

## RATIONALE FOR TWO VOLUMES

The rationale for setting out this thesis in two volumes is (a) that the subject material logically belongs in two distinct camps and (b) this makes the large volume of material more manageable. A detailed account of the circumstances leading to the development of the two volumes is given in the 'Introduction' to volume 2, and will not therefore be discussed in any depth here. However, a simple tabulation allows the reader to gain some insight into the different characters of the two volumes.

### Differences between Volume 1 and Volume 2

	Volume 1	Volume 2
1	The laboratory experimental work was done in 1987, site abrasion-wear was measured in 1993, initial draft copy was informally submitted in 1994, and carefully revised in 2001.	Intensive reading and summarising of relevant technical publications commenced in 1997. Most of the write-up was done in 2000 and 2001. It is completely independent of the 1994 document, covering the subject of abrasion resistance from a quite different perspective.
2	Supervised by Professor MG Alexander	Supervised by Professor GE Blight
3	Applies mainly to pavers, and is specifically dedicated to improving the abrasion resistance of pavers.	Applies to concrete surfaces in general, and contributes to the improvement of abrasion resistance of all concrete surfaces.
4	The deductions and conclusions are based on experimental work done by the writer	The deductions and conclusions are based on an extensive literature review. This formed the basis of a considerable degree of synthesizing and theorising.
5	The mix design variables are quite limited (water content, binder content and binder type).	An extensive study is made of the concrete system, including some relatively exotic materials and processes, with a view to their effect on abrasion resistance. This study even extends beyond the boundaries of concrete, allowing comparisons to be made with ceramics, alloys, metals and polymers.
6	This investigation concluded that the MA20SA test was the most worthy of consideration as a national standard, subject to some improvements (i.e. 'CMA20') to reduce variability.	Chapter four concludes that three further abrasion tests should be investigated, suggesting that they have more merit than those used in the experimental work of volume 1.
7	1994 terminology: b/w = binder/water ratio. MGBS = milled granulated blastfurnace slag 'cbp' or simply 'blocks' are used to describe the product under investigation.	Equivalent 2001 terminology: w/b = water/binder ratio. GGBS = ground granulated blastfurnace slag 'pavers' is generally used to describe the product.
8	Limited emphasis is placed on the mechanism of wear, although wear mechanisms of three abrasion tests are considered briefly.	The wear mechanisms of 66 surface tests are considered, and a full chapter is devoted to the mechanisms of wear.
9	Appendices A through Z, except for appendix R, S and U.	Appendices R, S and U.

# OUTLINE OF BOOK 1

## A. Preamble

	page
Title page	i
Declaration	ii
Consolidated Abstract	iii
Acknowledgements	iv
Dedication	v
Two volumes	vi
Rationale for two volumes	vii
Outline of Book 1	viii
Outline of Book 2	x
Formatting constraints	xi
Note to the Examiner	xii
Nomenclature	xiii

## B. Volume 1

### Abrasion Resistance and Related Strength Characteristics in Concrete Block Paving

Title page (vol 1)	xv
Abstract	xvi
Table of contents	xvii
List of figures	xxv
List of tables	xxxiv
<b>Section A - Introductory Section</b>	xxxvi
Chapter 1 Introduction	1 to 13
Chapter 2 Background	1 to 27
<b>Section B - Experimental Procedure</b>	xxxvii
Chapter 3 Manufacturing Controls and Procedure	1 to 15
Chapter 4 Laboratory Testing	1 to 28
Chapter 5 Site Testing	1 to 17
<b>Section C- Results and Discussion</b>	xxxviii
Chapter 6 The Effects of Water Content, Binder Content, and Binder Type	1 to 49
Chapter 7 Compressive Strength Tests	1 to 19
Chapter 8 Classification of Abrasion	1 to 49
Chapter 9 Critical Evaluation of MA20 Abrasion Test	1 to 52
Chapter 10 Critical Evaluation of Wire-brush Test	1 to 27
Chapter 11 Critical Evaluation of ASTM C418 Abrasion Test	1 to 17
Chapter 12 Comparison of Abrasion Tests	1 to 32
Chapter 13 Water Absorption in Cbp	1 to 22
Chapter 14 Correlation of Mix Designs & Laboratory Tests with Wear on Site	1 to 51
Chapter 15 Designing for Improved Abrasion Resistance	1 to 24

