International Journal of Engineering, Science and Mathematics
Vol. 9Issue 9, September 2020,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

ASSUMPTION OF REINFORCEMENT CORROSION IN SUBMERGED CONCRETE STRUCTURES

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ABSTRACT

This paper presents a quick review of the models developed by earlier researchers to predict the service lifetime of the concrete structure considerately to style, materials, internal control, construction technology, environmental factors and also the maintenance/monitoring strategy adopted. Additionally varieties of case studies on the concrete structures under marine environment were considered for the life performance assessment through non destructive half-cell potentiometer test data. The results of the remaining service life obtained from the model are compared with the particular field condition and it's found that both are matching appropriately.

KEYWORDS: Concrete, Corrosion, Cracking, Service Life Model.

I. INTORDUCTION

The service lifetime of a structure may be defined because the expected life time where it remains fully functional with none major rehabilitation (Sohanghpurwala, 2006). The functional service life as driven by chloride induced corrosion of upper deck reinforcement will be divided into three time periods. First is that the initiation time (T) which is related to the duration of period for CO or Cl ions to diffuse to the steel-concrete inter-face and activate corrosion reactions. other is that the expansion time (Tf...), which is that the duration expressed by the amount where the corrosion products start expanding and filling the porous zone without resulting pressure build up within the concrete. The third one is that the stress build-up time (T,,,,,,), which may be defined because the time ranging from the start of stress development up to the primary crack occurs when the build stress is larger than the strength of the concrete.

II. REVIEW OF MODEL

There are several ways of predicting service life because of the corrosion damage of reinforcement in concrete using different deterioration models. a number of the models reviewed here are presented well below.

1. Cady-Weyers' Deterio ration Model

Based on the premise that salt-induced corrosion of the steel is that the main explanation for deck deterioration a deterioration model developed by Cady and Weyers, 1979 has been wont to estimate the remaining lifetime of concrete bridge components in corrosive environments. The model predicts deck deterioration as measured in a region percentage of the whole deck. the full area of spalls, delaminations, asphalt patches, and crack lengths multiplied by a tributary width combine to provide the overall damage. There are three distinct phases within the model: diffusion corrosion and deterioration. the primary phase, diffusion is defined because the time for chloride ions to penetrate the concrete cover and to initiate corrosion. The diffusion time usually is determined empirically using Fick's Second Law. The second phase, corrosion is defined as a period of your time from initiation of corrosion to first cracking of concrete cover, the time to cracking ranges between 2 to five years. The third phase, deterioration describes the time for damage to achieve grade of percent damage which is deemed because the right time for repair or rehabilitation. in line with Cady-Weyers' model, the corrosion rate is that the key to predicting the time to cracking. The corrosion rate is essentially controlled by the speed of oxygen diffiision to the cathode, resistivity of the pore solution and temperature.

2. Bazant's Mathematical Models for Time to Cracking

According to Bazant's models, the time to cracking may be a function of corrosion rate, cover depth spacing, and certain mechanical properties of concrete like durability modulus of elasticity, Poisson's ratio and creep coefficient. A sensitivity analysis of Bazant’s theoretical equations demonstrates that for these parameters, corrosion rate is that the most important parameter in determining the time to cracking of the quilt concrete. Unfortunately, Bazant’s model has never been validated experimentally.

3. Morinaga’s Empirical Equations

Based on field and laboratory data, the empirical equations suggested by Morinaga, 1988 will be used for predicting the time to cracking. it's assumed that cracking of concrete will first occur when there's a specific quantity of corrosion products forming on the reinforcement.

4. Empirical model by Maaddawy and Soudki

As per the model, determination of your time from corrosion initiation to corrosion cracking (T„„) will be defined as the time during which the strain builds-up as corrosion products having filled the porous zone. The expansive corrosion products create tensile stresses on the concrete surrounding the corroding steel reinforcing bar. this may result in cracking and spalling of concrete cover as a usual consequence of corrosion of steel in concrete.

