Appendix U.1.2 – Cantabrian Paver Tumbler

Generic Name of Test	*Impacting* Steel Drum : Abrasion Test
Principle of Test	Paver tumbling in steel drum (i.e. Los Angeles machine)
Historic Development of Test	'Abrasion is by Cantabrian Los Angeles'. For this test Pagbilao (2000) used the Los Angeles machine (see figure U.1.1.2) with just one half paver as a specimen.
Apparatus	The apparatus is a standard Los Angeles machine. It has a large rotating steel drum, which contains a shelf that lifts and drops the internal contents. No abrasive charge is used for this test.

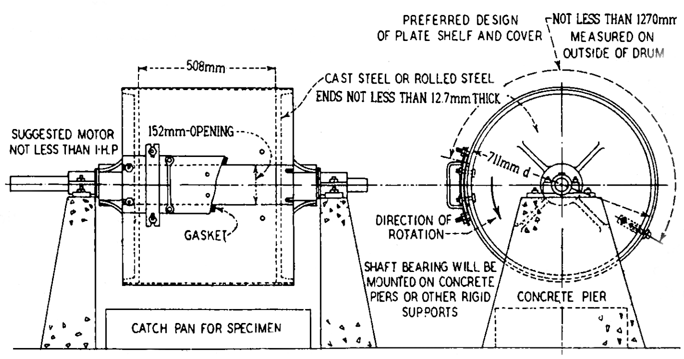


Figure U.1.2.1 The Los Angeles Machine [ASTM C131]

Test Method	A single test specimen (half of a paving brick) is weighed, placed inside the Los Angeles machine and subjected to 300 revolutions at 30 rpm. [Pagbilao (2000)]
Abrasion Wear	This is measured as the percent loss of mass. [Pagbilao (2000)]

Wear Mechanisms according to Author

(i) Pagbilao (2000): No comment of the mechanism of abrasion, but his results show that abraded material ranged between 16% through 22%. This may be considered severe for a 10 minute test.

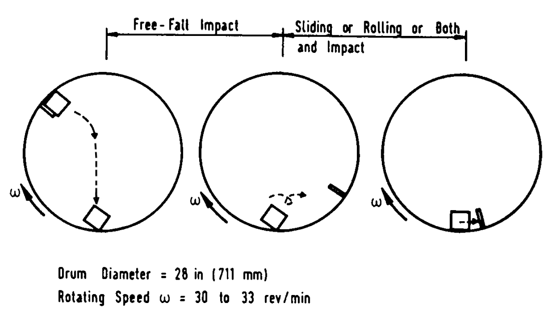


Figure U.1.2.2 Schematic representations of apparatus and wearing actions, respectively showing impact, rolling and sliding [Fwa (1990)]

(ii) Visual Effects: None shown by author

References	Author	Comment
	Pagbilao (2000)	Source document
	Hutching (1992)	Source document
	ASTM C131	Source document
	Fwa (1990)	Source document

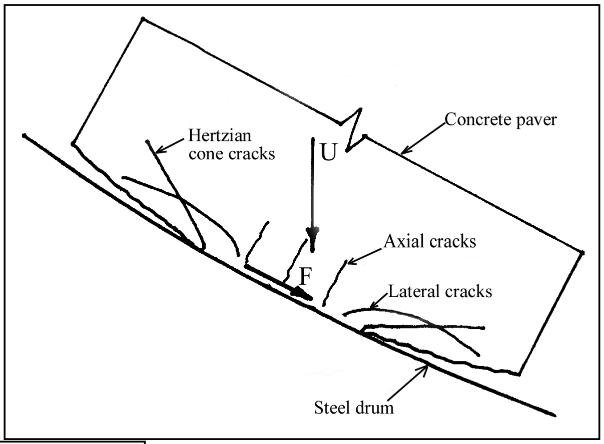
APPENDIX U.1.2

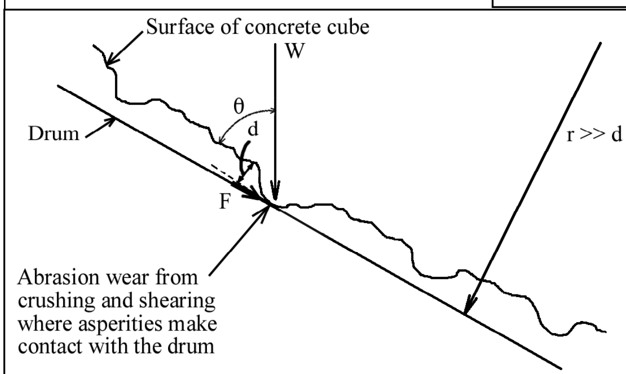
Wear Mechanisms according to writer [R2 S2 I4]

The concrete paver is lifted by the shelf inside the drum. At a certain height it slides out and falls against the drum below. On landing the paver will both roll and slide until it is lifted again. (The combined action of falling together with rolling and sliding is referred to as ‘tumbling’). Impact wear induced by falling is likely to be an order of magnitude greater than rolling and sliding induced wear. These mechanisms are considered in more detail below.

(i) Impact: The abrasion wear Q arising out of the initial impact of the paver against the drum may be quantified by the expression $Q \propto \frac{m.U^2}{H}.f(\theta)$ in mm^3 [Hutchings (1992)]. Clearly the velocity at impact, U, is the most dominant factor, while the mass of the paver, m, the hardness of the concrete, H, and a factor $f(\theta)$ based on the angle of impact θ are also important. The severe impact in this test very likely leads to forms of sub-asperity cracking including Hertzian cone cracks, lateral cracks and axial cracks indicated in figure U.1.2.3.

Figure U.1.2.3
Presentation of different crack mechanisms occurring on impact





The radius of the drum, r, is a few orders of magnitude greater than the average height of the asperity, d.

Figure U.1.2.4
Microscopic abrasion mechanism for rolling and sliding

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

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

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

Where $Q_{Crushing}$ and $Q_{Shearing}$ represent the loss of material owing to crushing and shearing (See figure U.1.2.4) at the microscopic asperities where contact is made. W and F are respectively the weight of the ½ paver and the frictional drag from sliding, and μ is the coefficient of friction between concrete and steel.

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