Estimate Freeway Exit Sign Locations

Chiu Liu, PhD, PE, PTOE and Zhongren Wang, PhD, PE, TE
California Department of Transportation, 1120 N Street MS-36, Sacramento, CA 95831

ABSTRACT
Considering that a driver decides to exit a highway upon seeing the guide sign upstream of an exit, subsequently the driver in an inside lane or the middle lanes must move onto the outside lane prior to exiting. The concern is whether the driver can accomplish this task safely and smoothly. It is apparent that an upstream exit sign cannot be placed too close to an exit or too far beyond several exits upstream. The MUTCD recommends that the sign should be placed 1 mile and 2 miles upstream of an exit without explaining the reasons for selecting the 1 mile distance. By integrating driver decisions, vehicle acceleration characteristics, tire-road traction into a single analytic framework, the location upstream of an exit where an exit sign should be installed is determined for a driver to get off at the right exit successfully. Practitioners can easily apply these user friendly formulae and equations derived from the framework to compute the required distance 'D' between a highway exit and an upstream exit sign for guiding drivers to exit the highway safely. Additionally, parameters for these formulae can be adjusted to resemble various exiting scenarios.

1. INTRODUTCTION
According to the Manual on Uniform Traffic Control Devices (MUTCD) [1], freeway exit guide signs are placed 2 miles ahead, 1 mile ahead of the exit, and right at the exit gore area. The exit sign which drivers see first would alert driver the exit is 2 miles ahead and they should adjust the traveling speed; the exit sign which the drivers see next would remind the drivers to get into the right lane; and the exit sign at the gore shows the driver where the exit is. However, the reasons for installing the guide sign 1 mile apart from the exit and 1 mile apart from each other haven't been explained in literature with clarity based on user-oriented physical scenarios. An analytical formulation is presented in this paper attempting to determine quantitatively the installation location for these advance exit guide signs. It is suggested that the exit guide sign should be placed at a location to allow a passenger vehicle driver to have sufficient time to accomplish the necessary lane change by either overtaking or following a vehicle ahead. This exit maneuvering becomes more difficult if the overtaken vehicle is long/heavy as schematically sketched in Figure 1.

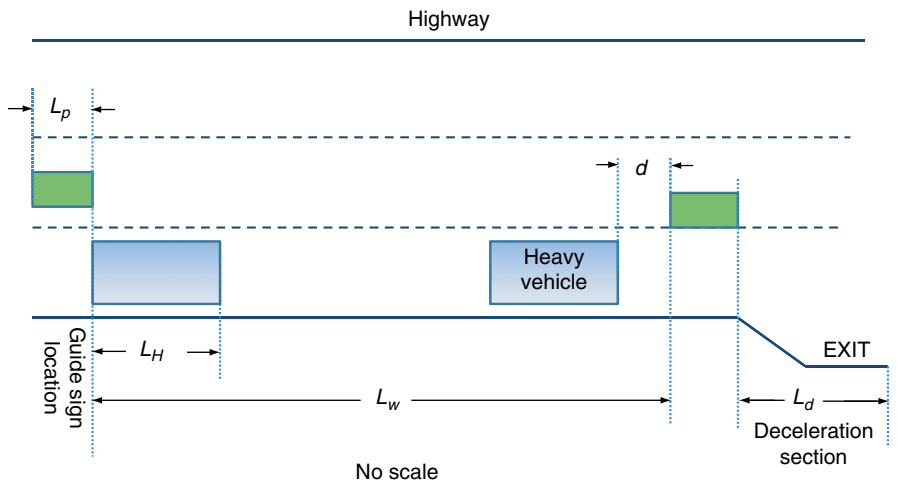

Figure 1. A schematic plot of the exit sign location before an off-ramp with an overtaking scenario

When a passenger vehicle driver is preparing to exit upon seeing the exit sign, the driver must decide either to slow down to merge behind the heavy vehicle or to accelerate to pass the heavy vehicle. It is apparent that the exit guide sign must be installed far enough upstream to allow the passenger vehicle driver to decelerate to coast behind the heavy vehicle or pass the heavy vehicle to exit the freeway ahead. In order to determine the distance where the exit sign should be placed upstream of the exit, one may break the entire existing process into two phases, the first one is to accelerate to overtake the heavy vehicle in the outside lane, and the second one is to decelerate to an intended or desired speed right before moving onto the off-ramp. The exit sign location will then be found based on a physical framework by summing up the required distance traveled by the passenger vehicle in each phase [2].

2. FORMULATION

In Figure 1, the passenger car and the heavy vehicle are traveling at speed v_p, and v_T. The distance 'D' from the decision point to the exit is given by

$$D = L_d + L_p + L_w \tag{1}$$

In order for the passenger car to pass safely before moving onto the exit off-ramp, the distance 'S_p' traveled by the passenger car in phase 1 of the exiting process, should be related to the distance 'L_T' traveled by the heavy vehicle for the same duration via the following equation

$$S_p(L_T / v_T) - L_w = L_p \tag{2}$$