Friction on road surfaces contaminated by fine particles: some new experimental evidences

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Contaminants

- Contaminants can be originated from different sources: temporary (pollution due to road works), seasonal (road salting in winter), accidental (hazardous chemicals) or chronic (vehicle exhaust, pavement and tire wear)[1].
- Research focused on their impact on environment : impact on road safety is missing.

...and skid resistance

- Accidents increase sharply during the first rain after a long dry period [2]. This trend is due to the accumulation of fine particles that contaminate the road surface.
- The friction drop is attributed to the high-viscosity mix of rain water and road debris [3].

Experiments

On site

In laboratory

Relevance of the test results

Laboratory results

Literature [3]

The test protocol reproduces qualitative trend found in the literature [3]. The simulated curve includes all phases involved in the variation of friction during dry phase (before rain), wet phase (during rain) and drying phase (after rain).

Effect of initial concentration of contaminants on friction

- Friction values can be very low even when the surface is dry.
- Friction is lowest at the beginning then increases progressively with increasing number of slider passes.
- Further passes do not help to recover the value of a clean surface.
- Higher particle concentration induces lower friction values.

- Water induces a viscous lubricant which reduces the tire traction.
- It removes the particles by first dislocating them and then removing them by washing and restores the friction value of a clean surface.
- Washing process starts rapidly for a concentration of 1 mg/cm² (from step 2). The time needed to wash the particles increase with the quantity of deposited particles.

Role of mass of particles on lubrication mechanisms

- Data from the three tested particle concentrations follow the same "master" trend.
- Friction starts from a minimum value (shearing mechanism) then increases with successive passes of the rubber slider (sliding mechanism with partial contact between the rubber slider and the surface asperities).
- The trapped particles can explain why the friction coefficient at the end of dry tests is lower than that of a clean surface.

- A "critical" water mass (minimum friction irrespective of initial particle concentration) was found. The cohesion of the mixture is maximum and then the rubber pad slides on a rigid contaminant layer without any (or few) resistance due to heaping of particles
- Adding water to a dry granular material (particles) can increase first their cohesion due the formation of water bridges between the particles then, when water saturates the space between the particles, decrease this cohesion [4].

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