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# Distress Assessment of a jetty after *Tauktae*-2021

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**ABSTRACT:** Piles are long, thin, columnar features commonly utilized in shoreline constructions. This was disrupted for a variety of reasons. Natural disasters such as cyclones, tsunamis, and other natural disasters are some of the most common sources of suffering in the environment. The major focus of this research is on visual assessment of a jetty in order to assess its structural health after the impact of cyclone *Tauktae* in 2021 which hit western coast of India. A part of jetty has been collapsed and structural audit of remaining part is to be done for performance. Marine environments are the most difficult for reinforced concrete to withstand. The jetty showed various structural flaws, including concrete spalling and exposing rusted steel. The audit in this article was carried out with the assistance of a concrete specialist and the designer's suggested restoration methodologies.

**KEYWORDS:** Challenges in piling, auditing piles, maintenance of piles

## I. INTRODUCTION

India is a country where the construction is trending more and more due to the urbanization, but the structures built centuries ago are also the shelter of mankind of which some building has developed the extreme damage and such buildings can cause a sudden collapse causing a major threat to human lives and economy. So as to prevent the hazard, prediction of the structure life can be useful. Many auditing techniques have been developed so far to give precise results. But their implementation on time is necessary.

India witnessed cyclone *tauuktae* in 2021 to its Arabian Sea coastal area and especially extreme severe in Gujarat and Maharashtra Region. The concerned jetty being located in Gujrat got extremely damaged (fig 1.1). It was a 1500 m X 300 m jetty with approach trestles. It had a triangular section (shown in fig 1.2). Due to highly turbulent wind waves it got collapsed causing serious damage to the un-collapsed structure. But due to vibration transfer along with the cyclonic air structure has been partially collapsed and partially intact with visible damages and cracks shown in figures below.

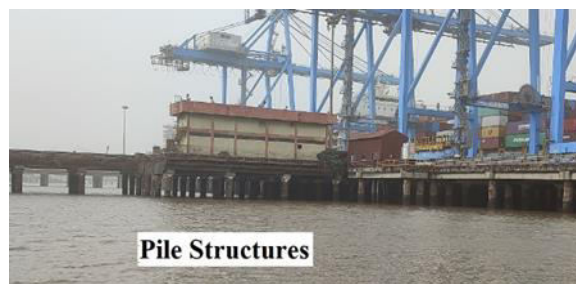


Fig 1.1 A Typical Pile Structure

The main of the study is to inspect the jetty visually to understand the strength status of the part of jetty left un-collapsed for regular use as the structure is subjected to heavy and dynamic loads. But due to reduction in strength caused by damages, it can lead to some serious issues resulting in economical and loss of human lives. The jetty is primarily used for cement manufacturing which includes heavy load transfer throughout the day and night and therefore need to be taken care of.

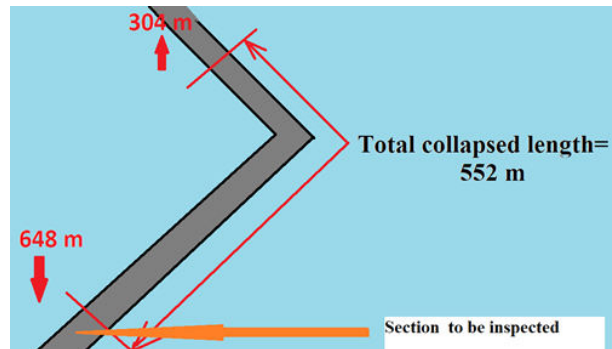
## II. VISUAL INSPECTION

For carrying structural audit the first step is to carry out visual inspection of the site by experienced project engineers and technician's team to assess the extent of damages occurred. Structure has to be mapped and measured for all its dimension for better understanding and deciding repair strategies for the structure. Followings are the findings by the team.

### A. Dimensions of the structure

The structure under reference consist of one main jetty structure and an approach trestles and existing deck on cluster of RCC piles, pile muffs and beams. The total length of berth used to be 1500 m long but now a length of 648 m is left. 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.



**Fig 1.2 Line diagram showing position of jetty**

The section of Approach Bridge consist of slab of same cross section as of jetty. These slabs rest on primary beams of 1.00m depth. Secondary beams are 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.

### B. Visual damages encountered on site

Following shows damages to the structures, which includes damages to pavement on jetty and approach trestles as shown in fig 1.3. Poor patchwork has been shown on several locations.



**Fig 1.3 Damaged pavements**



**Fig 1.4 Damaged expansion joint**

Sudden jerks, accidents, impact by water vehicles are also responsible for damages in the structures along with sudden and turbulent wind waves which breaks the piles or births which disturbs the stability and intactibility of the strcutre resulting in infunctionality of the strucutre. (Fig 1.7). Photograph shows the same kind of damages.





**Fig 1.5 Damaged side walk**

Small pores may lead to severe cracks and corrosion of the steel in the concrete as water percolates through. Which in turn provides better environment to the corrosion of steel. It is evidenced from site that there may be presence of percolating water up to the steel which is corroding steel resulting in increase in volume of steel and causing bulging of concrete in fig 1.6.



**Fig 1.6 Bulging of concrete**

Not following IS codes, under-estimating the load, not considering load factor, etc. can contribute to the reduction in strength of the structure. Negligence during construction process can also lead to loss of strength of piles. Thus, it is very necessary to design and construction of the structure should have utmost importance.



**Fig 1.7 Spalling of cover-Crete**

Due to bulging of concrete, weakens the cover to the reinforcement and spalling simultaneously (fig 1.7) which exposes the reinforcement to the saline environment which further speeds up the rate of corrosion. Exposure of the reinforced was also seen on the field as shown in fig 1.8.



Fig 1.8 Exposure of steel 1.9 Corrosion on piles

### III. ANALYSIS OF DAMAGES & RECOMMENDATIONS

Analysis is done on the basis of photographs and visual inspections report to account extent of damage and disrupted occurred. Map cracking, crazing, spalling of concrete, exposure of reinforcement, expansion and contraction joints assessments, etc. are checked and their categorization is done accordingly. Analysis is headed by experienced project manager and on the basis of analysis, recommendations are suggested. The jetty shows various damages as shown in chapter I, after the analysis phase, the team provided following recommendations:

1. Identifying and classifying the pieces according to the need for repairs. Distress maps are being prepared for the same.
2. Using sharp chisels or high frequency low impact hammers, prepare the rough surface by breaking/chipping off the loose delaminated concrete without injuring the existing concrete.
3. Using appropriate methods to remove corrosion from the steel, adding anti-rust coatings, and rebaring it with existing steel.
4. Determine the best technique of repair, such as grouting, guniting, or micro-concreting, based on the circumstances and the amount of formwork necessary.
5. Install sacrificial anodes at regular intervals to slow down corrosion.
6. Paint the completed surface with anti-carbonation or water resistant paints in layers.

### IV. CONCLUSION

Natural calamities like Cyclones, Storms, Tsunamis, etc. can contribute to damage and disruptions caused to structure. This may damage the structure severely giving rise to cracks and crazing which may further turn out to be major problem. Over a period of time piles may deflect and reasons may be any. If damage extends exceeds a certain limit set by Indian Standards, it may cause fatal accidents causing loss of lives and economy simultaneously. Performing structural audits regularly helps to maintain health of the structure. The assessment concludes that the jetty has been severely damaged and needed repairs for some part of jetty and for the extremely damaged part it is suggested to go for further testings like rebound hammer and UPV testing. On the basis of the results obtained through the testings further recommendations will be given.

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