RESEARCH ARTICLE OPEN ACCESS

Estimation of Marine Salts Behavior Around The Bridge Structures in Coastal Regions of India

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Abstract:

A developing obstacle for higher assessment of existing concrete structures has published a necessity for extended figuring out of the structural results of degradation. The two most usual causes of deterioration in concrete constructions are freezing of the concrete and corrosion of the reinforcement. The intention of this study is to deepen the understanding of the structural results of decay with specified awareness to the bond between deformed bars and concrete. The effects of freezing on the material houses of concrete and the bond behaviour of bars had been investigated by way of experiments. A big impact of frost injury was found on the stress-stress response of concrete in compression, tensile stress-crack opening relation, and bond-slip behaviour. Situated on this, a suite of approaches was offered to foretell the mechanical behaviour of reinforced concrete structures with a measured quantity of frost harm. The methodology was applied to frost broken beams utilizing non-linear finite element evaluation on the structural degree. Service existence prediction is fitting one of the crucial primary duties in the design of concrete structures. The sturdiness designhas got to be founded on regular items that can describe the deterioration units extra competently. The progress of chloride penetration units is important for the comparison of the carrier lifetime of concrete buildings exposed to marine environment. Easy units are derived from Fick's 2nd law of diffusion are at reward the pleasant approach to foretell chloride penetration in useful situations. Nonetheless these items need to be calibrated with experimental outcome.

Keywords **— Concrete structures, corrosion, salt behaviour, strength and damages.**

I. INTRODUCTION

A considerable percentage of highway bridges in coastal area of Andhra Pradesh are in a structurally/functionally deficient state due to aging, aggressive environments, and increased traffic load and volume. In 2010, about ¼ bridges in A.P were either structurally deficient or functionally obsolete. On a bridge structure, the substructure is one of the most prone components to the movement's utility of dicing salts, repeated freeze-thaw cycles, and different dangerous effects together with environmental resultsThe effects of frost on material homes of concrete and bond behaviour of deformed bars were investigated by means of experiments. There may be very little know-how involving the softening behaviour of frost-broken concrete within the literature; in addition, the restrained on hand expertise shouldn't be experimentally validated. The bilinear tensile stress-crack opening relation estimated by way of inverse evaluation of wedge splitting experiment outcome is believed to be the only available estimation made out of experiments. The precept of the methodology proposed for frost-broken concrete is that the effect of frost will also be modelled with the aid of adapting material and bond houses and by editing geometry. Even though strategies for adjusting the material and bond properties of frost-broken concrete have already been given by using other researchers, their software to concrete beams in superb state has not been done earlier than. The influence of reinforcement corrosion on the bond mechanism is studied in detail via experiments and analyses.

Mechanical behaviour of corroded reinforced concrete structures:

The mechanical behaviour of strengthened concrete buildings, in phrases of load-carrying capacity, as well as stiffness and force redistribution, is plagued

by the corrosion of reinforcement, see determine 1.2. Both uniform and pitting corrosion decrease the reinforcement bar field and ductility, which causes volume enlargement. Reduction of the reinforcement bar discipline results in reduced shear and second capacities as well as lowered stiffness of the structure. A metamorphosis in rebar ductility directly influences the stiffness of the structure, the likelihood for drive and second redistribution, and boundaries the weight-carrying ability of a statically indeterminate structure. In addition, volume enlargement of reinforcement bars could motive the encompassing concrete to crack and spall off, which decreases the concrete cross-part and concrete cover.

Scope of study:

• In world as consists of more than 70% cover by oceans, river, etc., with salty content.

• Bridge is only way to travel, exchange a goods by land.

• Bridge structure is structural element which is constructed by means of concrete ingredients in salty water which can easily corrosion in bridge column.

• To prevent and overcome the damage by increasing the concrete cover and concrete quality requirements and prevent the corrosion of the reinforcement.

• Additionally it can be used for fixed formwork in column.

Objectives and observation process:

1. Chlorides in the environment build up on the concrete surface.
2. Chlorides are transported through the concrete mainly through the diffusion process.
3. The chloride concentration builds up with time at the steel surface.
4. Once the chloride level achieves a critical threshold level, the protective oxide layer on the steel breaks down and corrosion starts.

The main objective of this project work is to develop a probabilistic-based model for the durability analysis of concrete structures in marine environment, and understand how the model parameters influence durability analysis.

