Diffusion Studies on Concrete Sample Exposed to Different Chloride Level

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***Abstract*: It discusses the mechanism of chloride-induced steel corrosion embedded in concrete, the chloride entry into concrete, and the threshold chloride content for corrosion to occur. Consideration is given to the binding of chloride ions by cement compounds and the related effect of using various cements, both Portland and blended, as well as other corrosion influencing factors. Tests are described regarding the penetrability of concrete to chlorides. It discusses corrosion prevention. Initiation of steel corrosion in reinforced concrete (RC) structures that are exposed to chloride mainly depends on the coefficient of concrete chloride diffusion. Hence one of the key parameters needed to predict reinforcement corrosion initiation seems to be. The information presented in this paper would be useful for predicting accurately the corrosion initiation time of chloride-exposed RC structures, considering the effects of chloride binding, the effect of time and space on, and the interaction effect of multidirectional chloride ingress. Durability means the resistance of concrete to physical or chemical deterioration resulting from interaction with the environment (physical deterioration) or interaction of concrete components (chemical deterioration). A robust concrete guarantees the resistance of embedded steel to corrosion, which in effect guarantees a stronger lifespan of the whole structure.**

***Index Terms*: Chloride Penetration, Compression Test, Rapid Chloride Permeability Test and Slump Test.**

I. INTRODUCTION

Reinforcing steel corrosion is the leading cause of the deterioration of reinforced concrete structures. The main causes of corrosion are carbon dioxide, and particularly chlorides. The coefficient of chloride diffusion determines the capacity of any specific concrete to withstand chloride penetration and is used to estimate the service life of reinforced concrete structures. Concrete is a material of widespread utility that can be adapted to many purposes, but there are situations where precautions need to be taken to provide protection against potentially destructive agencies that may be physical in action, such as frost or chemical. There are numerous damaging chemical substances, including those naturally occurring in soils and waters, and those of industrial origin. Briefly, it is the weathering of concrete, interpreting weathering in a broad sense that will be considered here, to include both natural agencies and artificial conditions. There are conditions under which a strong concrete will be attacked, while a weaker one made of chemically more resistant materials will be more durable. Results of a study investigating the long-term leaching by the Netherlands of toxic trace metals from different Portland cement mortars in an aqueous environment. The leachates generated were analyzed using atomic absorption spectroscopy for the various toxic metals outlined in Directive 80/778 / EEC. The analytical results revealed only vanadium leached from poorly cured concrete in detectable quantities, and its removal from the surface was restricted only. Typically, it is measured experimentally with self (gravity) diffusion or migration tests, but variations can be found in the coefficients' numerical values depending on the technique used Either diffusion or migration tests can be carried out under stable or non-stable conditions. It takes a long time for pure diffusion experiments but migration tests are carried out in relatively short time. Migration tests (otherwise known as electro migration) vary from diffusion tests, since a continuous variation in the electrical potential is applied to the concrete. For others, the flux is calculated based on the measured change in chloride concentration when the ions moving through the sample have reached a steady state, the chloride penetration is determined using the colorimetric process, is not easy to quantify and has a high variability. To give an alternative to the traditional methods used to measure the chloride diffusion coefficient for concrete. The paper's main objective is to present the theoretical basis method consisting of the experimental determination by RCPT method of the chlorides in cement grade M40 and M50.

