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A NEW CONTINUUM TRAFFIC MODEL WITH THE EFFECT OF VISCOSITY*

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Abstract: Through considering the connection between microscopic car-following model and macroscopic continuum model, a new viscous vehicular flow model is proposed, in which the viscosity coefficient is determined by a more realistic constitutive relationship between averaged reaction time of drivers and the car density. Further analysis indicates that two traffic sound speeds in this viscous model may determine the existence and the stability of traveling wave solutions with an analytical method.

Key words: viscosity, continuum traffic model, reaction time, traffic sound speed, traveling wave

Introduction

For modeling and analyzing traffic phenomena, it is essential to understand drivers' driving behaviors. A viscosity term has been added in the continuum traffic model, which may be analogous to the Navier-Stokes equations for viscous compressible fluids and smooth the shock-like waves[1-4]. This approach aims to explain that drivers are aware of the magnitude and gradient of local density, and thus change their driving speeds in a car-following way. However, this hypothesis does not have a rigorous theoretical foundation for vehicular flow treated as a viscous fluid-like continuum, especially for the introduction of the viscosity term. Until recently, on the basis of a microscopic car-following model with considering drivers' memory, Zhang[5] established a viscous continuum traffic model and showed the self-consistency and the connection of this model with other models. Furthermore, he gave a reasonable explanation for the viscosity in traffic flow that the viscous effect describes the drivers' tendency to resist sudden changes of velocity, and is related to vehicular speed changing mechanism.

Nevertheless, the value and form of the viscosity coefficient are not very clear up to now. Previous assumptions on constant viscosity and fluid-like representations were empirical[2-4] or complicated expressions formatted for unintelligibility[6,7]. Even in Zhang's viscous traffic model, the coefficient was not determined because of containing a dimensionless parameter with less physical meaning[5].

In this work, the authors suggest a viscous

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