Appendix U.4.3 – SP Swedish Steel Wheels

Generic Name of Test	*Rolling* Steel Wheels : Abrasion Test
Principle of Test	Loaded 47mm diameter wheels orbiting – tangentially displaced.
Historic Development of Test	This test was devised by a Swedish testing laboratory specifically for abrasion tests on concrete surfaces, although Siro (1991) does not state when.
Apparatus and Abrasives	Three steel wheels of diameter 47mm and width 12mm are mounted on a circular plate thus travelling in a circular path of 300mm diameter. The wheels form an angle of 30^0 with the tangent of the circle. The wheels carry a load of 0.13kN. [Siro (1991)]

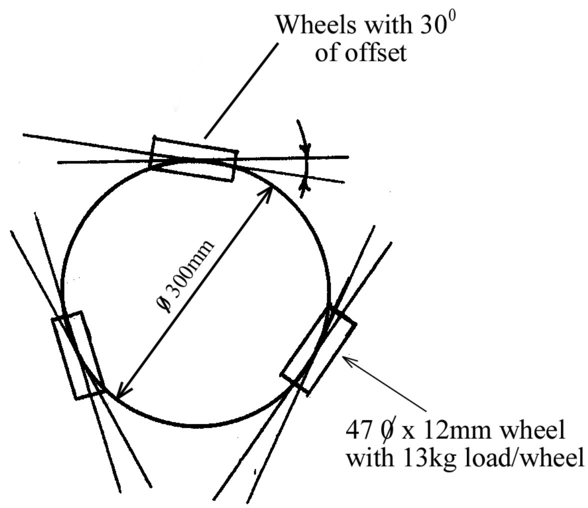

Figure U.4.3.1 The offset angle to the tangent ensures substantial sliding, simulating slewing actions.

Test Method	The total revolutions and speed of rotation are unknown.
Abrasion Wear	This is almost certainly measured as the average depth of abrasion wear.
References	<u>Author</u> / <u>Comment</u> Siro (1991) / Source document

APPENDIX U.4.3

Wear Mechanisms according to Author

(i) Siro (1991): Stresses on the concrete are the combinations of total wheel load, surface pressure from the wheel, skidding of the wheel and impact of the wheel when the surface becomes uneven. Small wheel loads break particles loose from the surface less effectively than a large load, even at the same wheel surface pressure, since the larger load has a deeper stress field into the concrete as shown in fig U.4.3.2 The surface pressure at the wheel's point of contact is high. Computed by the Hertz formula it is approximately 70 MPa. However, due to the low wheel force of 0.13kN the stresses at deeper levels remain minute compared to the Nordic (NT BUILD 044) and Finnish tests, which respectively have wheel loads of 2kN and 3kN. The offset angle of 30^0 was found to give 'maximum increase in wear'.

(ii)Visual Effects:

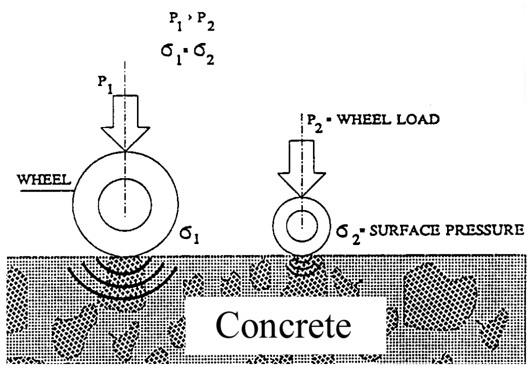

Figure U.4.3.2 Small wheel loads break particles loose from the surface less effectively than a large load, even at the same wheel surface pressure [Siro (1991)]

Wear Mechanisms according to writer [R3 S3 I2]

(i) <u>Rolling and Sliding:</u> As the loaded wheels roll over the surface, the concrete asperities beneath the wheels will be subject to crushing effects. There is also very significant tangential shear as a result of the wheel sliding on the surface owing to the large offset wheel angles (see figure U.4.3.1). The compressive force is shown as W in figure U.4.3.3, while the tangential skidding/slewing effect is shown as F, where F=μW, and μ is the coefficient of friction between the sliding wheel and concrete. Figure U.4.3.4 recognises that there is likely to be some sub-asperity cracking, given the high contact pressure of 70MPa, but since the wheel load is only 13 kg, these cracks are unlikely to penetrate deeply although the asperities shown in by figure U.4.3.3 will be substantially crushed.

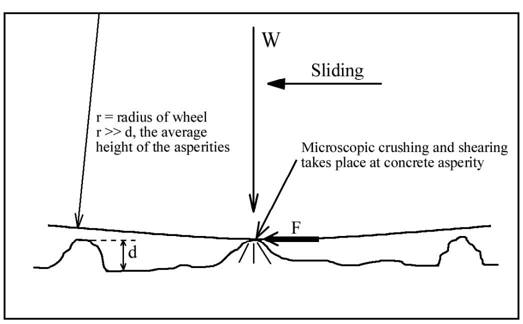

Figure U.4.3.3 Microscopic wear effects on the concrete induced by the steel wheel.

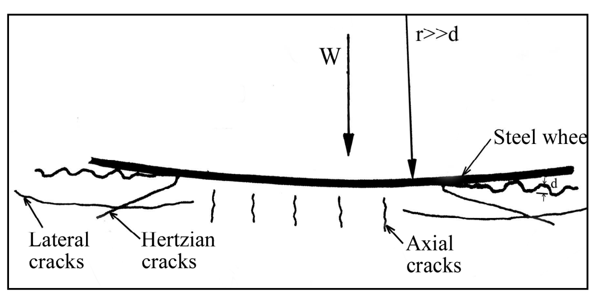

Figure U.4.3.4 Cracking wear mechanisms from large loads **and** high contact pressures

(ii) <u>Adhesion and deformation:</u> See note 1 in introduction to appendix U