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Conditional Assessment of a Jetty In Mumbai Harbor.

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Abstract - this paper describes the rehabilitation on of jetty in Mumbai harbour. The structure was constructed in early 1990's and there were no as such drawings of jetty structure available. The jetty was in a deteriorated state and as a apart of audit inspection a very thorough investigation was carried out to determine the state of deterioration and to developed a design for rehabilitation thereof. From the investigations it was found that the concrete used for jetty was of high quality and the cover depths to most areas exceeded 50 mm. however some parts of structure suffer severe chloride contamination, corrosion to reinforcement, spalling of concrete etc. over years the repairs provided have been deteriorated and are now unworthy to offer any protection to structure. The methods proposed are to be employed to rehabilitate jetty patch repair, recasting of the structural areas, replacement of reinforcement etc.

Key Words: *concrete deterioration, distress, corrosion to reinforcement, chloride induced corrosion, spalling of concrete, rebar corrosion, delamination.*

1.INTRODUCTION

Mumbai Harbor is considered to be one of the largest ports in India handling more than 50% of cargo container access to all ports in India. the site is located approximately 50kms south of Mumbai, Maharashtra. The jetty is been used for imports and exports of goods internationally. The structure under reference is existing deck on cluster of RCC piles, pile muffs and beams. The jetty shows extensive corrosion of reinforcement, cracking and spalling of beam concrete damage to existing concrete gunite, corrosion marks in gunite etc. other areas where previous repairs were carried out also showed signs of deterioration.

2. Description of structure.

The structure under reference consists of one main jetty structure and four numbers of approach trestles and existing deck on cluster of RCC piles, pile muffs and beams. The total length of berth is 680 m long. The was constructed in two parts. The original berth was 530m long whereas as new existing wharf is of 150m summing up to a total length of 680m.

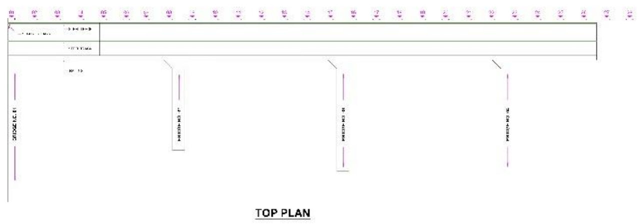

Figure 2 Jetty Layout

The section of jetty consist cross section consist of 375 mm thick reinforced slab (250 mm precast,150mm cast-in-situ and 75mm overlay) resting on 1500 mm deep primary beams.

Supporting the primary beams are secondary beams 1.00m x 1.00m in cross section. The total width of jetty is 45m including 1.5m width of service area. The piles are spaced 5.40 m along the length of jetty and 5.00m along the width of wharf area. The beams rest on pile muffs 1.50m x 1.50m which are supported by piles of 750mm diameter.

The section of approach bridges consists of slab of same cross section as of jetty. These slabs rest on primary beams of 1.00m depth. Secondary beams consist of 0.75m x 0.75m cross section resting on pile muffs of 1.40m x 1.40m which in turn are supported by piles of 0.90m diameter piles. The width of approach trestles is 15m and the piles are spaced 5m along and across the section.

3. Details on Distress

3.1 General Condition of Concrete.

Laboratory testing concluded that the matrix of concrete was found to be dense, well compacted and well graded with insignificant amount of carbonation. However, the concrete showed higher amount of chloride

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contamination. This was higher especially in case of beams.

3.2 Damage Related from Alkali Aggregate Reaction.
The aggregate used is identified as basalt. The extracted core shows very insignificant amount reaction. Considering the age of structure, it is not likely to cause any more damage to structure.

3.3 Deck Slab
The overlay of deck slab shows severe deterioration and cracking. Map cracks are formed at various places. Also the expansion joints are completely worn out. The joints need to be filled with proper filler material. The following figure shows map cracking and exposed.

Figure 3- Worn Out Expansion Joints

Figure 4- Map Cracking In Overlay

3.4 Deck Slab Soffit and Beams.
The average depth of cover of beam observed was 50 mm in both horizontal and vertical direction and depth of cover for slab was in between 30mm to 40mm.
Some portions of slabs and beams were heavily contaminated with chlorides which went beyond the level of reinforcement.
Such portions showed large cracks, corrosion of reinforcement, delamination and spalling of concrete. The survey showed that fender slabs and soffits of beams were more susceptible to such damage. These were areas that showed reduction in reinforcement greater than 40% and in some area reinforcement steel was snapped indicating higher rate of corrosion. Presence of distress in areas subjected to alternate wetting and drying process. These are the areas that needs urgent attention and should be rehabilitated as soon as possible. Following distress are shown below

Figure 5- Snapped Reinforcement Of Fender Slab

Figure 6- Corrosion In Beam Soffits

3.5 Piles
The cover depth for piles was in between 50mm to 60mm.
The liners of pile showed heavy corrosion damage and heavy growth of sea vegetation was noted on piles. the measurements taken suggested that piles are to be subjected to reinforcement corrosion and it is occurring even though piles are not showing any visible damages

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like spalling or delamination of concrete. However, when these piles subjected to hammer test, the hammer sound did not indicate delamination of piles. Pile muffs showed corrosion cracks and corrosion marks.

Figure 7- Pile with Damaged Liner

3.6 Fenders
The joints of fenders shown corrosion at the surface. Old wooden fenders at some locations need to be replaced with new rubber fenders. The slabs supporting fenders showed honeycombing at many places

Figure 9- Damaged Fender

3.7 Gunite Repairs Previously Applied.
Gunite applied for previous layer was in varying thickness. At various locations shrinkage cracks were seen on gunite. The failure of gunite was most predominantly seen at the soffits of beams. Vertical faces of beams also showed significant failure of gunite. The gunite reinforcement mesh was also exposed at various places

Figure 10- Failure Of Gunite At Soffit Of Beam And Exposed Wire Mesh

4.0 Repair Strategy

1. Identifying and categorizing the elements on basis of urgency of repairs required. Preparing distress maps for the same
2. Preparation of rough surface by breaking/chipping off the loose delaminated concrete without damaging the existing concrete by means of sharp chisels or high frequency low impact hammers.
3. Removing corrosion of the steel by suitable means, applying anti-rust paints and rebaring it with existing steel.
4. Depending upon the conditions select the method of repair like grouting, guniting, micro-concrete etc. in accordance with formwork required.
5. Install sacrificial anodes to reduce corrosion rate at regular intervals
6. Apply layers of anti-carbonation paints or water repellent paints to the finished surface

5.0 Conclusion

Marine conditions are the most aggressive conditions subjected to reinforced concrete. The JNPT jetty revealed several distresses to the structures liked spalling of concrete exposed corroded steel. The primary reason for distress can be summarized as chloride ion contamination in concrete. The audit in this paper are conducted with help of concrete specialist and rehabilitation proposed by designer.it is believed that with proper monitoring and regularly maintenance the life of structure can be increased to great extent.

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