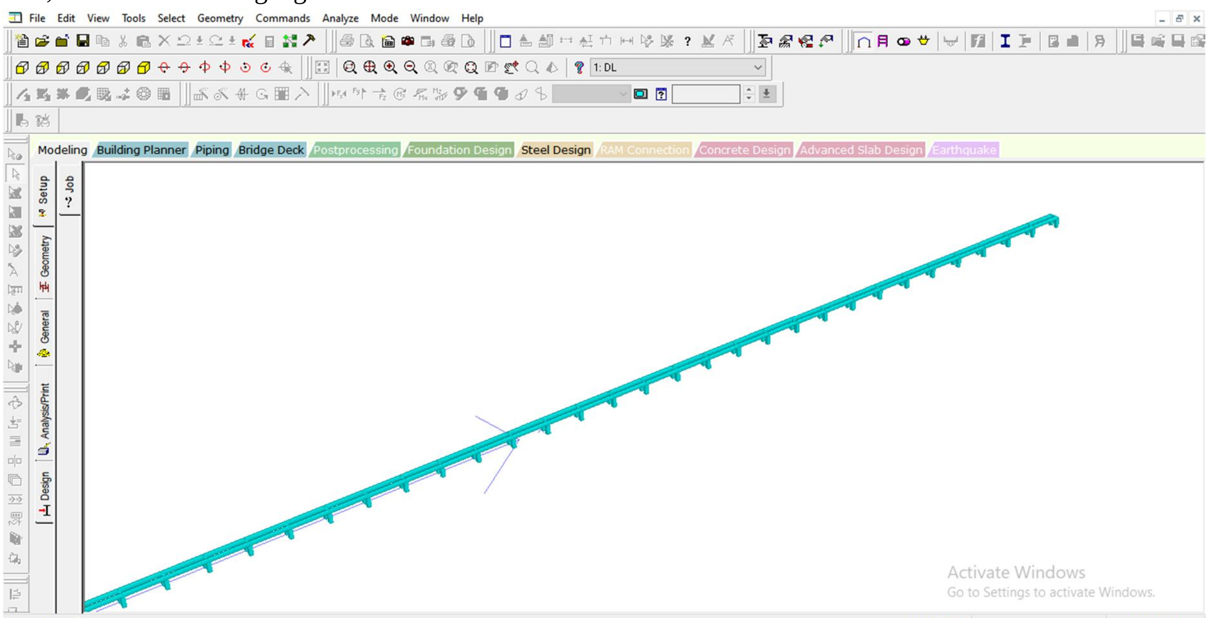

Fig.1: 3D modeling of non ballasted track

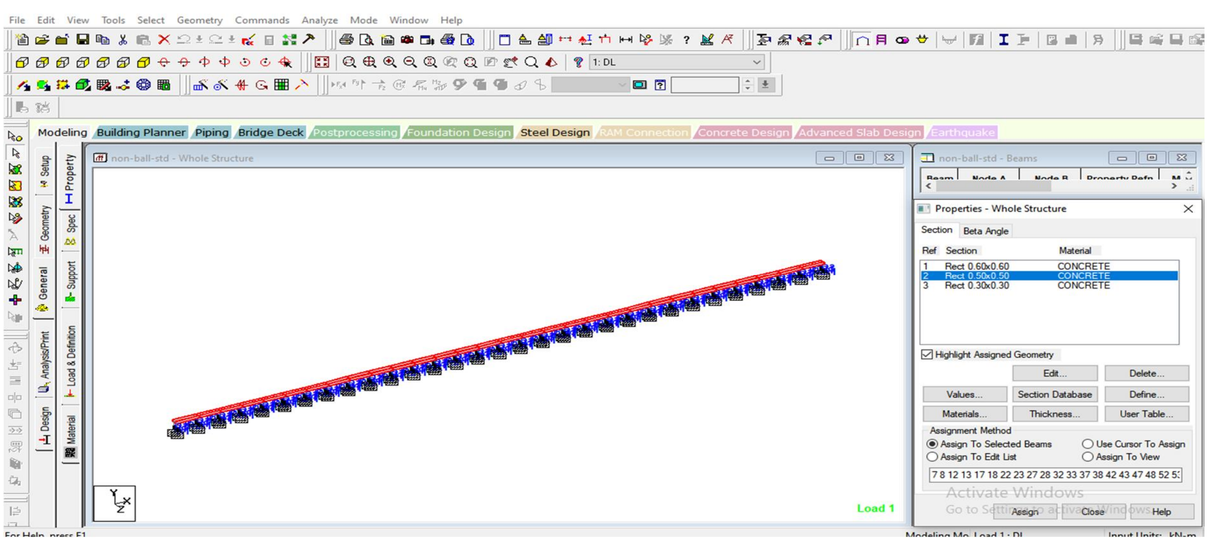

Fig.2: Analysis in STAAD-PRO

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IV. RESULTS

The results of the modeling of non ballasted track is as follows:

