Appendix U.2.5 – Impact Box

Generic Name of Test	*Impacting* Steel Balls : Abrasion Test
Principle of Test	Steel balls tumbling in a rotating box lined with concrete flags.
Historic Development of Test	This test was developed in Liverpool for the testing of precast concrete paving flags and is based on the impact procedure of BS 368 : 1956. [Khalid (1993)]
Apparatus and Abrasives	Concrete flags are secured with their wearing faces inwards, over openings provided in a motorised rectangular container, (impact box) which rotates on a steel shaft about its longitudinal axis (see figure U.2.5.1). 1000 steel balls of 12mm diameter are used as the abrasive medium. [Khalid (1993)]

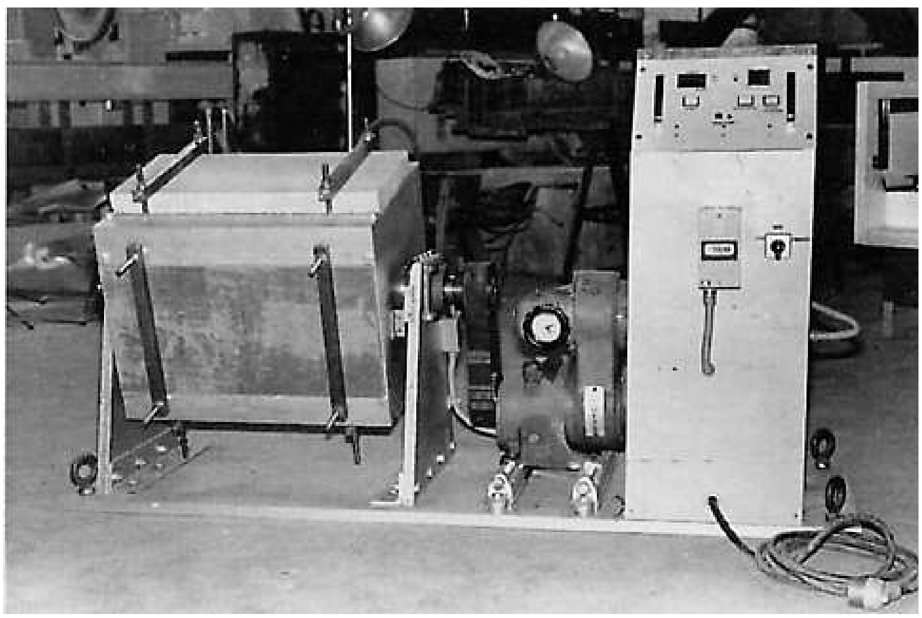

Figure U.2.5.1 The Impact Box [Khalid (1993)]

Test Method	The paving flags are attached to the Impact Box and the 1000 steel balls added. The Impact Box is rotated at 60 rpm for 2 hours. [Khalid (1993)]
Abrasion Wear	This is measured as the weight loss (g) per square meter of area. [Khalid (1993)]
References	<u>Author</u> / <u>Comment</u> Khalid (1993) / Source document

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Wear Mechanisms according to Author
(i) Khalid (1993): No comments on the mechanism of wear
(ii) Visual Effects: None shown by author.

Wear Mechanisms according to writer [R2 S2 I2]

As the impact box rotates the balls will roll, slide, bounce and fall. Collectively this may be referred to as tumbling. (Bouncing will be accentuated as the concrete's surface becomes rougher). Rolling will result in crushing effects, sliding in shearing, while bouncing and falling results in impact. These mechanisms are considered in more detail below.

(i) Impact: The abrasion wear Q arising out of the initial impact of the ball against the concrete may be quantified by the expression $Q \propto \frac{m.U^2}{H}.f(\theta)$ (mm^3) [Hutchings (1992)]. Clearly the velocity U, at impact, is the most dominant factor, while the mass of the ball, m, the hardness of the concrete, H, and a factor $f(\theta)$ based on the angle of impact θ are also important.

(ii) Rolling and sliding: The abrasion wear corresponding to rolling and sliding may respectively be quantified by the expressions:

$Q_{Crushing} \propto W$ (for rolling)

$Q_{Shearing} \propto F = \mu W$ (for sliding)

Where $Q_{Crushing}$ and $Q_{Shearing}$ represent the loss of material owing to crushing and shearing (See figure U.2.5.2) at the microscopic asperities where contact is made. W and F are respectively the weight of the ball and the frictional drag from sliding, and μ is the coefficient of friction between concrete and steel.

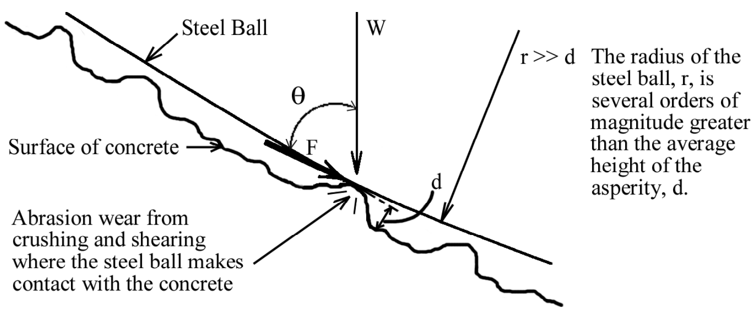

Figure U.2.5.2 Microscopic wear mechanism for rolling and sliding

Relative severity: Impact from bouncing and falling will result in substantially more severe crushing and shearing than rolling and sliding. However, given the relatively small mass of the balls, and the fact that they mainly roll with minimal free fall, cracking may be limited to a degree of sub-asperity Hertzian cone cracking. Lateral cracks and axial cracks are less likely. (discussed in detail in chapter 3.)

(iii) Adhesion and deformation: See note 1 in introduction to appendix U