<b>Section D - Summary and Conclusion</b>	xxxix
Chapter 16      Summary, Conclusions and Recommendations	1 to 15

## **C. Volume 2**

### **Factors Affecting the Abrasion Resistance of Concrete, Mechanisms of Abrasion-wear in Concrete, and Classification of Concrete Abrasion Tests**

	page
Title page (vol 2)	xli
Abstract	xlii
Table of contents	xlili
List of figures	I
List of tables	lii
Chapter 1      Introduction and Overview of Volume 2	1 to 4
Chapter 2      Factors Affecting the Abrasion Resistance of Concrete Floors and Concrete Pavers – a Review of the Literature	1 to 178
Chapter 3      Mechanisms of Abrasion Wear	1 to 61
Chapter 4      Classification of Abrasion Tests	1 to 36
Chapter 5      Summary and Conclusion of Volume 2	1 to 9

## **D. References, Bibliography and Examiner's Reports**

References	1 to 18
Bibliography	1 to 6
Examiner's Reports	1 to 17

# OUTLINE OF BOOK 2

## E. Appendices

A.1	Aggregate data sheet	
A.2	Physical and chemical properties of OPC	
A.3	Physical and chemical properties of MGBS	
A.4	Physical and chemical properties of Matla fly ash	
A.5	Specification – PCI.TM.7.11 - Determination of abrasion resistance of concrete using a wire brush or silicon carbide grit.	
A.6	Specification – CMA20 abrasion test	
A.7	Specification - determination of visible wear using a syringe	
A.8	Statistical formulae used for the analysis of data in this thesis	
B.1-B.8	Compressive strength to SABS 1058	
C.1-C.8	Compressive strength to ASTM C140	
D.1-D.8	Compressive strength to MA20	
E.1-E.8	Tensile splitting strength to ISO 4108	
F.1-F.8	Abrasion to wirebrush method - dial method	
F.9-F.16	Relationship between revolutions of wirebrush and abraded depth of wirebrush crater	
G.1-G.8	Abrasion to wirebrush method – vernier method	
H.1-H.8	Abrasion to wirebrush method - clay method	
H.9	Determination of average specific gravity of clay	
I.1-I.8	Abrasion to ASTM C418	
I.9	Determination of average specific gravity of clay	
J.1-J.8	Abrasion to MA20	
J.9-J.16	MA20 : details of abraded groove	
J.17-J.24	Relationship between maximum depth of groove and revolutions of ball race	
J.25-J.32	Relationship between volume of groove and revolutions of ball race	
J.33-J.40	Regression analysis : log p vs log r	
J.41-J.48	Regression analysis : v vs r	
K.1-K.8	Water absorption to ASTM C140, ISAT to SABS 1058	
L.1-L.8	Water content by drying at 100° C and firing at 1000° C	
M.1-M.8	Results of mass measurements taken at the University of the Witwatersrand, Nov 1988	
N1-N.6	Utilization of soft wear	
R	Analysis of Sukandar(1993)'s results	
S	Extracts from Samson Construction Chemicals product list	
T.1-T.8	Relationship between water content and dry density	
T.9-T.16	Relationship between compressive strength and dry density	
T.17-T.24	Relationship between tensile splitting strength and dry density	
T.25-T.40	Relationship between abrasion resistance tests and dry density	
U.1-U.66	Catalogue of 66 abrasion tests	
Y.1-Y.48	Photographs of blocks in pedestrian sidewalk directly after installation, Westgate	
Z.1-Z.96	Photographs of blocks in pedestrian sidewalk after 5,5 years of traffic, Westgate	
Z.100-Z.196	Photographs of blocks in bus lane after 5,5 years of traffic, Westgate	