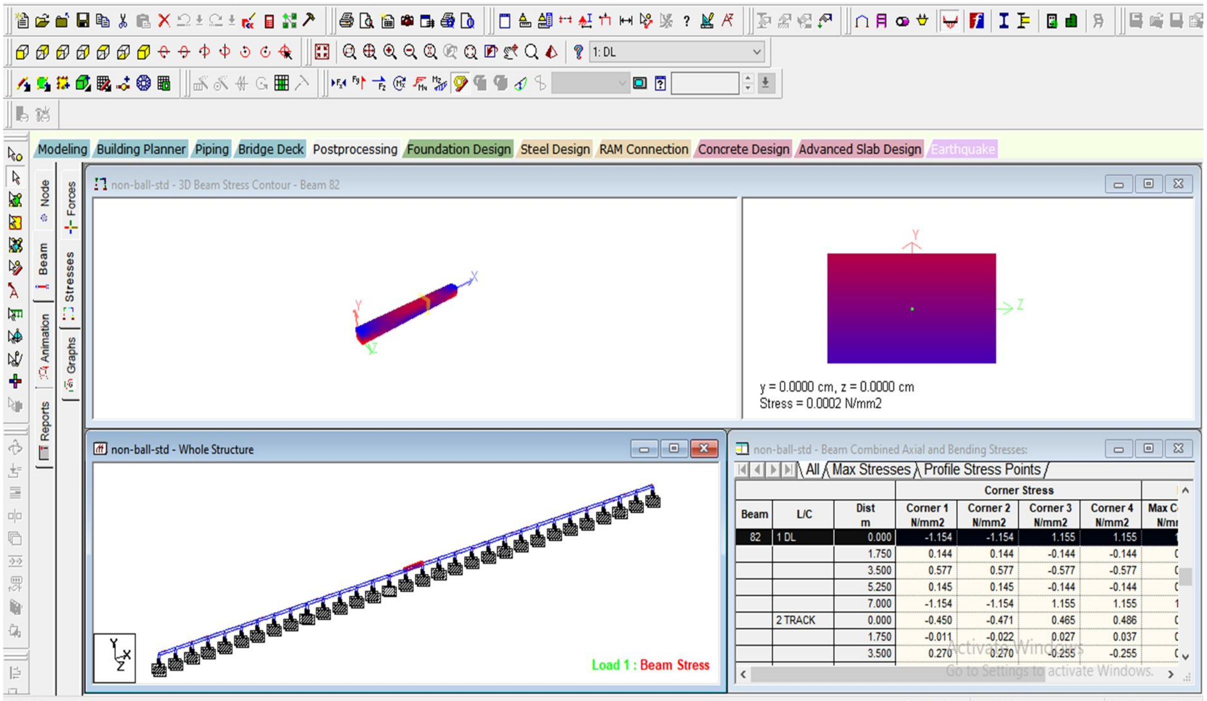

Fig.3: Stresses in the element of track

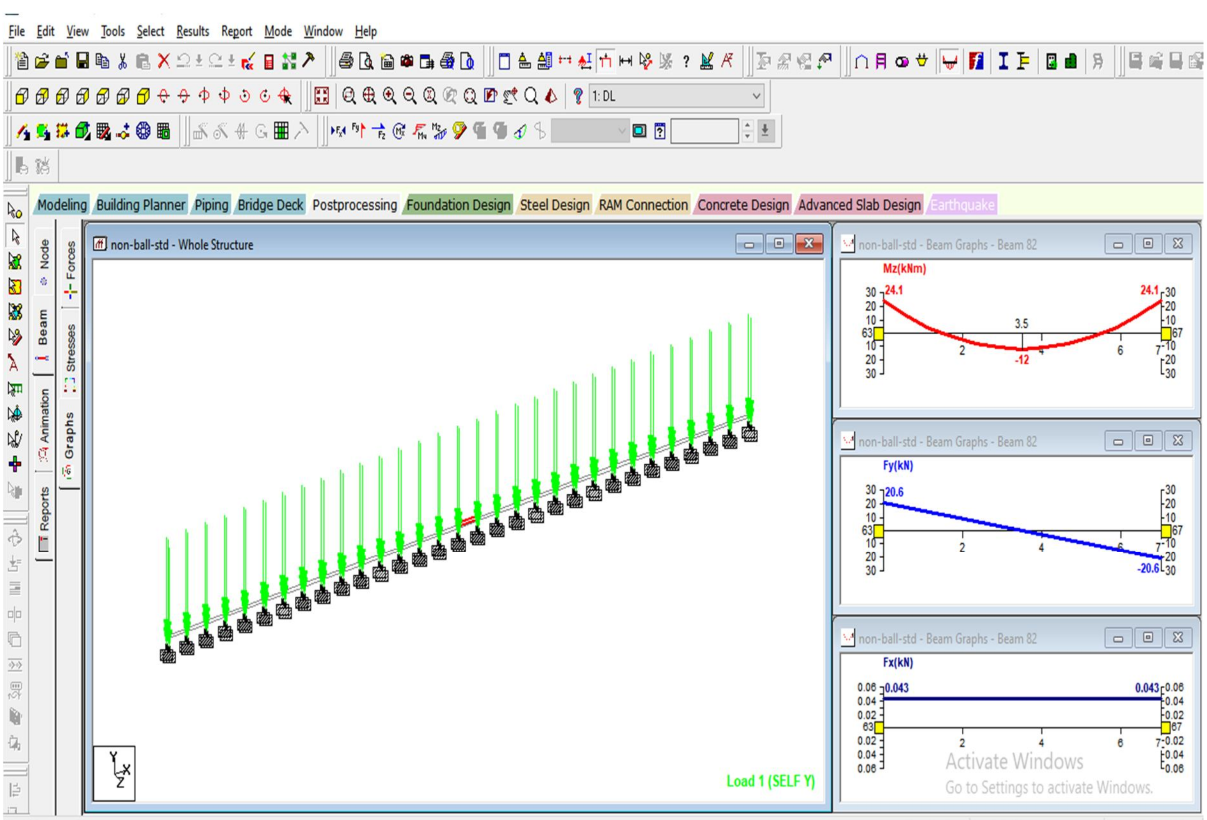

Fig.4:Forces in the element of track

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Table 1: Displacement in standard gauge

			Horizontal	Vertical	Horizontal	Resultant
	Node	L/C	X mm	Y mm	Z mm	mm
Max X	4	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	0.055	-0.016	-0.024	0.062
Min X	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.146	-0.017	0	0.147
Max Y	1	1 DL	0	0	0	0
Min Y	119	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.121	-0.029	0	0.124
Max Z	11	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.045	-0.028	0	0.053
Min Z	4	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.001	-0.021	-0.033	0.039
Max rX	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.146	-0.017	0	0.147
Min rX	4	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.001	-0.021	-0.033	0.039
Max rY	4	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.001	-0.021	-0.033	0.039
Min rY	3	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.002	-0.018	-0.03	0.035
Max rZ	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.146	-0.017	0	0.147
Min rZ	4	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	0.055	-0.016	-0.024	0.062
Max Rst	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.146	-0.017	0	0.147

Table 2: Displacement for Broad gauge

			Horizontal	Vertical	Horizontal	Resultant
	Node	L/C	X mm	Y mm	Z mm	mm
Max X	3	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	0.055	-0.013	0	0.057
Min X	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Max Y	7	2 TRACK	-0.051	0.001	0	0.051
Min Y	119	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-0.035	-0.022	0	0.041
Max Z	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Min Z	124	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Max rX	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Min rX	124	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Max rY	124	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Min rY	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Max rZ	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127
Min rZ	3	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	0.055	-0.013	0	0.057
Max Rst	123	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-0.126	-0.013	0	0.127

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Table3: Reaction for standard gauge

