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Train operation control in the occurrence of an unexpected delay at a low speed approaching mode during rush hours

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Abstract

In this study, we investigated the train operation control in the occurrence of an unexpected delay at a Low Speed Approaching mode (LSA mode) during rush hours. The crowdedness of passengers causes train delays, and the propagation of the delays has become a problem. In order to recover train delays, one approach called LSA mode has been introduced into a railway line. The LSA mode is a traveling mode at which a train approaches a station at lower speed than that at a Normal Speed Approaching mode (NSA mode). Train delays are separated into unexpected delays and expected delays caused by handling passengers. Unexpected delays are caused as by an urgent case and vehicle inspection, and take longer time than expected delays. For recovering unexpected delays, we consider that it is effective to change a traveling mode from an LSA mode to an NSA mode, and propose train operation control at which the LSA mode for trains is cancelled (changing to the NSA mode) at certain places between two stations. The purpose of this study is to investigate effectiveness of train operation control for recovering unexpected delays during rush hours. By computer simulation, we introduced the train operation control at the effective places, and compared differences between with or without the operation control. The result shows that carrying out immediately the operation control in the occurrence of unexpected delays is the most effective timing, and that effectiveness is reduced as the timing for introducing the operation control is delayed.

Keywords: train operation, microscopic simulation, delay, robustness

1 Introduction

In this study, we investigated the train operation control in the occurrence of an unexpected delay at a Low Speed Approaching mode (LSA mode) during rush hours. The railroads networks in the Tokyo metropolitan area are always crowded during rush hours. The crowdedness causes train delays, and the propagation of the delays has become a problem. In order to recover train delays there have been some studies about train operation methods [1]. As one of the methods, an LSA mode has been introduced into a railway line. The LSA mode is a traveling mode at which a train approaches a station at lower speed than that at a Normal Speed Approaching mode (NSA mode). Approaching at low speed allows to prevent stopping at a place between two stations caused by rapidly approaching, then it is expected that the propagation of the delays is suppressed. Train delays are separated into unexpected delays and expected delays caused by handling passengers. Unexpected delays are caused as by an urgent case and vehicle inspection, and take longer time than expected delays. For recovering unexpected delays, we consider that it is effective to change a traveling mode from an LSA mode to an NSA mode. The purpose of this study is to investigate effectiveness of train operation control for recovering unexpected delays during rush hours.

2 Methods

We have developed a micro simulator that can simulate the plurality of running trains under the condition of a route. By the simulator and actual train operation data we evaluated the train operation and the tendency of the propagation of delays for days on which unexpected delays were occurred. At the present time, all trains are always traveling at the LSA mode in the occurrence of an unexpected delay. In this study we propose train operation control at which the LSA mode for trains is cancelled (changing to the NSA mode) at certain places between two stations. For the simulations we select an existing railway route under the simulation conditions for evaluation shown in Table 1.

Table 1: Simulation conditions for evaluation.

The number of days	21 days
Time	7:30am – 8:30am (1 rush hour)
The number of trains	27 trains
The number of stations	10 stations

In the simulations we set the times until carrying out the proposed train operation control as parameters for finding optimal timing to cancel the LSA mode for trains. The number of timing are seven from 0[min] to 60[min] at an interval of 10[min]. As a method of evaluation, we get the arrival times at the last station, and compare differences between with or without the operation control..

3 Results

Prior to introducing proposed operation control, we found out that which places between two stations are effective or not in the target route. We confirmed that stopping at a place between two stations is frequently caused at the places where are not effective for introducing the operation control. Next, we introduced the operation control at the effective places, and compared differences between with or without the operation control. Figure 1 shows the result of evaluation for introducing proposed train operation control. The horizontal axis is the time until carrying out the operation control (canceling the LSA mode) and the vertical axis is the differences between with or without the operation control (recovery of delay time) as the average values of all days. The result shows that carrying out immediately the operation control in the occurrence of unexpected delays is the most effective timing, and that effectiveness is reduced as the timing for introducing the operation control is delayed.

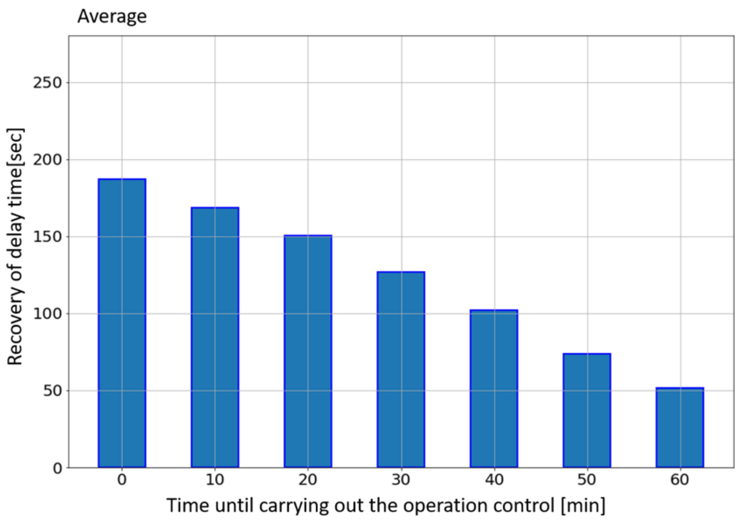

Figure 1: Result of evaluation for introducing proposed train operation control.

4 Conclusions and Contributions

In this study, we investigated the train operation control in the occurrence of an unexpected delay at a Low Speed Approaching mode (LSA mode) during rush hours. We have developed a micro simulator that can simulate the plurality of running trains under the condition of a route. In this study we propose train operation control at which the LSA mode for trains is cancelled (changing to the NSA mode) at certain places between two stations. By the simulator we introduced the operation control at the effective places, and compared differences between with or without the operation control. The result shows that carrying out immediately the operation control in the occurrence of unexpected delays is the most effective timing, and that effectiveness is reduced as the timing for introducing the operation control is delayed. The originality of this study is that the traveling mode (LSA mode) for recovering an expected delay is cancelled for recovering an "unexpected" delay.

References

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