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Development of Inverse Magic Formula for Tire Performance Requirement Analysis

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Toward the transformation of automotive industy, autonomous driving vehicles and electric vehicles are expected as new mobilities. More than before, tire technology should be enhanced to accelerate and contribute the change. To that end, tire requirement analysis regarding tire forces and moments is required at the planning stage of vehicle. Since MBD have been widely implemented to the development process recently, it is desirable to carry out the requirement analysis in virtual environment. However, various kinds of tire models used for vechiel dynamics simulation are identified with the result of tire measurement. Accordingly, parametric study can not be available prior to the stage of detailed design, prototyping and testing. Magic Formula (MF) has been widely used to evaluate vehicle dynamic handling performance all over the world, but is so-called semi-empirical tire model. Since the identified parameters are complicated, chassis desginers are not allowed to use it as a parameter study tool.

In this paper, MF tire model are focused on, and the inverse function of MF is formulated (IMF). As a certain set of typical tire performances (normalized cornering stiffness, normalzed SAT stiffness and et al.) at the nominal load is input to the inverse function, it output the MF parameters corresponding to the tire perforamce. That is, IMF is capable of generating a MF model artificially without prototyping. Fig. 1 shows the overview of the IMF system. By using both IMF and vehicle dynamics simulation, tire requirement analysis can be realized at the planning stage.

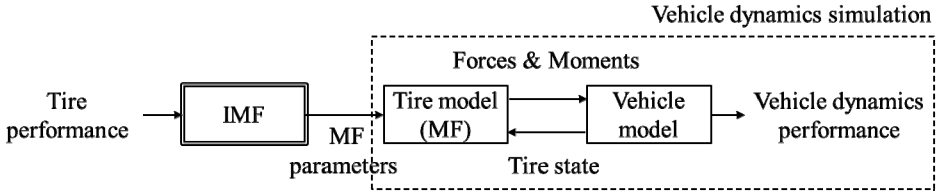
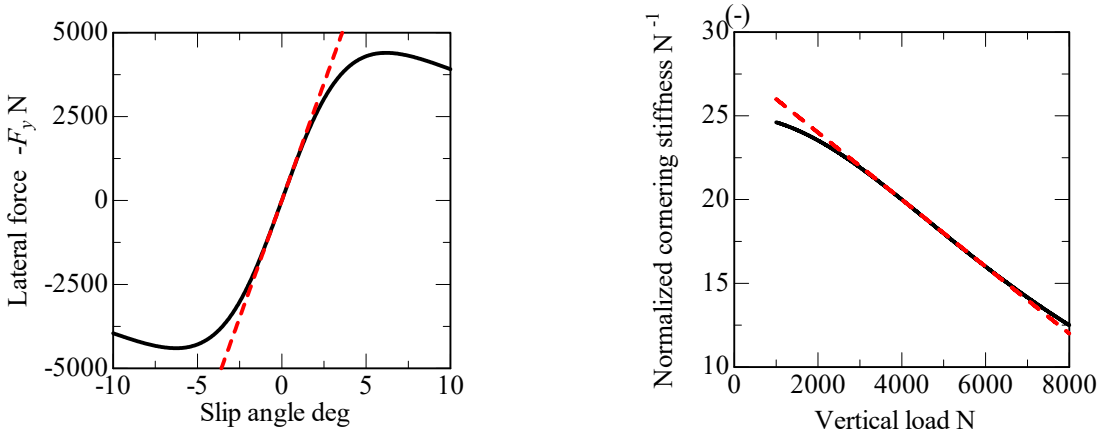


Fig.1 Overview of tire requirement analysis using IMF

Fig.2 shows the tire model generation results. The black lines indicates the calculation results of MF. The red dash lines indicates the specified tire performance using IMF. At the neighborfoods of origin (Fig.2 (a)) and nominal load (4000 N, Fig.2 (b)), the MF model behaves as specified. IMF is expected to acceleate the performance analysis, optimize the development process of tire.



(a) Lateral force (b) Normalized cornering stiffness

Fig.2 Tire model generation results using IMF