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Challenges in Maintaining and Checking Verticality of Piles

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Abstract: *Pile driving and maintaining the alignment of piles during its life span can be most erroneous jobs in construction industry. Slight deflection in piles alignment causes a major damage to the whole structure as it affect the group efficiency. Pile foundation is widely used in marine structures due to its stability and long-term durability. However, in pile structures many factors causes the misalignment of the pile which leads to major haphazard and accidents due to loss of strength. Thus, a research should be conducted to identify issues in maintaining alignment of piles at waterfront development. This paper covers a wide range of problems associated, in brief associated with pile verticality and problems in measuring the eccentricity which will lead to find exact solutions needed.*

Keywords: Challenges in pile operations, verticality of piles, maintenance of piles

I. INTRODUCTION

There are several issues encountered during construction of pile foundation which leads to cause deficiency in the capacity of the pile unless they tackled properly. This paper deals with enlisting challenges during driving operations and service period of piles and in maintenance period also in three sections which enables us to rethink for the precise solution.

1.1 Challenges During Driving Operation

A. Buckling of pile tip

When the pile doesn't reach its target penetration depth and so the anticipated design can longer apply. This occurs with steel piles, in both onshore and offshore projects due to their diameter and wall thickness, which can make them more susceptible to pile tip buckling as they're driven into hard soils or soils with an unexpected structure (like rock layers or boulders). Carrying out numerical analysis to simulate the buckling conditions can lower the construction risk considerably.

B. Integrity of pile

Whether you're driving a concrete or a steel pile, damage can occur along the pile shaft including cracks and other anomalies. If the integrity of the pile is damaged, it's likely to cause problems with the remaining structure installation.

Pile driving monitoring and specifically using fibre optic sensors, is a reliable method of monitoring the integrity of an entire pile. When compared to standard pile driving monitoring which only provides an estimate of the distribution of resistance along the shaft, fibre optic sensors allow stresses to be measured during driving over the entire length of the pile, providing more accurate results from top to bottom to help inform the installation process.

C. Pile Driving Out of Alignment

When piles move out of alignment tolerance, it is often due to control issues with hammer-pile alignment or to soil conditions. If due to poor hammer-pile alignment control, a pile gate, template, or fixed lead system may improve the ability to maintain alignment tolerance. Soil conditions, such as near-surface obstructions or steeply sloping bedrock

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having minimal overburden material, can also disrupt alignment.

D. Piles Are Driving Out of Location

Piles that shift locations out of accepted tolerance can also be caused by problems with hammer-pile alignment control or due to soil obstructions. If due to poor hammer-pile alignment control, a pile gate, template, or fixed lead system may improve the ability to maintain location tolerance.

For piles encountering shallow obstructions, excavation/removal of the obstruction is probably feasible if the obstructions are within 3 feet of working grade. If the obstructions are at deeper depth or below the water table, or if the soil is contaminated, excavation may not be feasible. In these cases, spudding or predrilling of pile locations may provide a solution.

E. Deep Pile Obstructions Are Encountered

If deep obstructions are encountered during driving, contact the engineer for remedial design. Ultimate bearing capacity of piles hitting obstructions will need to be reduced based on pile damage potential and soil matrix support characteristics. Additional piles may be necessary to compensate.

F. No Hammer That Meets Driving Stress and Resistance Limits.

When there is no hammer available that matches the driving stress and resistance limits required by the wave analysis, both the calculated stresses and blow counts on the piles may be too high. When this is the case, you can Increase the pile impedance or material strength, or redesign for lower capacities. If the soil is fine-grained or known to exhibit setup gains after driving, the end-of-driving capacity may be selected to be lower than required. Confirm the capacity by restrike testing or static load testing.

G. Adjacent Ground

Adjacent settlement is caused by vibrations in sandy soil during driving piles. Sinking holes of bored piles in soft clay of water bearing sand is another cause of adjacent settlement of buildings. Such problem can be noticed by checking level of buildings or ground before and during pile construction. Lastly adjacent ground or structural settlement may be declined or minimized by keeping head of water in the casing during boring piles. Added to that, site engineer may select suitable solution for the problem.

1.2 Challenges During Service Period

During the service period of piles it may get deflected. Deflecting factors may be any of following. But it deteriorates the structure resulting in poor pile performance.

A. Sudden Impact

Sudden jerks, accidents, impact by water vehicles damages the structures abruptly and breaks the piles or births which distrurbs the stability and intactibility of the strcutre resulting in infunctionality of the strucutre.

B. Poor Design and Construction Practices

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 ut-most importance.

C. Nearby Underground Construction

Construction activities in nearby area of the pile strcture may hamper its instability. As the undistrurbedness of the soil beneath gets affected. If sufficient care isnt taken it may cause partial deflection, settlement or sudden collapse of the stucutre.

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D. Natural Calamities

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.

E. Challenges in Checking Eccentricity

Over a period a time piles may deflect and reasons may be any. If eccentricity exceeds a certain limit set by Indian Standards, it may cause fatal accidents causing loss of lives and and economy simultaneously. Therefore, in order to avoid this, along with other structural auditing techniques, verticality assessments must be carried once in a while for maintenance.

F. Tidal and Wavy Nature of Water Body

Going for the equipment's like, theodolite and total station. But one can't mount the equipment's on the boat and work effortlessly, because there's a tidal-wavy circumstances which will cause hindrance to the work. Various equipment's requires a firm stable ground surface which will provide a greater stability and maintain a smooth flow of job. But tidal situations may impede the job.

Using the equipment on the ground near to the structure won't work as it may not cover the whole jetty piles from a large distance. Therefore there arises a need of an equipment which will cover all the piles in one go and whose work won't get hampered by the tidal nature.

G. Nature of Structure

Pile structure being a massive structure in middle of water body is not similar as compared to normal residential and ground based structure. Pile structures are essentially designed to carry heavier loads and that of dynamic loads too. Therefore the structure is heavier itself and that on saturated soil to cause less skin friction and rests on hard strata available deeper. It needs special construction process and needs special care to be taken of.

Fig 1.1 A Typical Pile Structure

1.3 Limitations of Conventional Instruments

One can't use conventional plum bob and piano string. These instrumentations have become obsolete for the new generation problems.

Fig 1.2 Conventional Instruments

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Now, moving for the advancements in the technology because we are in the era of internet of things, as photogrammetry and LIDAR. Both are much similar , but differs in working principle, one works by overlapping photographs using camera and other works using laser light. The difference between this two is that photogrammetry can't penetrate through denser area as deep as the LIDAR can! Therefore LIDAR was selected as means for carrying out experimentation.

Lengthy Calculations

For analytical methods which uses lengthy calculation may consume time and can give results with least precision. This kind of calculation include uses of profile rings [1]. In this one profile ring is selected to be the datum and their geometric centres are compared. If there occurs any offset, it will be computed for the divergence of each profile ring centre. Also in other method it uses analytical and mathematical lengthy calculations to extract eccentricity which is in turn is impractical way. It consumes time and results may vary as field situation may differ.

II. CONCLUSION

From all of above discussion we can arrive at a conclusion that, pile structure being a massive structure and preferred for almost every water front structure. Despite all of this pros it serves, its maintenance is high and if not taken care of it's verticality and eccentricity is kept as minimum as possible it a may cause fatality causing life and economic losses. It's not an easy task to measure the eccentricity by using obsolete equipment's and lengthy calculation .it gives rise to have an equipment to give results in minimum time and highest precision. The further part of this provides solution for the problem.

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