Effect of Axle Load on Adhesion Coefficient between Wheel and Rail under Wet Conditions

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This paper describes the effect of axle load (contact pressure) on adhesion characteristics in response to running speed and surface roughness under wet conditions, investigated by the mixed lubrication analysis considering Elasto-Hydrodynamic Lubrication (EHL) and rough surface contact based on Greenwood-Williamson's (G-W) stochastic model for Gaussian distribution in roughness heights, as well as laboratory experiments with a twin-disc rolling contact machine. The numerical calculation results indicate that the adhesion coefficient increases with an increase in the contact pressure when surface roughness (the standard deviation of surface asperities height) is lesser. In contrast, the adhesion coefficient decreases with an increase in the contact pressure when surface roughness is larger. The reversal phenomenon in the effect of contact pressure on the adhesion characteristics in response to surface roughness is considered to relate the loads supported by asperities contact (Wc) and water lubrication film (Wh), respectively. Generally, the friction coefficient between asperities contact is much greater than that of water lubrication film, therefore, the adhesion coefficient is dominated almost by the ratio of asperities contact load to total load (Wc/W). In the past researches concerning adhesion in railway system, the experimental results obtained by Ohyama [1] also indicated a similar behavior of the adhesion coefficient in response to contact pressure. Hence, it is confident there is a critical value of surface roughness to change the relationship of adhesion coefficient with contact pressure. Furthermore, higher running speed creates a larger critical value of surface roughness than that in lower running speed.