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Effect of Speeds and Time-Gaps as Setting Conditions of Adaptive Cruise Control System on Driver's Risk Feeling when the Leading Vehicle Decelerates on Snowy Road Surface

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ACC systems installed in current vehicles do not support irregular car-following situations, such as when a leading vehicle suddenly decelerates. Furthermore, current ACC systems are not adapted to snowy roads and it has not been clarified what driving conditions will be required for car-following situations on snowy roads. It is necessary to consider the settings of ACC that take the driver's RF into account to ensure that drivers can continue to use ACC even on snowy roads. Therefore, the goal of this study is to quantitatively seek ACC settings that prevent driver's overrides on snowy roads. The following are the detailed objectives.

1) To develop a model to estimate RF when the leading vehicle decelerates on snowy roads based on the results of a field experiment.

2) To propose a car-following simulation for driving with ACC when the leading vehicle decelerates on dry and snowy roads based on the results of a field experiment.

3) To estimate RF under various time-gap settings by the car-following simulation for driving with ACC and to clarify ACC settings that prevent driver's overrides on snowy roads.

The present study clarifies how leading vehicle deceleration and ACC time-gap settings affect RF on snowy roads. A field experiment for driving with ACC was conducted to measure RF with changes in the leading vehicle's deceleration, the ACC time-gap settings, the driving speed, and the road conditions. We proposed a model to estimate RF for each of two road conditions and for each of two driving speeds using the minimum TTC value when the leading vehicle decelerated. Also, driver's override were measured under various driving conditions on dry and snowy roads. In addition, we measured the running behavior of the leading and the following vehicle in order to determine parameters for proposing a car-following simulation for driving with ACC on dry and snowy conditions.

Aim of the car-following simulation for driving with ACC is to estimate RF under various time-gap settings on dry and snowy roads. Then, it is required to predict the deceleration behavior of the ACC-following vehicle when the leading vehicle decelerates on dry and snowy roads. Using the deceleration behavior, we will predict the minimum TTC under various time-gap settings and deceleration levels on dry and snowy roads. We tried to estimate the driver's RF when the leading vehicle decelerated under various ACC time-gap settings and decelerating levels of the leading vehicle by the car-following simulation for driving with ACC. It is found that RF could be estimated by substituting the TTCmin estimated by the car-following simulation for driving with ACC. Changes of RF by driving conditions were similar with those measured by the field experiment. The values of RF became large at the same conditions on snowy roads rather than on dry roads. In addition, estimated values of RF suggest that overrides could occurred easily on snowy roads rather than on dry roads (Fig.1).

The results of the field experiment showed that the number of overrides on snowy roads were larger than those on dry roads. The advantages of using ACC decrease on snowy roads because the driver frequently disengages the ACC. Thus, from results of car-following simulation in changing time-gap settings and deceleration of the leading vehicle, the driving speed of the ACC should be set as low and the time-gap was set as long on snowy roads in order to avoid occurrence of overrides. These findings are consistent with the results of previous studies (3) (4). Also, the car-following simulation for driving with ACC may be able to enhance the analysis on the estimation of RF on snowy roads because driving experiments on actual snowy roads are risky. In the future, it is required to validate the results obtained in the present study on various snowy roads in winter.

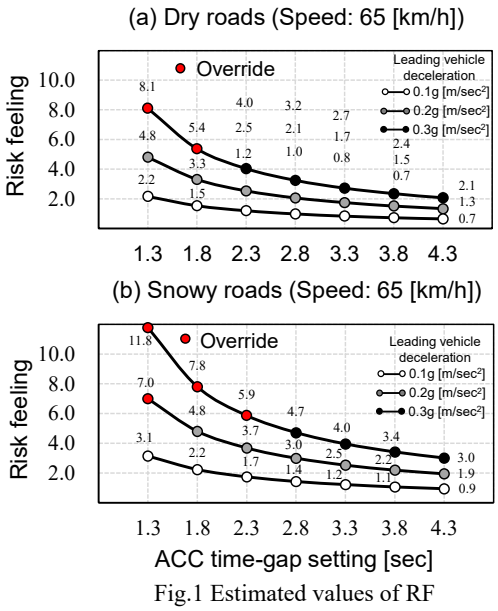

Fig.1 Estimated values of RF