Foreword to concrete durability

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Published version deposited in CURVE April 2014

Original citation & hyperlink:
Claisse, P.A. (2009). Foreword. In M. Soutsos (Ed). *Concrete Durability* (pp: xi-xii). London: Thomas Telford
http://dx.doi.org/10.1680/cdapgttdodcs.35171

Foreword

Far more concrete is produced than any other manufactured material. It is the basic material for the construction industry that employs 7% of the workforce worldwide and over half in some countries. One tonne of concrete is produced every year per head of population on the planet.

Over a hundred years ago in 1907 Knudson showed in his paper entitled 'Electrolytic Corrosion of Iron and Steel in Concrete' that the passage of a small current through the reinforcement in concrete would cause corrosion. His opinion that stray currents were the cause of the problem was shared by most researchers at the time but within a few years Rosa, McCullom and Peters had concluded that 'the presence of chlorides always facilitated trouble' ('Electrolysis of Concrete', 1912). At the time this was written the chlorides that did the damage were almost always from sea water. It was not until half a century later that winter salting of roads became widespread and soon after that extensive deterioration in highway structures was observed. This corrosion is the most significant of a wide range of different problems that affect modern structures that are discussed in this book.

Clients are now expecting their structures to last longer with service lives over 100 years being demanded in some cases. In order to avoid the liability for long term repairs they are looking for a 'warranty' from the construction company and, in many cases, giving them contractual responsibilities for long term maintenance. The contractors can therefore no longer bid on the cheapest solution. They must consider the long term durability of the structure to avoid spending their profits on repairs.

Durability is a very difficult area for design. A structural engineer can decide on the size and shape of components and carry out the necessary calculations (or get a computer to do them) and determine load bearing capabilities with great accuracy. No such process is possible with considerations of durability. The mix design of concrete can be specified and the exposure conditions determined (often not very accurately) but the only things that these will affect directly are properties of the matrix

such as the hydrate structure and the pore size and fluid chemistry. All that these will affect is the transport properties and it is these that finally determine the durability of the structure. The link between what we can control and the result we get is therefore extremely complex and can only be determined by experimental or probabilistic methods.

To add further complications to a complex problem, concrete practice is currently going through a series of fundamental changes. These have been driven partly by costs but primarily by environmental concerns. Cement production is responsible for approximately 5% of the world's carbon dioxide emissions. To put this into context it should be noted that CO_2 emissions for concrete are 20 times less per tonne than that of steel but the quantities are vastly greater. Thus there is enormous pressure to replace as much cement as possible with other materials. The use of these materials and their effects on durability are discussed in detail in this book.

The final issue is that of workmanship. Despite many advances in quality control the plans and specifications which are produced by the designer are often not accurately followed. The depth of cover concrete which protects the steel from the exterior environment often ends up less than that specified. Also the curing which should prevent the concrete from drying out during the days after it is poured is often not effective. On road bridges drainage systems are notorious for failing to keep the damaging salt water away from vulnerable concrete surfaces. These factors combine to make failures of even the best designs if inadequate provision is made to prevent, or allow for, poor construction.

In the past there has been a clear division between the structural engineers who have carried out designs and the concrete technologists who have often only become involved when durability problems have arisen. This has come about due to conflicting pressures on the syllabus in civil engineering courses. But the designers are now finding that durability considerations have become a central part of the process and must be considered at every stage from concept to completion. Those wishing to study the topic have found the relevant information to be fragmented partly due to the massive volume of research that has been published in the numerous journals that cover the area. Much of the information is also presented in terms of complex physical and chemical theories. This book is a compilation of essays by a selection of leading practitioners covering the full range of durability topics at a level that can be understood by engineers without the need to study the science in great detail.

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