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A Precast slab track partially reinforced with GFRP rebars

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ABSTRACT

The precast slab track system partially reinforced with glass fiber reinforced polymer (GFRP) rebars in transverse direction for loss mitigation of track circuit current by reducing magnetic coupling between rail and steel reinforcements is investigated. It is verified with the electric analysis that the GFRP rebars work for mitigating the reduced current strength produced by electro-magnetic induction. Both three dimensional finite element method and flexural experiments are used to study mechanical behavior of proposed slab track.

1. INTRODUCTION

The importance of the railway signalling system which controls the train speed, train to train distance, and routes is being emphasized for the efficiency of the railway system. There are three types of signalling systems according to the way of transmitting train control information: (1) on-board system using the track directly, (2) establishing an instrument on the track, and (3) establishing an instrument on the trackside such as traffic lights. Especially, the automatic train control (ATC) system using track directly as a conductor for a part of track circuit to transmit control signals has been used in Korean high speed railway system.

The track circuits are operated by sensing the electric current through rails on the

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slab track. However the concrete slab track has a lot of steel reinforcements to resist loads stably. They could have had influence negatively on train control systems employed track circuits (Theeg and Vlasenko, 2009). The currents flowing on the rails produce electro-magnetic fields in which several magnetic couplings take place between the rails and steel reinforcements. The magnetic couplings generate lots of small circulation currents in the steel reinforcements and then consumes the electric power of the track circuit.

In general, in order to overcome the aforementioned loss of track circuit current due to magnetic coupling, insulating joints made of wood or plastic material are installed between two adjacent rails (Lichtberger, 2005). In Korea, both cast-in-place and precast slab track system need a lot of insulation works using plastic blocks or rubber hoses at the contact points of steel reinforcements (about 700 points per a slab track). In spite of this advantage for insulation, however, it is noticed that the use of the insulation causes the construction process delay and increase in labour cost. The primary objective of this study is to develop a precast slab track system for loss mitigation of track circuit current by reducing magnetic coupling for high speed railway systems.

2. SLAB TRACK SYSTEM FOR LOSS MITIGATION OF TRACK CIRCUIT CURRENT

By electro-magnetics theory, a lot of the circulation currents generated by the induced magnetic fields of the main current on the rail are produced on the reinforcements with different directions. The circulation currents disturb the main current flowing on the rail and shorten its transmission length. It is noticed that the signal information of train may not be able to be transmitted due to the circulation currents. Since the induced circulation current is proportional to the cross section area of its circulation, both the number of the circulations and their area should be reduced to mitigate the main current loss on the rail (Hill, 1993).

In this paper, we have developed a frame-shaped slab track reinforced with electrical insulator in transverse direction to mitigate the induced current effect caused by steel reinforcements as shown in Fig. 1. It is expected that the developed frame-shaped slab track could reduce the insulation works during the construction process and also save the construction expense.

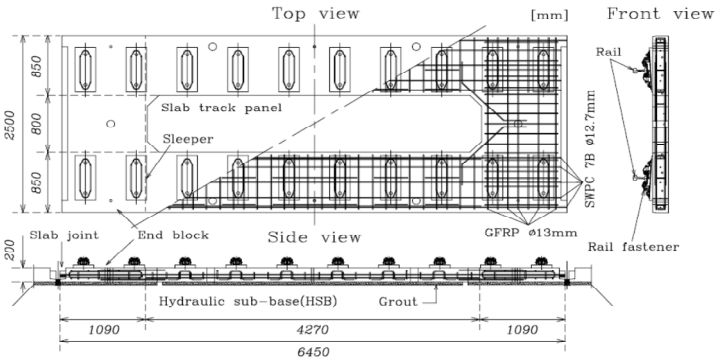

Fig. 1 Precast concrete slab track considered in this paper