

Chapter 1

Introduction and Overview of Volume 2

1.1 Background

This short introductory chapter offers an overview of volume 2 (see 1.4).

But first, a question that begs an answer is: 'Why a second volume'? After all volume 1 is already a document of many pages!

Volume 1 started out in 1987 as a M.Sc. dissertation. However it became apparent that the scope and content of the research justified a PhD, and the writer was encouraged to write it up as such by his supervisor, Prof M G Alexander, (now Head of Civil Engineering at UCT).

The laboratory testing for Volume 1 was done in 1987 and 1988, while the final field measurement of abrasion wear was made in 1993, when the blocks were 5,5 and 6 years old. In 1994 the completed document was submitted to the faculty, for comment. By this time Prof Alexander had relocated to UCT and the document was therefore read by Professor G E Blight. He forwarded the document to Professor B Shackel of the University of New South Wales, Australia, to obtain his informal opinion.

An extract of Prof Shackel's reply is given below:

1.2 Shackel's Comments

'I have now completed looking at Nick's thesis. Unfortunately I must tell you, informally, that I have reservations about awarding a PhD for the work *as it now stands* (italics by Shackel). Overall, I believe that this is an excellent and useful piece of research. I know that I will often refer to the work, and I believe that there is a great deal in it that will be of interest and practical benefit to the paving industry both in South Africa and elsewhere.

I believe that the research is generally thorough and comprehensive and I find the volume of experimental data to be quite impressive. However, there is relatively little in the way of synthesis, critical comment, or formation of theory that I would normally expect to be key elements of a PhD dissertation. I believe that it would be possible to rectify these deficiencies relatively easily and would urge this to be done.'

1.3 Carrying On

This assessment, while not without hope or encouraging words, left the writer deflated and at a loss regarding the way forward. He did not see how to increase 'synthesis, critical comment, or formation of theory' over and above the considerable body of text that was already there, and his commitments to his employer/family/church left him with little spare time/energy.

Nevertheless, in 1997, he re-established contact with Prof Blight, and also entered into communication with Prof Alexander, and Dr. B Addis. Two informal meetings with Prof Shackel also took place. These individuals all gave valuable pointers as to the way forwards. As a starting point the writer was advised to bring his literature review up to date. He set about re-acquainting himself with the existing literature, making careful summaries. He also obtained recent publications on the subject of abrasion resistance from the C&CI library.

In 1998 the writer was awarded a diploma in 'Advanced Concrete Technology' by the Institute of Concrete Technology, UK, for attending six weeks of intensive full time lectures, followed by two three-hour exams and the submission of a 170 page project entitled 'Splitting Cracks in Pretensioned Prestressed Concrete Sleepers'. The course

work was very wide involving some 60 different topics, and possible as many as 200 publications. It gave the author a grasp of the many aspects encompassed by concrete technology, and gave additional impetus for completing his work on abrasion resistance.

In October 1999 the writer applied for and was granted a severance package that his employer was offering to 'volunteers' as part of a rationalization programme. This allowed the writer the opportunity to devote himself to the thesis on a full time basis.

Having re-assessed the contents of the 1994 'submission', Prof Blight considered all that remained to do was to update the literature review, and make some relatively minor corrections, as well as change the way some of the data was presented. He stated that the subject matter did not lend itself to the formation of new theories, etc.

1.4 Volume 2 Emerges

Following the writer's extensive review of the many relevant publications, he realised that it would be possible to link up the many materials and processes that have a bearing on abrasion resistance by means of an extensive wiring-diagram/family-tree/organigram, seen in figure 2.2. The relationships between widely recognised principles of concrete technology that have a bearing on abrasion resistance, as well as factors relating to abrasion resistance that are not so well known, are all clearly identifiable from the various headings and sub-headings in the diagram. The graphical aspect of the wiring diagram makes it easy for the reader to establish relationships. Furthermore by arranging the relevant information from the various sources under the headings represented in the wiring diagram, it was possible to establish a readily locatable 'databank' for each topic. Also included beneath the various headings the writer has stated his own views, made additional observations, commented critically, etc.

It appears that this is the first time such an attempt has been made to systematically classify abrasion resistance on such a scale. The extensive literature has thus been carefully arranged/catalogued in 'Chapter 2 – Factors Affecting the Abrasion Resistance of Concrete Floors and Concrete Pavers – A Review of the Literature'.

On a number of occasions the findings of investigators (arranged under one or other heading in the wiring diagram) appear to be contradictory, or go against the expected trend. It soon became apparent that these differences could often be resolved by delving into the wear mechanism, or some other aspect of the investigator's abrasion test. This led to a study of the many abrasion tests including the apparatus, the test methodology, and most importantly the actual abrading action and abrading medium. This finally resulted in a catalogue of sixty-six surface tests (see Appendix U) that may well end up as the most valuable component of this thesis for future researchers in years to come.

However, in order to save a great deal of repetition in this appendix, it was prudent to set out up front the essential principles governing the various mechanisms of abrasion wear that are represented, as well as some basic definitions and terminology. Also included here is a classification of the different tests according to the various abrasive actions and abrading mediums. This may be regarded as the heart of the chapter, and explains the title 'Chapter 4 – Classification of Abrasion Tests'. The most salient aspects of the various tests are also incorporated in the classification (Table 4-1).

In describing the abrading actions of the various abrasion tests the writer became aware of the need for a greater depth of understanding of the various processes and mechanisms of wear. Unfortunately, very little work appears to have been done specifically on the mechanisms of abrasion wear in concrete, and where sources could be found the nature of the experimental work was found to be superficial. This led the writer to a study of specialist literature on wear by Hutchings(1992), a compilation of research into the field of 'friction and wear of engineering materials' where clearly a great deal of research *has*

taken place. Although the engineering materials referred to in this book are generally limited to metals, steel alloys, ceramics, and polymers, many of the principles may be applied to concrete. Therefore using this as a primary resource together with what other sources were available, the writer has attempted to formulate a theory on the wear mechanisms that occur in concrete subject to abrasion, and hence 'Chapter 3 – Mechanisms of Abrasion Wear'.

1.5 Conclusion

What started as an upgrade to the existing literature research in Volume 1 has grown into a second volume. In essence Volume 2 is a mammoth literature study (chapter 2) that sprouted two additional chapters (chapter 3 and 4) to explain how the use of different tests could at times explain the apparently contradictory conclusions made by different investigators.

Volume 2 amounts to an extensive discourse on the work of many investigators. It is hoped that a number of useful theoretical models and observations come out of this. By way of contrast Volume 1 is mainly a discussion of the writer's own experimental results.

It is also hoped that Volume 2 will make up for such deficiencies as may have existed in Volume 1 regarding 'synthesis, critical comment, or formation of theory' (Shackel), while also giving the writer the opportunity to demonstrate his ability in Volume 2 to reason at a higher level.

In addition, Volume 1 has been carefully reviewed and updated. The minor changes/corrections considered sufficient by the writer's supervisor have been made. Notwithstanding, numerous 'enhancements' have been added to Volume 1, owing to further insights gained from the literature read and experience gained by the writer in the period 1994 through 2001.

Finally, the writer hopes that the reader will concur that the addition of Volume 2 to Volume 1 augments and improves the overall presentation, and that together they make a positive contribution towards improved abrasion resistance in concrete.