# CASE STUDY

5

## Rehabilitation of Durgapur Chemical Factory

Built to last

At Durgapur, once called Rurh of India, was established Durgapur Chemical Limited, one of the largest chemical factories in India in sixties. The concrete shell structure for the caustic chlorine plant was a unique structure of its type at that time. In the sixties one could seldom find such a gigantic shell structure with such; intricate design and aesthetic beauty. But due to various reasons and due to absence of systematic & scientific maintenance, the reinforcements were totally corroded.

The structural stability was in question and ultimately the plant remained non-operative. However, as a rehabilitation programme, the Government of West Bengal decided to run the plant and sanctioned funds for the rehabilitation of both the caustic chlorine plant and monochlorobenze plant.

Before the actual rehabilitation work was taken up, D.C.L Authority engaged I.I.T. Kharagpur to assess the degree of deterioration by conducting non-destructive testing of concrete such as ultrasonic pulse velocity, rebound hammer test, chloride penetration test and corrosion of reinforcements. On the basis of preliminary investigations by IIT, M/s. S.P. Banerjee & Associates were appointed as consultant for finalising the basic repair scheme, selection of construction chemicals and the tender specification.

On the basis of the repairing scheme, only few specialised contractors having sufficient infra-structures to undertake such a huge repairing work and who had in-house facilities for manufacturing various construction chemicals required for rehabilitation were selected. After a detailed study, **CICO** was selected for undertaking repair and rehabilitation work, which can be considered as the largest rehabilitation work were selected of an industrial structure in eastern India, perhaps even in India. Basics Repairing Scheme

1. As the main-reinforcements of columns and beams were severely corroded and the stirrup reinforcement was missing at many places, property designed supporting structures were erected to transfer the load to the supporting structures.
2. Appalled, cracked and any bad concrete was removed by mechanical as well as manual methods.
3. Neutralization of acid affected concrete by means of alkaline solution and / or high water gel was done to bring PH to more than 7.0
4. Corroded reinforcements were cleaned thoroughly by means of sand blasting, scrubbing, wire-brushing and rubbing with Emery paper.
5. 4 angles, one at each corner were fixed and stirrups at a spacing as per design requirement were welded to the angles.
6. New main reinforcements were placed wherever required to form a new reinforcement cage.
7. Polymer based anti-corrosive paints. "**Tapecrete Marine Coating**" was applied on the reinforcement as a corrosion inhibitor.
8. Epoxy based bonding agent - "**CICO BOND EPO**" was applied on old concrete to have proper bond between old and new concrete.
9. Properly designed shutters were placed for final concreting. The design of Shuttering was done in such a way that fixing of shuttering could be completed within 45-60 minutes after application of bonding agent which is the open time of the Epoxy product used.
10. Concrete mix-proportion with specially made **CICO Superplasticiser** and **CICO Tapecrete**

**Polymer** was selected in such a way that a flow concrete with low w/c ratio of 0.36 was achieved. Highly cohesive flow concrete was selected, as no needle vibrator or surface vibrator could be used.

## Actual Concreting Work

For long term durability i.e. to prolong the life expectancy of the structure for 25 years, the design of polymer concrete was a Herculean task. To withstand both acidic and highly alkaline environment from caustic and monoshlorobenzene plant the polymer loading was selected in such a way that it could be withstand the above mentioned aggressive environment and at the same time give sufficient compressive strength for the progress of the work. In the concrete testing laboratory various mix-designs were conducted with the following variability:

1. Cement Content - 380 to 500 kg per cu.m
2. W/C ratio - 0.35 to 0.40 with superplasticiser of varying doses so that slump in the range of 170 to 200 mm is achieved.
3. Polymer Loading - From 10% to 22% by weight of cement.

From durability point of view, Durgapur slag cement was supposed to be used for total rehabilitation work. However, as the early strength of slag cement was less, the progress was slow. Since the whole job was completed in nine months, Caustic Chlorine plant supposed to be handed over within four months for operational purpose, ultimately L & T OPC cement were used for faster progress.

To determine the effect of both alkaline and acidic environment, concrete cubes were cast with various polymer loading as mentioned above and soaking cloth wrapped around the concrete in 20% of HCL solution and benzene. The cubes were immersed alternatively in HCL and benzene and dried and wetted alternatively.

As there is no standard test to determine the effect of acidic and highly alkaline environment on reinforcement, the reinforced concrete were subject to severe aggressive environment as mentioned earlier. After the completion of the test the reinforcement corrosion was tested and compared with those reinforcements which were not subjected to alternate acidic and alkaline environment as mentioned above. From various polymer loading was best, as at higher polymer loading the reduction in compressive strength was appreciable.

## Concluding Remarks

1. It was possible to change and select correct materials and methodology for repair in the short time due to close monitoring of the product.
2. A good R&D Laboratory within house construction chemicals proved to be beneficial for such type of rehabilitation work.
3. Practical knowledge of Structural stability is a must for the site engineers to avoid any catastrophe.
4. A highly skilled foreman, carpenter and mason with basic knowledge of good quality workmanship can give the best end results.