1.0 Literature review:

Klieger 1980, Manning 1989, Gjørv 1987the construction of a frost resistant concrete which has a good and steady air void process throughout transportation and handling of the fresh concrete. Large investigations of present concrete constructions with deliberately entrained air have revealed that no air used to be present or used to be inadequate with the aid of present specifications for a average-force concrete without using any tremendous plasticizer, the production of a just right and stable air void approach may represent a challenge, but in the presence of an ideal plasticizer, nonetheless, this can be an even more extreme predicament For this reason, much concentration has been given in up to date years to discover whether or not a frost resistant high-performance concrete can be produced without any air entrainment. Already in **1947 Mielenz et al.** Published a ”black record” of alkali-reactive aggregates and minerals. This type of degradation happens when alkalis launched from the hydrating cement react with aggregate containing reactive components. Gilliot (1975) advised that AAR must be subdivided into the next three corporations of reaction: alkali-silica reactions with siliceous aggregates (some cherts, opal, and siliceous lime stones), alkali-carbonate reactions with carbonate aggregates (some argillaceous dolomites) and alkali-silicate reactions (equal as alkali-silica reaction except that the reactive constituent in the combination is silica reward in the type of phyllosilicates).**(Verbeck 1975, Mehta 1975).**Sea water contains sulphates and could be expected to attack concrete in a similar manner to that described in the previous section but, because chlorides are also present, sea-water attack does not generally cause expansion of the concrete. That is seeing that the expansive merchandise (ettringite and gypsum) shaped due to the reaction of C3A with sulphates in sea water, aren't accompanied with the aid of the extent of swelling seen in pure solutions of sodium and magnesium sulphate, considering that ettringite and gypsum are more soluble in options containing chlorides akin to sea water **(Gonzalez, Jalali 2004).**chlorides in a concrete structure is very much a function of the environmental conditions, mainly the concentration and duration of the solutions in

contact with the concrete surface. The conditions are quite different in different exposure situations.Below the level of sea water, the concentration of chlorides is more or less constant with time. The penetration is a pure diffusion process at constant boundary conditions. At early ages, however, a negative pressure (suction) is produced as the hydration of cement takes place in the interior parts of the concrete

2.0 Materials and Methods:

Durable concrete is defined as having has the ability to resist external results, which could also be mechanical, physical, or chemical, with minimal injury. Low permeability is key to lengthy-time period sturdiness of concrete. Low permeability in high performance concrete supplies security towards: damage as a result of freezing and thawing, alkali-aggregate reactivity, carbonation, acid assault, chemical resistance, sulfate attack, seawater exposures, and so on. The work is taken in an tremendously corrosive atmosphere and care ought to be taken to be certain that any structural metal within the concrete is protected from chloride acid assault.For this experiment, two four with the aid of eight inch cylinders have been solid from every combine design.The 4 mixes in the 2nd phase have been water cured for six days earlier than the transfer to the moisture cabinet. It is principal for concrete constructions to participate in well no longer simplest within their designated mechanical requirements but also within their sturdiness expectations. Very traditionally the problem of durability is being lost sight of seeing that engineers make the assumption that powerful concrete can be durable.

Materials Cement: The cement in the concrete provides security to the reinforcing steel towards corrosion with the aid of retaining a excessive PH within the order of 12.5-thirteen to the presence of Ca(OH)2 and other alkaline substances in the hydration fabricated from cement, and by means of binding a gigantic quantity of complete chlorides. OPC of 43 grades in one lot was procured and stored by way of air tight.

WATER: The common consuming water on hand at the construction laboratory used to be utilized for training of concrete for casting all specimens of this investigation. Ordinary water available is used for the curing rationale

FINE aggregate: Aggregates containing chloride salts rationale severe corrosion problems, chiefly these on hand close seas and people whose normal web sites are in ground water containing excessive attention of chloride ions. A fine aggregate obtained from the river is used for experimental purpose.

Figure: fine aggregate used for sample preparation

Coarse Aggregate: The coarse combination will have to be strongest and porous aspect of concrete. The coarse aggregate in concrete reduces the drying shrinkage and other dimensional changes taking place due to movement of moisture. The Coarse Aggregates is easy and dry. The highest size of aggregate is 20mm

Concrete Mix Design:

Mix design may also be outlined as the approach of identifying suitable elements of concrete and determining their relative proportions with the article of producing concrete of detailed minimum force and durability as economically as viable. The principal objective is to stipulate the minimum force and sturdiness. It also displays the relation between aggregate and paste. The other stipulations being equal, for manageable mixes the force of concrete varies as an inverse operate of the water/cement ratio. In view that the variety of water rely on the amount of paste, it's major that as little paste as feasible should be used and hence the significance of grading. 1:1:2.18

Compression Test:

The cubes of size 150 x 150 x 150 mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks.

