Rate and State Dependent Friction Law and Static Friction Force

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It is well known that the Rate and State Dependent Friction Law (RSF) plays an important role in the study of earthquake including slow-earthquake [1, 2]. RSF was introduced by Dietrich [3] and Ruina [4] based on the laboratory experiments and describes the sliding velocity and state-variable dependences of the friction coefficient. The dependences are analyzed by the thermal activation process of the deformation and detachment of actual contact points [5-7]. The thermal activation of the deformation of actual contact points, which is called the indirect process, cause the increase of the actual contact area and then the friction force with increasing contact time of actual contact point, which is inversely proportional to the sliding velocity. The thermal activation of the detachment of actual contact points, which is called the direct process, cause the increase of the friction force with increasing sliding velocity. Such analysis discuss the change of friction coefficient depending on the sliding velocity and state-variable. Here we extend the analysis and discuss the absolute value of the friction coefficient. In the case that the direct process overwhelm the indirect process, the friction coefficient can vanish in the limit of vanishing sliding velocity, that means the vanishing static friction force. The vanishing static friction force results from the thermal activation of the detachment of the actual contact points. The velocity dependence of the friction coefficient in the low velocity regime is investigated. It is also shown that even in the case that the indirect process overwhelm the direct process in the usual velocity regime, the direct process overwhelm the indirect process in the law velocity limit. In this case the steady state friction coefficient once increase from zero in the low velocity regime, shows a peak and then decreases with increasing sliding velocity. The relations with the laboratory experiment [8] and slow earthquake are discussed.

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