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A macroscopic traffic model for highway work zones: Formulations and numerical results

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Abstract: This study presents a multilane model for analyzing the dynamic traffic properties of a highway segment under a lane-closure operation that often incurs complex interactions between mandatory lane-changing vehicles and traffic at unblocked lanes. The proposed traffic flow formulations employ the hyperbolic model used in the non-Newtonian fluid dynamics, and assume the lane-changing intensity between neighboring lanes as a function of their difference in density. The results of extensive simulation experiments indicate that the proposed model is capable of realistically replicating the impacts of lane-changing maneuvers from the blocked lanes on the overall traffic conditions, including the interrelations between the approaching flow density, the resulting congestion level, and the exiting flow rate from the lane-closure zone. Our extensive experimental analyses also confirm that traffic conditions will deteriorate dramatically and evolve to the state of traffic jam if the density has exceeded its critical level that varies with the type of lane-closure operations. This study also provides a convenient way for computing such a critical density under various lane-closure conditions, and offers a theoretical basis for understanding the formation as well as dissipation of traffic jam.