Development of Automatic Irregularity-Correcting Sleepers

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Background

In ballasted track, when sleepers are hanging from the rails without contacting the ballast under no train loads they are called hanging (or suspended) sleepers. When a train passes on the track under these conditions, the hanging sleepers contact the ballast below and generate impact loads that can break ballast and/or cause mud-pumping. This causes track conditions to quickly deteriorate. Hanging sleepers tend to occur mostly in the vicinity of rail joints and the boundary between ballasted and ballastless track and at other places where the settlement of ballasted track is discontinuous (Fig. 1).

RTRI has been developing different versions of automatic irregularity-correcting sleepers (AICS) that will automatically compensate for discontinuous settlement of ballast tracks and minimize the occurrence of hanging sleepers. This paper introduces one version; a low-cost short-sleeper type (hereinafter referred to as "AICS-SS"), which will soon be commercialized.

Summary of AICS-SS

An AICS-SS is a short sleeper version to be fixed on the rail bottom with strong magnets between existing sleepers. In effect, it creates an extra (short) sleeper as shown in Figs. 2 and 3. Each AICS-SS has a built-in automatic subsidence compensating (ASC) device composed of a set of nested cases. See Fig. 4. The inner case is filled with granular particles, about 2 mm in diameter. The top of the inner case contacts the bottom of the rail via an insulating plate and the bottom of the outer case contacts the ballast via a base plate. When the surrounding ballast sinks together with the outer case, a gap is formed between the inner and outer cases allowing the granular particles in the inner case to drop through an outlet bored in the bottom of the inner case. These particles fill the gap between the two cases to subsequently increase the effective height of the device. As a result, the AICS-SS maintains the rail level unchanged and prevents the state of hanging from occurring even as local ballast settlement progresses.

Figure 5 illustrates changes in the amplitude of rail displacement in repeated loading tests on rail joints of a life-size track model in a laboratory. Deteriorated ballast with a high sediment mixture ratio was used to simulate a local line. During load application, water was sprayed to simulate a heavy rainfall. In the case where AICS-SS were not used, the ballast lost strength after the water spray and became muddy. This caused hanging sleepers to occur and the support rigidity was sharply decreased as a result. In the case where AICS-SS were used on the other hand, decreases in the support rigidity due to watering were nominal, while the amplitudes of rail displacement remained at 2 to 3 mm, even when the axle load was increased to 205 kN. This demonstrates that AICS-SS have the potential to prevent hanging sleepers even under high axle load conditions on deteriorated ballast tracks.

RTRI is now checking the practical validity of AICS-SS on a trial basis on an actual track while aiming at commercialization of the devices at the end of 2013.

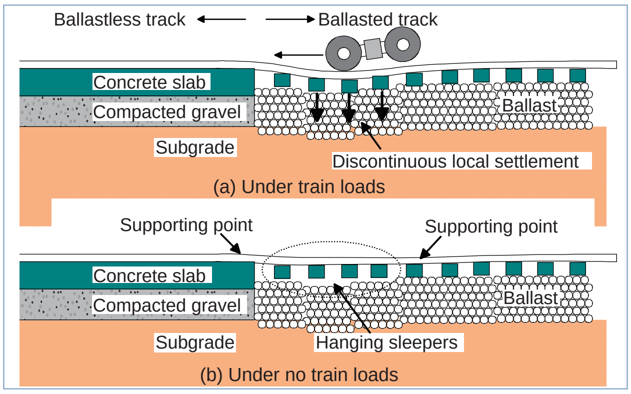

Fig. 1 A concept of the state of hanging sleepers in the transition zone

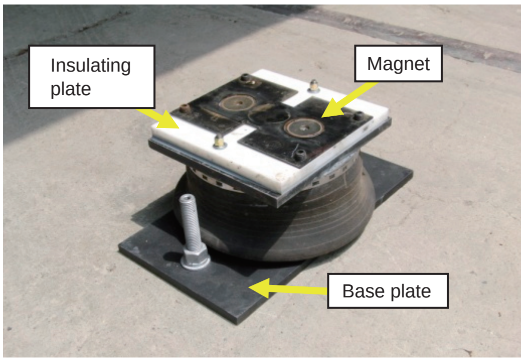

Fig. 2 A prototype of AICS-SS

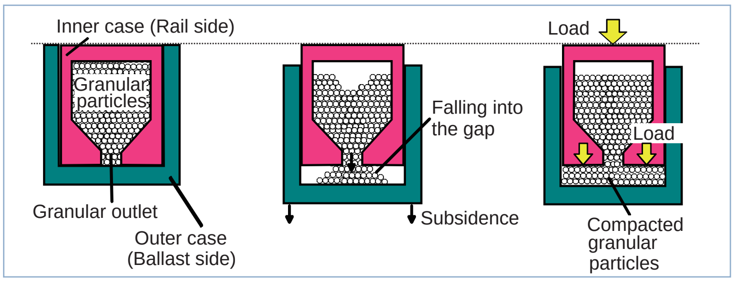

Fig. 4 Principle of the automatic subsidence compensating device

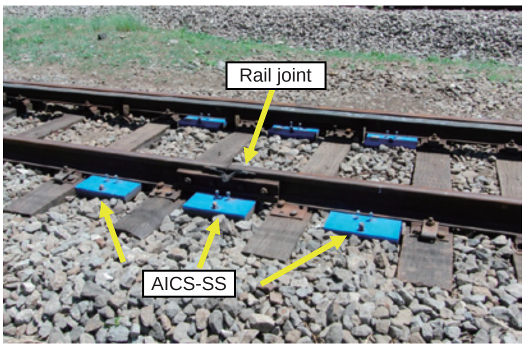

Fig. 3 AICS-SS installed on a track

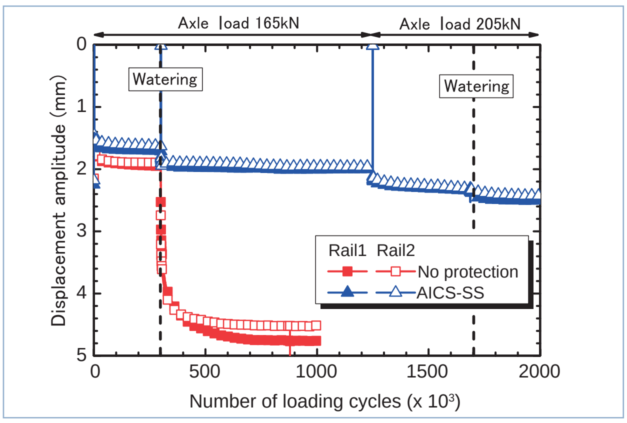

Fig. 5 Amplitudes of displacement of the left- and right-side rails