Experimental Investigation of Frictional Sleeper Effect on the Lateral Resistance of Railway Track

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ABSTRACT

Welding rail joints in Curves with radius less than 400 meters is not applicable. Consequently, maintenance costs in many old-fashioned railway tracks increases rapidly. Moreover, destruction of track components, plastic deformation and critical cracks to the rail head, fractures in sleepers, failure in fasteners, ballast bed damage and lateral movement of railway track occur in rail joints. There are many methods to increase the lateral resistance of the railway track such as changing the type of sleepers, changing sleeper intervals and employing new technologies. The new frictional sleeper is designed with cross-wise ridges at the underside to utilize more of the high internal friction potential of the crushed stone ballast by forming a coarse toothing with adequate dimensions.

Since the lateral resistance of a standard mono block concrete sleeper in a ballast bed mainly consists of the frictional forces between the ballast stones and the sleeper bottom, this article will investigate the changes in lateral resistance of railway track by employing STPT test on frictional sleeper and comparing the results with standard sleeper.

An experiment has been directed on a track with and without frictional sleepers in SRE LAB-IUST and it has been found that the lateral resistance of the railway track increases %59.1 by using frictional sleepers. According to the test results rail joints in curves with radius less than 400 meters can be welded by employing frictional sleepers.

1- Introduction

To increase speed limit for railway tracks is applicable by welding rail joints and employing Continues welded rails (CWR). Unfortunately, there are a lot of curves with radius less than 400 m in most old-fashioned railway tracks. Field investigations show that the lateral resistance of the railway track is not adequate for welding rail joints in mentioned railway tracks. In fact, omitting rail joints causes huge longitudinal forces in rail leading to track lateral movement. There are many methods to increase the lateral resistance of the railway track such as employing winged sleeper, dual block sleepers, sleeper anchoring, frictional sleeper, Xi Track method and …. This paper investigates one of these methods, employing frictional sleeper, by conducting an experiment on a special frictional sleeper designed for this purpose. At first, lateral resistance of the railway track and its components will be discussed then the experiment on a track with and without frictional sleepers which has been directed in SRE LAB-IUST will be explained.

Lateral resistance of the railway track generally consists of two components: the lateral resistance provided by ballast for the single sleeper and rail bending stiffness and fasteners torsional stiffness in the horizontal plane. The rail resistance and fastener resistance are often very small and the rail contribution becomes zero during buckling since the rail produces the force causing the lateral movement. The resistance between a standard mono block concrete sleeper and the ballast bed mainly consists of three components: F_b, friction at the bottom, F_c, friction on the sides (crib zone) and F_s, passive pressure at the end of the sleeper (shoulders), (figure 1).

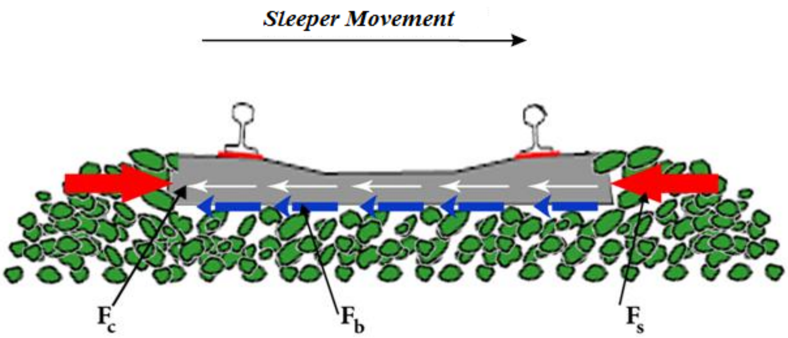

Figure 1. Sleeper resistance factor in a ballast bed

The bottom resistance is a force which overcomes frictional resistance. The frictional force, of course, depends on the sleeper weight and the friction coefficient. Frictional resistance on the sides of the sleeper under a normal force caused by lateral ballast pressure causes the crib resistance. This resistance increases directly by the depth of ballast in the crib. The contact between ballast particles and the sides of the sleeper reduces in a timely manner. The crib contribution, consequently, will be reduced or omitted. Passive pressure resistance at the shoulders mostly depends on the shoulders geometry which prevents sleeper movement caused by the ballast shear force. The shoulder contribution also increases directly with the height of the shoulder above the sleeper bottom and the shoulder width.

2- Conclusion

The lateral stability of the railway track depends on the lateral resistance of the sleepers, ballast bed and fastening systems. Omitting and welding rail joints cause huge longitudinal forces in the rails leading to the rail buckling. Consequently, professionals have suggested different method to increase railway track lateral resistance. This study introduces a new frictional sleeper with a course toothing surface at the bottom. Employing this frictional sleeper increases the railway track lateral resistance by exploiting high internal friction potential of ballast stones. In this study, laboratory tests were directed on the frictional sleeper and the test results indicated that employing frictional sleeper increases the lateral resistance of the railway track by approximately 59%. Consequently, rail joints in curves with radius less than 400 meters can be welded by employing frictional sleepers instead of ordinary sleepers.

Keywords: Railway Track, Ballasted Track, Lateral Resistance, Sleeper, Rail Joints, Conventional Railways