II. SCOPE AND SIGNIFICANCE

The type of cement, the proportions of the mixture and the presence of reinforcing bars. The modern study of the diffusion has ignored the presence of concrete steel plates. The purpose of studying the reinforcement effects on the chloride diffusion in concrete structures by incorporating realistic models of diffusion. For this purpose, in the chloride diffusion analysis, the nonlinear binding isotherm that includes the effects of cement types and mixes Chloride penetration into concrete is influenced by many parameters of such true proportion. The effects of the reinforcements on chloride penetration were studied through analysis of finite elements. The effects of the reinforcements on chloride penetration were studied through analysis of finite elements. The present study suggests that the chlorides are deposited in front of a reinforcing plate, and chloride accumulation is even more pronounced for larger bars. The higher chloride concentration at bar position allows the reinforcing bars to corrosion more quickly. The initiation time for corrosion decreases by around 30 to 40 per cent when chloride diffusion research considers the presence of reinforcing bars. Therefore, the effects of reinforcements in the chloride diffusion analysis must be carefully considered in order to achieve a more reliable and practical calculation for the service life of concrete structures. A process which is appropriate for determining materials and material proportions for design and research and development purposes. Depending on the form of concrete and the curing process, the sample age has major effects on the test results. Over time, most concrete is gradually and substantially less permeable if properly treated. Factors such as ingredient materials used in concrete mixtures and the method and duration of curing test specimens affect the results of this test When using this method for mixture qualification and acceptance testing, it is imperative that the healing procedures and age are clearly specified at the time of testing. In project-specific cations, engineered concrete mixtures, statistically-based criteria and test age for prequalification or for acceptance based on job samples should be stated. Acceptance requirements for this test should consider the outcome-affecting sources of uncertainty and ensure a balanced risk between supplier and buyer. It is necessary to understand the expected conditions of exposure and the period before a system is placed into operation. We are addressing one approach to determining standards. The qualitative relation between the results of this test and the penetrability of chloride ions in concrete. Care should be taken in interpreting the results of this test when, for example, concrete treated with penetrating sealers is used on surface treated concretes. The results of this test on some of these concretes indicate low chloride ion penetration resistance, while 90-day chloride ponding tests on com- pinion slabs show a higher resistance. The various chloride penetration mechanisms are discussed, followed by a further elaboration of the chloride diffusion theory. The effect of concrete 's basic properties on its penetrability to chloride is also explored. Includes individual test procedures. Firstly, there is discussion of the existing long-term-procedures, namely the salt ponding test and the Nerdiest bulk diffusion test. Instead are given the current short-term tests. The method, the theoretical basis and any advantages and inconveniences are presented for each test. A chloride ion is a key factor affecting the durability of structures made of reinforced concrete (RC). Given the mesoscopic heterogeneity of concrete, concrete modeled here is viewed as a four-phase composite composed of aggregate, mortar, crack, and interfacial transition zone (ITZ) to examine chloride migration in cracked concrete. A, two-dimensional finite element models of cracked concrete with different crack widths and crack quantity are created, and the control parameters are calculated based on the NSSCM test. In addition, the chloride migration behaviors and characteristics are studied based on the concrete finite element models, effect of crack width, crack quantity, and erosion time. In addition, a predictive model of concentration of chloride is established on the simulated surface of a rebar in concrete influenced by various crack states. This model is used to derive a rebar 's corrosion current density and corrosion depth prediction models that engineers can use to estimate the chloride and rebar corrosion degree migration behaviors in RC structures in a short time, and to evaluate the duration of RC structures after knowing the status of cracks and chloride diffusion sources. Sodium-associated chlorides (Sodium Chloride) exert a salty taste when their concentration reaches 250 mg / L. Such add to water a salty taste. Chlorides in water supplies intended for public water supply are generally limited to 250 mg / L. In many parts of the world where water supplies are scarce, sources that contain as much as 2000 mg / L are used for domestic purposes without adverse effect development once the human system is adapted to the water. Concrete can corrode, too. After heating, magnesium chloride in water produces hydrochloric acid which is also highly corrosive and creates problems in boilers. Chlorides interfere in determining chemical demand for oxygen (COD) Chlorides are widely distributed in water and wastewater as calcium, sodium, and potassium salts. The salty taste created by concentrations of chloride is variable in potable water and depends on the chemical composition of sodium calcium.

III. LITERATURE REVIEW

Sajal K. Paul, Subrata Chaudhuri and Sudhirkumar V. Barai, "Chloride diffusion study in different types of concrete using finite element method (FEM): Corrosion in RCC structures is one of the most important factors that affects the structures durability and subsequently causes reduction of serviceability. The most severe cause of this corrosion is chloride attack. In this study, the mechanism of this chloride attack is understood and various parameters affecting the process are identified. The effects of fly ash and slag on the diffusion coefficient and chloride penetration depth in various mixes of concretes are also analyzed through integrating Virtual RCPT Lab and FEM.