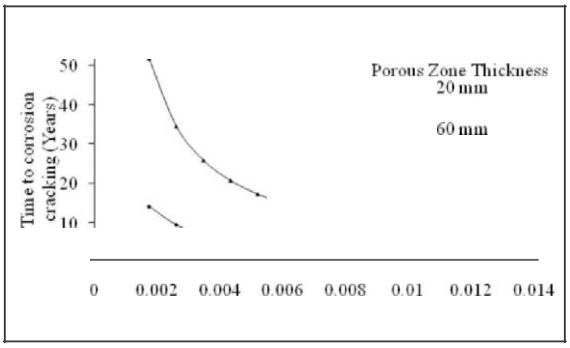

Fig. 1: Relationship between corrosion current density and time to corrosion.

5. Correlation between Corrosion Rate and HalF-Cell Potential

The model adopted during this research investigation need the corrosion rate (qm/year) because the one among the important input in determining the corrosion cracking time (T„„). However, accurately determining the corrosion rate of the steel reinforcement within the bridge isn't always possible thanks to variety of other reasons. On the opposite hand, measuring the corrosion potential by employing the corrosion analyzing instrument (CANIN) is well established and it's being adopted a handy tool for the sector engineers and therefore the maintenance personals. supported this idea a relationship between the corrosion rate (qm/year) data and therefore the half-cell potential (-mV) data is being given by previous researchers (Kibraeb A Gebreselassie, 2011) is taken into account during this study and is plotted. It are often observed from the figure that an influence relationship between the half-cell potential and corrosion rate with a correlation of 0.97 exist. By using this correlation all the half cell potential data (measured by CANIN) of the sphere investigated bridges were converted to corrosion rate which was later accustomed estimate the functional service life.

III. CASE STUDY ON PANVEL CREEK BRIDGE

Panvel creek bridge is the most access from Belapur, Navi Mumbai to Nehru Port Trust, Uran. It takes the load of medium and heavy traffic with majority of container load vehicles are plying throughout. The bridge is 40 years old, having total length of 397.00 meters, and width of 13.10 meters. It has 9.50 meters carriageways and 1.8 meter footpath on either side. The bridge is rest on support of circular pier with pile foundation. there's a 3.5 to 4.0 meter reference between high water level and tide levels (the splash zone) thanks to which piers are affected to an oversized extent.

Prediction of Remaining Life Service of Panvel Bridge- Case Study

The remaining service lifetime of the bridge structure is decided by considering the common half-cell potential value measured and presented in Table 3. Further detail investigation administered on this bridge is reported elsewhere (Godbole et. al., 2014). Based on the typical value of half-cell potential value measured within the year May-2013, the remaining service lifetime of the structure is set as per the procedure explain. Considering the half-cell potential data reported within the above table and therefore the calculated service life, it may be understood that the bridge is at the critical stage of degradation. supported the developed service life model, the remaining service life is just from 6 -9 years for all the components of the bridge. This needs a direct care and maintenance strategy of rehabilitation.

Validation of Model for Other Structures

Based on the information presented within the above Table, the remaining service lifetime of the flyover is decided considering the best and lowest value of the half-cell potential value. it's to be noted that the Flyover contains a remaining service lifetime of 34 years considering all-time low value of the half-cell potential data. However, some component of the structure is exposed to very severe environments and deteriorated at a faster rate than other part. it's to be noted that for many a part of the structure the upkeep program are going to be needed at the tip of 34 years, however, the inner and external web, where the half-cell potential reading is comparatively high need a maintenance program at the top of 10 years.
It is found that within the year 2019- 20 (at the tip of 8 years after the non-destructive testing), a minor repair work like crack opening and filling with high strength mortar, grouting and epoxy painting at external and internal surface of concrete girder, piers, bottom deck slab was already meted out. This can be justifying the model's authenticity in actually determining the remaining service lifetime of the structure and also validating it.

IV. CONCLUSIONS

Half cell potentiometer data are quite useful to to ascertain remaining life service of concrete structures. The life service model proposed by Maadawi and Sudoki to predict the tip of service function of structures is functioning perfectly and might be strategically employed to rehabilitee major repairs in order that any reasonably total loss of life and resources may be avoided.

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