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Specification Study of Railway Test Track with R33 Curve Section

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ABSTRACT — *In recent years, expansion of high-speed railway network and LRT network in cities are widely performed. On the other hand, research and development of automated driving technology on the roads and mobility service are actively carried out. In research and development of next-generation transportation systems, comprehensive research on both road and rail becomes important. This paper introduces the construction of test track using MBD in the construction of integrated research field ITS R&R experiment field.*

1 Introduction

The performance demanded for the railway vehicle has changed dramatically as compared to the age when the wheelset appeared. In recent years, high-speed trains have been required for service operations over 300 km/h, whereas LRT (Light Rail Transit) should have smooth curving ability in tight curve section at intersection for left or right turning. In the design of the conventional railway bogie with two solid axle wheelsets, the optimization design method for suspension stiffness and the theory of asymmetric suspension design have been developed. The LRT system attracts attention as the urban traffic system for next generation mobility, because of eco-ability and accessibility. The light rail vehicle (LRV) has independently rotating wheels to achieve low-floor design. However, conventional independently rotating wheels do not have a self-steering ability.

In order to obtain self-steering ability with independently rotating wheels, the EEF bogie which makes use of gravity stiffness was proposed. However, this system was not widely used because of complex structure with linkage mechanism in the bogie. The use of independently rotating wheels with inverse tread conicity to achieve self-steering ability without any complex bogie structure was proposed. The effectiveness of the vehicle with two single-axle bogies that use two independently rotating wheels units with inverse tread conicity was proved by 1/10 scale model experiment and full-scale model simulation [1]. In order to verify the experiment of the proposed bogie, it is necessary to examine the relation with the gauge widening (slack) existing in the curved section.

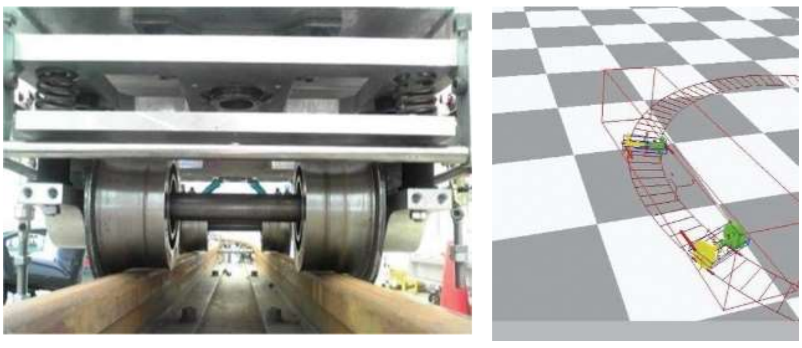


Fig. 1: 1/10 scale model experiment model (left) and full scale model simulation (right) [1]

2 Slack on the track

We investigated the relationship between vehicles and slack using multi-body dynamics simulation in order to construct Chiba Test Track 2.0 with 33m radius curve section and carry out real scale running experiment. In the running simulation, the slack value in the 33m radius curve section were set to 5, 10, 15, 20, 25 and 30 mm. The running velocity of vehicle is 10 km/h. From the simulation results, the wheel flange will ride on the rail when the slack value is 25 mm or more. Based on this result, the slack value in the curve section and turnout section in Chiba Test Track 2.0 is set to 15 mm.

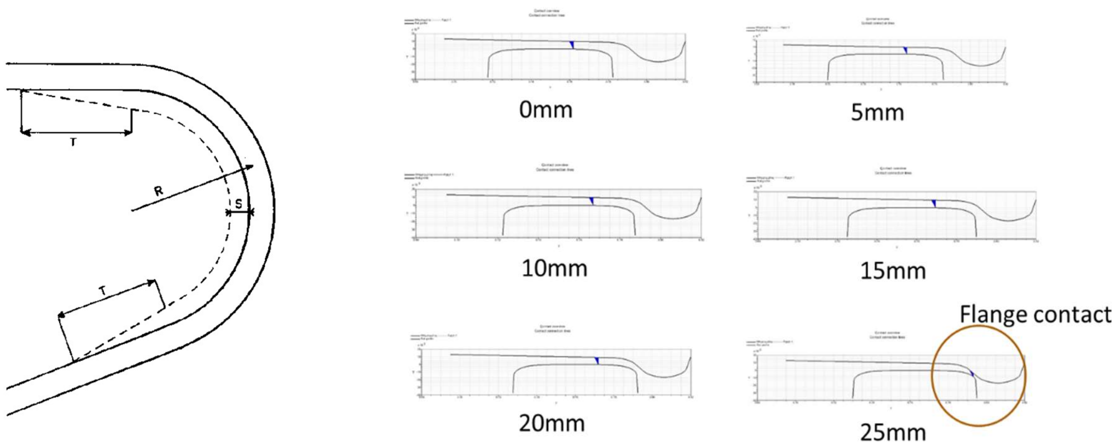


Fig. 2: Slack on the track (left) and full scale model simulation result with different slack value (right)

3 Chiba test track 2.0 in ITS R&R experiment field

The research environment on advanced vehicles at Nishi-Chiba was restructured as an ITS R&R experiment field at Kashiwa campus of the University of Tokyo in April 2017. The ITS R&R Experiment Field comprised of proving ground for road, experimental traffic lights, driving simulator and Chiba Test Track 2.0 for railway with R33 curve section, special turnout and railroad crossings.