FHWA Contract DTFH61-97-R-00022 "Prediction of Chloride Penetration in Concrete" K.D. Stanish, R.D. Hooton and M.D.A. Thomas Department of Civil Engineering University of Toronto Toronto, Ontario, Canada: Cement Concretes and Aggregates Australia, 2009 the tidal and splash zones, concrete undergoes wetting and drying cycles. In the tidal zone concrete is repeatedly immersed and dried. Concrete in the splash zone is exposed to seawater from wave splash and wind-blown aerosols. Transport by diffusion acts in conjunction with capillary absorption in these zones. The activity of these two mechanisms makes these zones particularly susceptible to chloride ingress, more so in the Splash zone than the tidal zones. Chlorine diffusion coefficient is an indication of the capacity of any type of concrete to resist chloride penetration. It is used to predict the service life of reinforced concrete structures. The determination has been subject of intense study in the last 50 years.

Determination of the concrete chloride diffusion coefficient based on an electrochemical test and an optimization model by Juan Lizarazo-Marriagaa, Peter Clarisse: The chloride diffusion coefficient is an indication of the chloride penetration resistance capability of any type of concrete and is used to predict the service life of reinforced concrete structures. Its determination has been the subject of intense study over the last 50 years and the methodologies used today are not entirely in agreement. Furthermore, the experimental commitment is time-consuming and it requires recourse. As an alternative, this paper presents a new methodology for finding concrete 's fundamental properties including the diffusion coefficients. The chloride-related properties can be found from measuring the electrical properties of concrete during a migration test, and using and integrated physical-neural network model. Results of normal diffusion experiments were compared with the results of the new methodology and gave encouraging results.

Altaf Ahmad, Anil Kumar, "Chloride ion migration/diffusion through concrete and test methods" International Journal of Advanced Scientific and Technical Research, Issue 3 volume 6, Nov.-Dec. 2013 ISSN 2249-9954: In the present day models for the life of concrete structures, the causes of failure have been earmarked and role of chloride ion has been placed at the top, because of comparative ease of Cl- transport in concrete structure and its extraordinary damaging effect on the existing passivating film on the rebar surface. Therefore, diffusion of Cl- ions through concrete media has been given pronounced recognition and various testing techniques for the measurement of ‘diffusion’ of Cl- have been developed and standardized.

IV. EXPERIMENTAL INVESTIGATION

Slump test on fresh concrete: Place the mould on a smooth horizontal non- porous base plate. Fill the mould with the prepared concrete mix in 4 approximately equal layers. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould then after the mould and check the amount of slump.

Compression test on concrete moulds: For cube test two types of specimens either cubes of 15cm x 15cm x 15cm or 10cm x 10cm x 10cm. These specimens are tested by compression testing machine after 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails.

RCPT Test: In this test, the constant voltage (V) is applied on a concrete specimen for 6 hours and the current (I) passing through the concrete is recorded to find the coulombs. The concrete sample is placed in between the two reservoirs (which is called as a single cell) having NaCl solution in one reservoir and NaOH.

V. OUTCOMES

The slump test investigation we observed a slump of 95mm, where the mortar stayed intact after removal of the mold, thus the mortar can be used for experimental purposes and for construction.

Table 1 Compressive Strength

Sl.No	**Compressive Strength**		
1.	***Grade***	***Compressive strength after normal curing tank***	***Compressive strength after accelerated curing tank***
2.	M40	47.85N/mm^2	46.47 N/mm^2
3.	M50	56.88 N/mm^2	56.67 N/mm^2

