

IMPACT OF CORROSION OF REINFORCEMENT IN PRECAST CONCRETE CONSTRUCTION

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Abstract- By for the greater part of the apartment houses, industrial buildings, transport facilities and other construction projects are more from concrete are reinforcement concrete in the form of precast and place in site elements yet the share of these building materials in the construction industries promises to grow further. This trend is assisted by the existing technology of precast reinforced concrete, while on the whole, the concrete industry in this and other countries at present is making fast progress. Corrosion the rusting of reinforcing bars in concrete can be a most serious problem. Normally, embedded reinforcing bars are protected against corrosion by being buried within the mass of the concrete and by the high alkalinity of the concrete itself. This Protection, however can be destroyed in two ways, first by carbonation, and secondly chloride ions from salts combine with moisture to produce an electrolyte that effectively corrodes the reinforcing bars. To solve this problem on a well justified technical and economic basis it is necessary to have a fair knowledge of the process of corrosion on exposure to attack by various aggressive agents and protective measures for it is necessary

Key Words – Precast/ Prestress concrete Institute (P.C.I.), Vapours Phase Inhibitors (V.P.I.S.), High Range Water Reducer(H.R.W.R.), Anti Corrosive Mix (A.C.M.)

1. Introduction

Precast concrete is a moldable material that offers great structural strength and durability, along with aesthetic flexibility. A variety of colors, textures and shapes enable designer to concrete structure that are not only useful, but attractive as well.

No other building material or combination of materials can rival precast concrete's design, functional and economic advantages when it comes to building. The benefits are many:

- Durability
- Low maintenance,
- Aesthetic flexibility,
- High quality,
- And swift erection in all weather conditions.

High concrete structures can make these advantages work for you by applying state-of-the art solutions to your functional and design need. At high concrete structures we set the highest standard, making us the leading producer of precast concrete

1.1 Advantages of precast concrete construction

• Durability

Precast concrete structures withstand the abusive forces of nature, such as rain, wind, ice, hail and even earthquakes. They also resist corrosion, including the harmful effects of road salt and acid rain. Quality concrete, Produced and cast under tight controls, is what makes precast concrete superior to materials.

• Fire resistance

Because it is non-combustible, precast concrete is resistant to fire, and actually controls and limits fire damage to structure. Precast concrete helps maintain the structural integrity of a structure during a fire.

- **Minimal maintenance**

Because they are so durable and corrosion resistant, our precast concrete construction retain their original appearance for many years, with no significant discoloration, staining or surface decay. Therefore, minimal maintenance is required, saving time and labor. Also, the durability to our precast concrete can greatly reduce the need for and expense or structural repairs, which increased your company's savings.

- **Quality control**

Building a durable, corrosion-resistant structure begins with high quality concrete at high concrete structures; precast concrete is manufactured under strict factory-controlled conditions. We use rigid standard to assure durability, strength and appearance.

The factory conditions at high concrete structure allows precast concrete to be manufactured with a low water/cement ratio for greater impermeability and strength and minimal shrinkage-related cracking. The factory conditions also allow for temperature and humidity control during the curing stage, which helps concrete quickly attain its strength, ensuring its durability and resistance to chemical attack.

High concrete structures factory precast concrete is high strength. Precisely controlled entrained air increases the concrete's ability to withstand thermal contraction and expansion, preventing surface scalling and cracking. High concrete structures are a member of the precast/prestresses concrete institute (PCI) and participate in its plant certification program, which ensures consistent quality from any factory.

3.0 Experimental Details

3.1 Bond Strength by pull out text

The samples were prepared from 75 cm long bar of 8 mm diameter embedded in 15 cm in siporex specimens of 10 cm x 10 cm z 15 Fig. 1 gives details of the size of samples etc. The bar was placed in the specimens in central position. Two types of samples were prepared, one with protective coating and other with protective coating and other without protective coating. These samples are subjected to accelerated corrosion cycle of one day immersion in 3 per cent NaCl solution and 4 days in air (these five days make one cycle) at 27 + 2 C and then these

samples were tested at 10,20,40 and 60 cycle for their bond strength by pull out Text method Bond strength has been measured as per IS:2770 , pull Out Test for Bond Strength in RCC.