Split Tensile Test:

The test is carried out by placing cylinder specimen of dimension 150 mm diameter and 300 mm length, horizontally between the loading surface of compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted.

Scanning electron microscopy (SEM):

After publicity, probably the most samples (from each and every set) were once selected for remark in Scanning Electron Microscope (SEM). The sample was once reducing into slices 2 cm thickness. Then, the transverse floor section was once polished with emery paper commencing on quantity 200 as much as 1200. A scanning electron microscope JEOL mannequin JSM-5600-LV was used. Two ingredients of the skin have been studied: atmosphere-concrete interface and concrete-steel bar interface. Calcium (Ca), chloride (Cl), Iron (Fe), magnesium (Mg) and oxygen (O) have been mapped.

3.0 Results and discussions

Test results at 7 days

S.no	Specimen	Compressive strength N/mm^2(7days)	Split tensile N/mm^2(7 days)
1	Cube1	16.78	
	Cube2	17.15	
2	Cylinder1		0.96
	Cylinder 2		0.99

14 days test results

Specimen	Compressive strength N/mm^2(14days)	Split tensile N/mm^2(14 days)
Cube1	23.9	
Cube2	23.95	
Cylinder1		1.64
Cylinder 2		1.68

SEM/EDS Analysis:

On the other hand, a comparative mapping about the elemental distribution in concrete samples is presented in Figures 3 (Ca), 4 (O), 5 (Cl), and 6 (Mg).

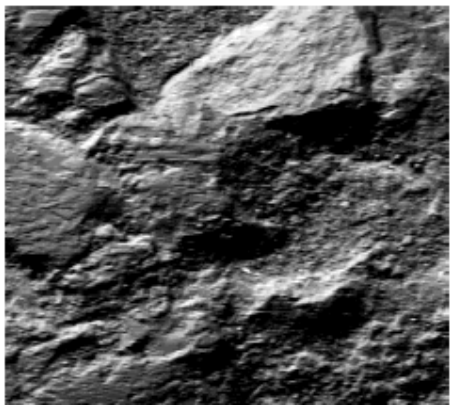

Figure: Concrete samples borders. ATM (130x),

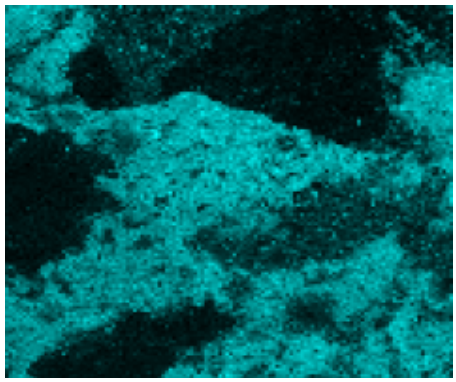

Figure: Calcium distribution at the borders a) ATM (130x),

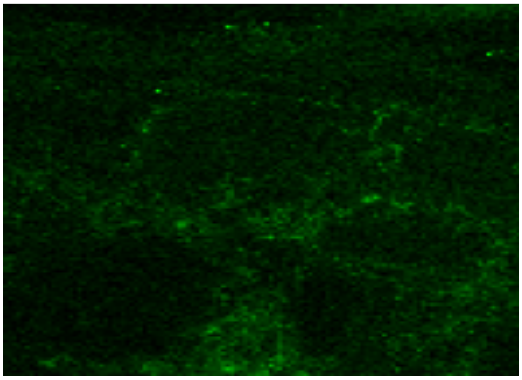

Figure: Chlorine distribution at the bordersIMM (1500x).

Conclusions:

This study performed immersion test in a 5% NaCl solution considering the type of cement, the eventual admixing of fly ash and the water-cement ratio as major test variables in order to examine the characteristics of chloride ion penetration in NPP

concrete structures. Especially, tests were performed for the case where carbonation is exerting composite action so as to secure basic experimental data concerning composite deterioration due to the effects of these variables. It was observed that concrete cast and immersed in seawater for 24 days beyond the curing period increases its weight due to penetrating of marine salts and increases in compression strength beyond the strength of concrete cubes cured in fresh water. Compressive strength is decreased as a result of curing in salty solution total ultimate load carrying capability of the specimen is devastatingly low. Given that the burden carried is about 240 KN whereas the average is set most effective 109 KN.

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