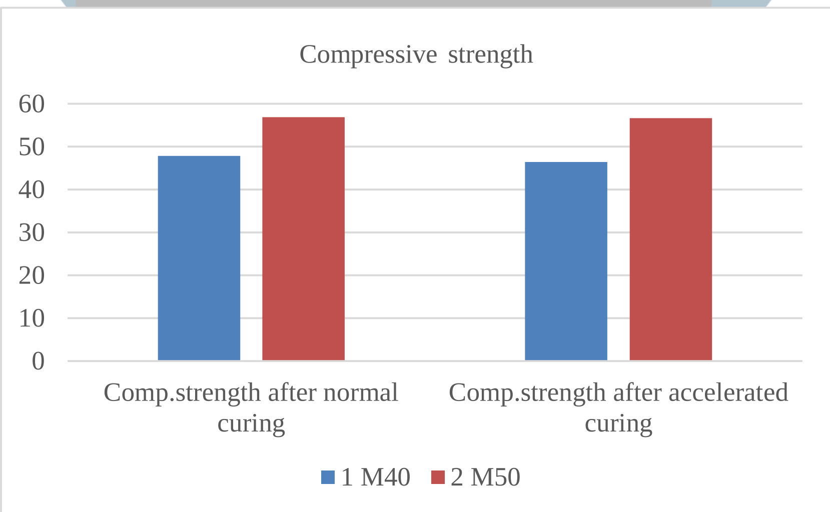

Fig. 1

Table 2 RCPT Test results for M40

Sl. No	RCPT Test Results for M40	
1.	***M40 Grade Samples***	***Average Chloride ppm of 3 Samples***
2.	0.04N NaoH+1000 ppm	4654.05
3.	0.04N NaoH+5000 ppm	4868.23
4.	0.04N NaoH+10000 ppm	3581.95
5.	0.04N NaoH+20000 ppm	5940.33
6.	0.04N NaoH+35000 ppm	4513.23

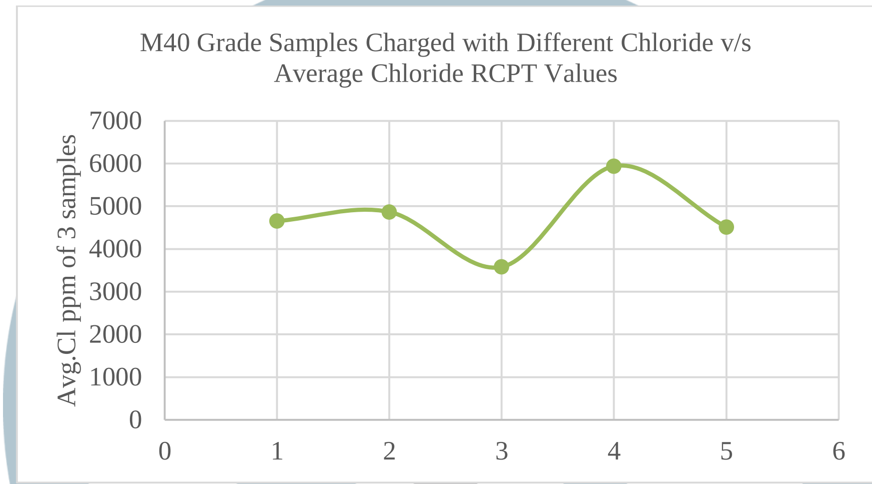

Fig. 2

Table 3 RCPT Test results for M50

Sl. No	RCPT Test Results for M50	
1.	***M50 Grade Samples***	***Average Chloride ppm of 3 Samples***
2.	0.04N NaoH+1000 ppm	4515.6
3.	0.04N NaoH+5000 ppm	4714.4
4.	0.04N NaoH+10000 ppm	3709.75
5.	0.04N NaoH+20000 ppm	4313.25
6.	0.04N NaoH+35000 ppm	4470.63

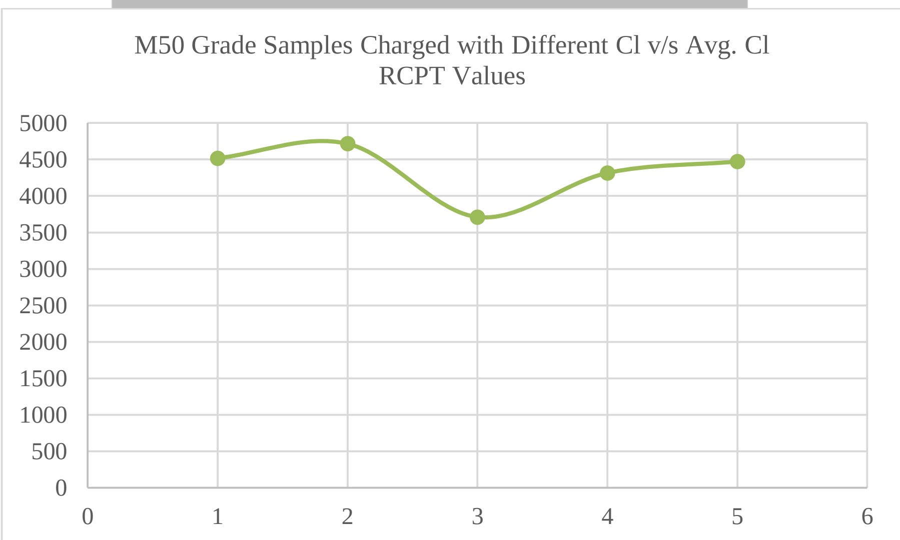

Fig. 3

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