



Concrete pipe exposed to acidic ground conditions or aggressive carbon dioxide

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ABSTRACT

Laboratory tests and records of field installations have been used to estimate the 100-year lives of concrete pipes exposed to ground conditions which are acidic or contain aggressive carbon dioxide. Results confirm that the CPAA limits are appropriate though somewhat conservative.

The data and method of estimation also allow covers to be determined for pipes operating in conditions where the levels of aggressives are higher than the limits set in the CPAA table.

Key Words: acid resistance, carbon dioxide, concrete durability, concrete pipes, corrosion, groundwater, soils.

INTRODUCTION

Concrete pipes are used for a wide range of applications because they are capable of operating in various types of environments. The actual performance of the pipe will depend largely on the environment in which it is placed and the quality of the concrete. Most pipes are subject to noise underground conditions which can result in a continued strength gain but also makes them susceptible to attack from any aggressive agents that may be present in the groundwater.

Two of the more common aggressives are acids, which react with the cement at the concrete surface usually forming a soft paste, and aggressive carbon dioxide which dissolves the hydrated cement. When concrete pipes are placed in environments where aggressives like these are prevalent then the durability of concrete is a concern. As a guideline the CPAA has set limits for the use of unprotected concrete pipe in the presence of various aggressives agents (Ref 1). These guidelines are based on information relating to the performance of concrete pipes in various aggressive environments which has been collated by Humes Concrete R&D over the years. The information itself comes from long term tests set up to monitor the performance of concrete against particular aggressives in simulated and actual field conditions, exhumed pipes from known conditions, and testing that other organisations and authorities have performed. The information which has been obtained in these ways has been formed into a corrosive index where particular note is made of the exposure period, type of aggressives present, soil conditions and depth of corrosion, if any, for each example.

ESTIMATION OF LONG TERM CORROSION DEPTH

The CPAA limits are specified so that an unprotected pipe which is exposed to a particular aggressive in the groundwater with the minimum allowable cover according to AS 1342 of 10mm to the reinforcement will have a life expectancy of 100 years. To be able to determine whether these limits are in fact reasonable requires some method of estimating the actual long term performance of concrete pipes in conditions similar to those listed in the CPAA recommendations from the relatively short term performance data that is available.

When concrete undergoes attack by an aggressive such as acid or dissolved carbon dioxide corrosion products are formed on the surface. If these corrosion products are removed it is reasonable to assume that the depth of attack is proportional to time. However, this is often not the case, as in many situations corrosion products remain adhered to the concrete surface. Should this occur the aggressives must firstly diffuse through the corrosion layer before further attack can take place. The corrosion layer, therefore, has the effect of slowing down the corrosion rate quite considerably. Information gained from previous testing performed at Westall R&D involving concrete beams exposed to both acidic and aggressive CO₂ environments without the removal