Fig. 3: Over view of Chiba Test Track 2.0 in ITS R&R Experiment Field

4 Digital model of Chiba test track 2.0

A digital model of the Chiba test track 2.0 was created for verification of simulation and experiment in track and vehicle. The basic line and the side track line can be performed as simple independent models due to a special turnout without large gap.

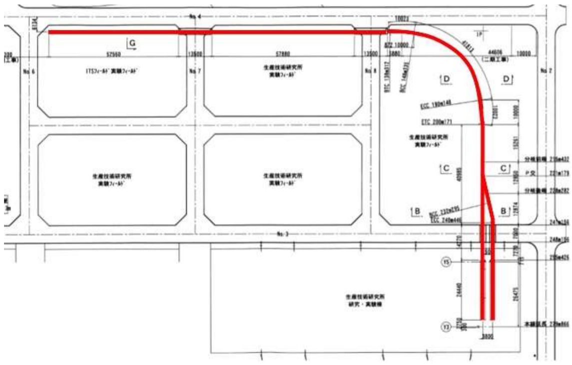
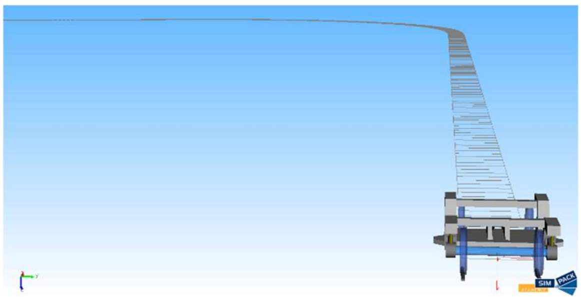
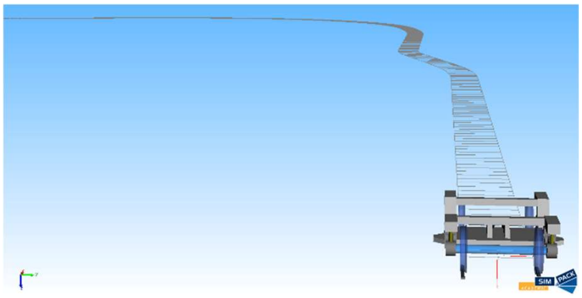


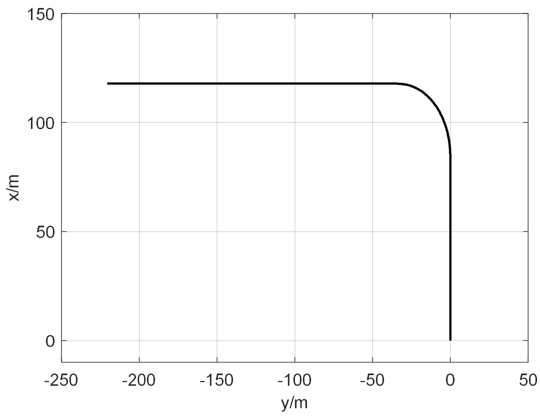
Fig. 4: Dwawing of Chiba Test Track 2.0 (red line)



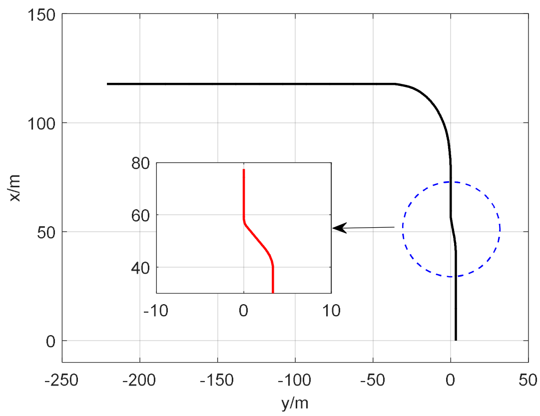
(a). View of basic



(b). View of sidetrack



(c). Top view of basic



(d). Top view of sidetrack

Fig. 5: Track setup on SIMPACK

5 Conclusion

In this paper, the specification examination of test track in ITS R&R experiment field using MBD was discussed.Based on the study results, the slack in the R33 curve section and turnout section was determined to 15 mm. Moreover,a digital model including basic line and a sidetrack line section was created for experimentation and simulation validation.

References

[1] Y. Suda , W. Wang , M. Nishina , S. Lin and Y. Michitsuji, "Self-steering ability of the proposed new concept of independently rotating wheels using inverse tread conicity," *Vehicle System Dynamics*, vol.50, pp. 291–302, 2012.