3.2 Rate of Corrosion by weight Loss Measurement

Reinforcement bars of 14 to 15 cm in length and 8 mm dia were embedded in Siporex to give effective average 15 mm Siporex cover on all sides while the cover in other specimens are 15 mm on one side and 30-40 mm on the remaining sides. Details of the specimen are shown in Fig.2. Again samples were prepared with two types of bar one with protective coating and one without protective coating. These samples were tested by accelerated corrosion cycle and one cycle consisting of one day immersion in 3 per cent NaCl solution and two days in air at 27+ 2 C and finally o in 2 days in air circulating chamber at 60 C. This one cycle consists of 5 days. After the 10,20,40 and 60 cycles were completed, bars were taken out from the sample, cleaned and weighed for weight loss.

3.3 Salt Spray Text

Sample steel bars of 14/15 cm in length and 8 mm dia were coated with protective anti-corrosive coating, one coat inertol and two coats of ACM and exposed in Salt Spray Chamber along with untreated bars as per ASTM B-117 Salt spray Test and were compared for weight loss after 10, 20 and 30 days.

4.0 RESULTS AND DISCUSSIONS

Results of bond strength by pull Out method weight loss measurements of treated and untreated M.S. reinforcement embedded in Siporex concrete at different cycles of accelerated corrosion tests.

The results are quite encouraging in case of treated samples. No corrosion was seen on the treated steel bars even after 40 cycles, while lot of corrosion was noticed on the untreated bars even after 40 cycles, while lot of corrosion was noticed on the untreated bars even after 10 cycles which goes on increasing with the increase in number of cycles. Weight loss measurements in untreated samples has gone as high as 10 per cent and 40 cycles compared to less than 0.1 per cent in treated samples which is a clear indication of the effectiveness of the coating. In 60 cycles all the untreated bar specimens got corroded and cracked while treated bar samples remain intact (figs. 3 & 4).

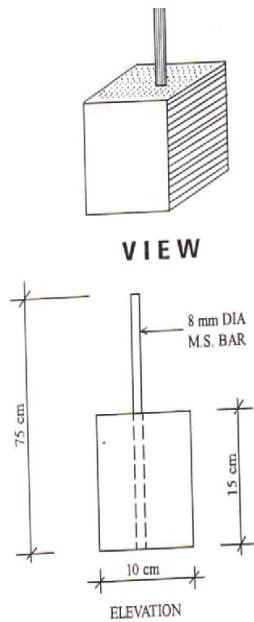
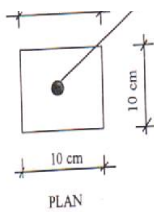


Figure 1 Details of specimen for pullout test



Salt Spray Test results carried out on treated and untreated M.S. bars are given in Table 3 and percent weight loss at different intervals of Salt Spray have been given. It is seen from these results that treated samples show less than 0.01 per cent weight loss in 30 days compared to untreated ones which have shown weight loss as high as 2.4 per cent in 30 days.

It is also observed that protective treatment given to steel reinforcement in Siporex is quite effective compared to corrosion of steel in normal conventional concrete. It can be seen from the results of percentage weight loss in steel reinforcement in normal concrete under similar conditions of cycles as given in table 4.

Trials of Siporex slabs treated with inertol system and used at Bandra and Oshiwara sites at Bombay of Maharashtra Housing & Area Development Authority

works were inspected by removing the siporex concrete cover to the M.S. reinforcement (figs. 5 & 6). It was found that the reinforcement treated with inertol and ACM (Latex + Cement) coating was showing no signs of corrosion and that the Inertol treatment was intact on bars observed after 1 to 2 years of construction. This treatment, therefore, appears to be quite effective in coastal and highly polluted areas like Bombay.

From above results, it is very clear that protective coating given to steel reinforcement in Siporex concrete is highly effective.

