Effect of impact blows on corrosion of steel in concrete

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While driving precast concrete piles, severe impact blows are imparted on the head of the piles and this dynamic force leads to the formation of micro and macro cracks in concrete. Due to the presence of these cracks, the concrete may become more permeable and corrosion of the embedded rebars is likely to be enhanced. In this paper, it is shown that corrosion rate increases steeply with the number of impact blows on the concrete specimens. It is also shown that corrosion resistance of concrete piles can be improved by suitable protective coating.

Key words: Concrete, impact blows, steel corrosion, protective coating

INTRODUCTION

Microcracking is a phenomenon observed in concrete even during the process of setting and hardening. The main causative factors are rapid evaporation of water leading to shrinkage, differential settlement around steel or aggregate, segregation, faulty compaction, local bleeding etc. Apart from these, microcracks are also formed when the concrete structural member is subjected to dynamic loading conditions. In the case of precast concrete piles, the driving operation itself involves imparting impact blows on the head of the piles and these impact blows will produce larger amount of microcracks. These cracks not only increase the porosity but also act as nuclei of fracture points.

Considerable studies have been made on the effect of microcracking on the deformation and strength of the concrete [1–3]. When these cracks coalesce to form continuous crack patterns, the porosity of the concrete increases making it more permeable. In view of the above, a precast concrete driven pile may be expected to be internally permeable. Very little work seems to have been done on the corrosion behaviour of precast concrete piles in spite of the fact that these piles may contain numerous micro and macrocracks. In this paper, corrosion of steel embedded in M40 grade concrete has been studied under varied impact blows. Protective schemes have been evaluated on such concrete specimens subjected to severe impact blows.

EXPERIMENTAL

Six mm dia, 70 mm long mild steel rods were mechanically polished, degreased and weighed before use. The bars were embedded in 100 mm cube of M40 grade concrete with a cover of 15 mm.

The concrete cubes after curing in deionized water for 28 days were subjected to specified number of blows using a miniature drop hammer system. Then the cubes were subjected to alternate wetting in 3% NaCl solution and drying in air for a period of 60 days. At the end of 60 days, the rebars were removed and corrosion assessed by weight loss measurement.

TABLE–I: Relationship between impact blows on concrete specimens and weight loss of embedded steel

Sl.No.	No. of blows	Weight loss (mgs)
1.	Zero	2.3 ± 0.1
2.	100	4.8 ± 1.6
3.	500	3.1 ± 1.6
4.	1000	25.7 ± 1.0
5.	1500	56.7 ± 0.9

In another set of experiments, cured reinforced concrete specimens were given the specified protective coatings. After air curing, the coated specimens were given 2000 impact blows. Thereafter they were subjected to alternate wetting in 3% NaCl solution and air drying for 60 days.

RESULTS AND DISCUSSION

Effect of impact blows on corrosion

The number of impact blows vs weight loss data are given in Table I. It can be clearly seen that up to 500 blows no significant difference in weight loss is observed. However weight loss is found to increase steeply when the number of impact blows is 1000 and above. It can be inferred that coalescence of microcracks to form continuous crack pattern is perhaps occurring when the impact blows exceed 1000. It is interesting to note that weight loss increases by a factor of about 20 when the impact blows are increased from 500 to 1500.

Evaluation of protective coatings

The weight loss data for different protective schemes are given in Table II. It is significant to note that different protective schemes can give different weight loss value. One epoxy base system and two polyurethane base systems are showing the minimum weight loss, which is only about one twentieth of that obtained for uncoated control specimens subject to 1500 blows. By this, it can be inferred that these effective protective systems are able to bridge the micro/macro cracks formed in the specimen and act as effective barrier. These coatings are obviously able to withstand the severe impact blows without any deformation.

CONCLUSION

It is shown that the impact blows can significantly increase the corrosion of steel embedded in concrete. It is also shown that the different protective schemes can give varied performance under impact blows and it is possible to identify the top performer.

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TABLE–II: Evaluation of coatings on concrete subjected to impact blows

Sl.No.	Protective system	Weight loss (mgs)
1.	Epoxy system - 1	2.35 ± 1.0
2.	Polyurethane system - 1	3.00 ± 3.00
3.	Polyurethane system - 2	3.00 ± 3.0
4.	Epoxy system - 2	6.00 ± 1.0
5.	Epoxy system - 3	24.00 ± 4.0

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