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	1	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	32.567	90.105	4.368	5.94	0.737	-19.609
Min Fx	121	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-15.59	66.802	0.347	0.195	0	3.235
Max Fy	117	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	22.196	130.946	1.166	0.656	0.26	-26.612
Min Fy	121	2 TRACK	4.62	13.22	0.543	0.302	0.3	-9.409
Max Fz	1	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	32.567	90.105	4.368	5.94	0.737	-19.609
Min Fz	2	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	32.027	87.149	-4.737	6.372	-5.34	-18.843
Max Mx	2	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	32.027	87.149	-4.737	6.372	-5.34	-18.843
Min Mx	10	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	9.779	129.185	-1.189	-0.678	-0.32	-10.66
Max My	1	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	32.567	90.105	4.368	5.94	0.737	-19.609
Min My	2	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	32.027	87.149	-4.737	6.372	-5.34	-18.843
Max Mz	6	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-6.313	100.62	-0.211	0.126	0.229	7.71
Min Mz	117	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	22.196	130.946	1.166	0.656	0.26	-26.612

Table 4: Reactions for Broad gauge

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	1	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	26.771	69.213	0.993	0.557	0.535	-18.232
Min Fx	121	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-15.59	67.185	0.475	0.264	0	3.235
Max Fy	5	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-6.28	101.084	0.475	0.264	0	7.704
Min Fy	6	2 TRACK	9.466	-1.298	-0.341	-0.188	-0.204	-11.204
Max Fz	1	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	26.771	69.213	0.993	0.557	0.535	-18.232
Min Fz	2	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	26.771	69.213	-0.993	-0.557	-0.535	-18.232
Max Mx	1	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	26.771	69.213	0.993	0.557	0.535	-18.232
Min Mx	2	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	26.771	69.213	-0.993	-0.557	-0.535	-18.232
Max My	121	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-2.996	67.297	0.982	0.538	0.535	-12.054
Min My	122	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	-2.996	67.297	-0.982	-0.538	-0.535	-12.054
Max Mz	5	5 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-6.28	101.084	0.475	0.264	0	7.704
Min Mz	117	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	19.914	99.297	0.989	0.55	0.306	-23.813

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Table 5: Forces in the standard gauge track

	Beam	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	144	117	126.371	-22.196	1.166	0.26	-0.656	-26.612
Min Fx	82	67	-2.728	-38.452	0.094	0	0.328	44.395
Max Fy	152	119	22.722	42.473	0.117	0	-0.373	56.223
Min Fy	8	8	18.524	-40.609	-0.44	-0.189	-1.12	49.857
Max Fz	2	2	82.562	4.937	32.027	-3.103	-19.338	6.372
Min Fz	3	3	4.297	7.794	-3.373	0.028	1.065	2.835
Max Mx	1	1	85.53	-32.567	4.368	0.737	-5.94	-19.609
Min Mx	2	2	82.562	4.937	32.027	-3.103	-19.338	6.372
Max My	2	4	47.602	0.827	26.402	-3.103	40.964	0.424
Min My	2	2	82.562	4.937	32.027	-3.103	-19.338	6.372
Max Mz	152	119	22.722	42.473	0.117	0	-0.373	56.223
Min Mz	149	123	47.058	14.284	1.161	0.45	1.733	-34.396

Table 6: Forces in the broad gauge track

	Beam	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	4	5	96.509	6.28	0.475	0	-0.264	7.704
Min Fx	5	8	-2.855	-5.716	-0.341	-0.204	-0.51	4.358
Max Fy	152	119	15.59	32.563	0	0	0	40.191
Min Fy	7	7	15.59	-32.563	0	0	0	40.191
Max Fz	3	4	0.854	-4.133	2.813	0	1.065	1.477
Min Fz	3	3	0.854	4.133	-2.813	0	1.065	1.477
Max Mx	149	121	62.722	2.996	0.982	0.535	-0.538	-12.054
Min Mx	150	122	62.722	2.996	-0.982	-0.535	0.538	-12.054
Max My	1	3	36.221	-21.146	0.993	0.535	1.477	30.883
Min My	2	4	36.221	-21.146	-0.993	-0.535	-1.477	30.883
Max Mz	152	119	17.058	30.643	0.139	-0.001	-0.441	41.622
Min Mz	149	123	36.527	15.59	0.475	0	0.71	-28.725

The above table gives the results in terms of displacement, reaction, shear force, bending moment. The results are tabulated for the standard and broad gauge.

V. CONCLUSION

The above work gives the following conclusions:

A. The displacement is found to be more in case of standard gauge
B. Shear force is found to be more in standard gauge as compared to the broad gauge
C. Moment is found to be more in case of standard gauge
D. The non ballasted gauge is suitable in case fast track construction
E. This type of construction do not require the excavation as in case of normal railway track.

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