Therefore, it is recommended that protective coating (one coat inertol + 2 coat of ACM) applied by Siporex India Limited is highly satisfactory for preventing corrosion of M.S. reinforcement in Siporex concrete in coastal and highly polluted areas

Table-1

Bond Strength of Reinforcement Bars with Siporex Concrete After Accelerated Corrosion Cycles

Number of Corrosion Cycles	Bond Strength of the Untreated Samples	Bond Strength of the Treated Samples
0	13.1	12.6
10	16.3	13.3
20	13.2	15.3
40	13.6	17.1
60	16.2	16.0

Table-2

Corrosion Loss by Weight Change Method

Type of Samples	Concrete Cover Thickness (mm)	% Weight Loss After (Cycles)			
		10	20	40	60
Treated	15 mm cover on all the sides	0.011	0.04	0.094	0.0984
Treated	15 mm cover on one side and 30-40 mm on sides.	0.002	0.06	0.085	0.0997
Untreated	15 mm cover on all sides.	2.2	3.0	8.05	Samples disintegrate
Untreated	15 mm cover on one side and 30-40 mm on other sides.	2.5	3.3	10.00	Samples disintegrate

Table-3

Salt Spray Test

Type of Sample	% Weight Loss After 10 days	% Weight Loss After 20 days	% Weight Loss After 30 days
Treated	0.005	0.007	0.01
Untreated	0.500	1.550	2.40

Table-4

Corrosion of Steel in Conventional Concrete by Accelerated Method

Type of Concrete Samples	Concrete Cover Thickness (mm)	% Weight Loss After (Cycles)		
		10	30	60
1:2:4	15	0.02	0.85	1.3

5.0 Conclusion & Recommendation

Reinforced concrete design must include adequate step for prevention of concrete and rebar corrosion due to a variety of corrodent. Field experience has shown that concrete cover in itself does not provide an adequate solution except in mild exposure. A number of measures are available for corrosion mitigation in design of reinforced concrete. The ultimate solution in design shrinking an optimum balance in developing a cost-effective method for enhancing the safe service life of this structure. The anticipated severity of the corrosive environment will dictates use of one or more of the prevention method.

Cathodic protection system is complex and must be designed by highly qualified personnel specializing in cathodic protection system and corrosion protection. When an existing structure that has somehow become contaminated and where significant steel corrosion is already in progress, the cathodic protection offer an effective way to prolong the service life of the structure.

Corrosion inhibitors are very selective in their performance. Certain brand name products work well in mild to moderate exposures. Actual documented field performance of a corrosion inhibitor must be verified prior to its use.

The protective measures suggested for reinforced concrete are follows

1. A possibly dense mortar or concrete for all structures exposed directly or indirectly to the effect of stack gases.
2. A dense embedding of the reinforcement, especially of the bars lying close to the exposed surface.

3. The reinforcement should preferably be painted with neat cement paste, to which chromium salt has been added.
4. The concrete cover over the outer or bottom bars of the reinforcement should be at least 4 cm thick, disregarding the rendering.
5. Cement of low lime content should be used (blast-furnace cement, addition to tress to Portland cement.)
6. Fresh concrete should be protected against exposure to stack gases.
7. The exposed surface should be painted with inertol.
8. The surface should be treated with fluorides, saturation with lead fluorides especially effective.
9. Other paints, e.g. nitrite, preolith, conserved etc. may also be considered.
10. Prefabricated elements may be okrated .

When the importance of the construction and the severity of service environment so warrant, some additional precautions may be necessary, which follow from the description of what constitutes a critical system given above. Some suggestions include:

- Adopt low water-cement ratio of about 0.4 or below to ensure water-tightness and low permeability. Concrete should, at the same time, be through compact. Adequate cement and use of super plasticiser will help.
- This will also ensure that concrete is of strength grade M35 or M40 and above: a step sometimes recommended to ensure protection against corrosion of reinforcement.
- Provide generous amount of cover to reinforcement. Monitor the actual thickness with a cover meter.
- Insist on prolonged and adequate moist curing with all the emphasis at your command.
- Use of fly ash, slag, silica fume, or blended cements incorporating such additives are

recommended, only if longer moist curing can be assured.

- Now a days special anti-corrosive steel which is green in colour is used in Mumbai and Maharashtra. This green steel is found very effective in corrosion control. Such steel costs Rs. 1507/- to Rs. 200/- more per tonne as compared with cost iron steel. Along with above precautions use of this steel is recommended.

Decrease measures are required to combat desperate situations. Additional protections to steel reinforcement are provided as listed below.

- Galvanizing
- Epoxy coating
- Cathodic protection
- Corrosion inhibitors
- Removal of chloride ions by ion exchange or realkalisation.
- Use of stainless steel or non-metallic reinforcement like glass reinforced plastics.

These measures have sometimes been adopted to avoid distress due to corrosion of reinforcement.

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