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Geotechnical Investigation at A Typical Approach Jetty and Intake Well Located Offshore

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Abstract. The paper presents some of the challenges faced to conduct the geotechnical investigation along the proposed approach jetty and Intake Well located Off Shore. The Intake well is located in East Coast about 30 nautical miles from the nearest sea port and about 800m from the shore. The dia of proposed intake is about 21 m . The approach jetty is proposed to be supported on piles. The location of the Intake in the sea has been arrived based on the Hydrographic and oceanographic studies and required water head . Detailed geotechnical investigation has been carried out along the approach Jetty and at the Intake well location.Few major challenges were encountered during geotechnical investigation ,collecting sample in intake well at 30.0m depth in sea and to conduct pile load test.in Off shore.One of the challenge was insufficient draft for the boat to access to various geotechnical locations coupled with tidal waves and currents changing every two hours and difficulty in breaking zone. Another major challenge was collecting block sample physically from bottom of Intake well with potential head difference of 30.0m This paper presents various measures taken to overcome the above challenges During investigation. Based on the properties of substrata ,the termination depth of Intake well and bored cast in-situ RCC piles socketed in rock, and socket length in rock has been estimated. Conducting Initial pile load test in breaking zone was another major challenge. To meet the above challenge a simulated initial pile load test was conducted on shore .The methodology adopted and the results are also presented in this paper. Based on the successful test results the same is adopted in the design and successfully executed.
Keywords: Challenges faced during Offshore geotechnical investigation, termination criteria for intake well and rock socket pile , simulated pile load test .

1 Introduction

1.1 Approach jetty and intake well

To make up the water requirements of the typical power plant a pump house is proposed to be constructed in mid sea. For this purpose an Intake well with inbuilt from sea . To support the inlet and discharge pipes in the sea from pump house to shore an approach jetty with deck slab supported on piles was proposed .An abutment was also provided at the shore and the length of Jetty from the shore/abutment to the In-

take well was about 800m. Each bent of the jetty was 48.0m. The sketch of the plan and elevation of approach jetty is shown in figure1 .

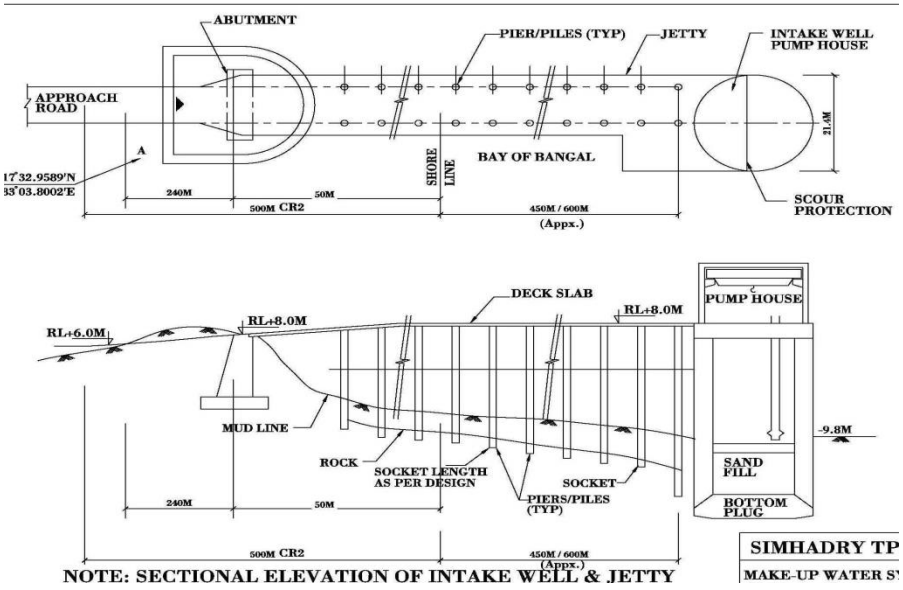

Fig.1. Sectional elevation of the approach Jetty and Intake well.

The typical sectional detail of approach jetty is shown in fig2. The approach comprised of 12.0m RCC deck slab and 5 nos of inlet and discharge pipes and an inspection road for maintenance.

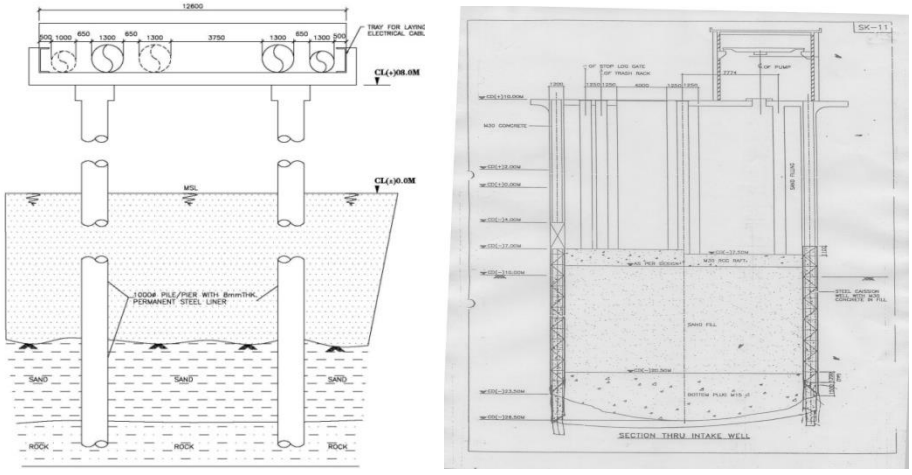

Fig. 2. Typical section on the Jetty and intake well..

Many major challenges were encountered during geotechnical investigation and execution.In this paper three major challenges only are presented. One of the challege was to access the off shore borehole location due to tidal waves and currents. Another major challenge was collecting block sample of rock physically from bottom of Intake well with potential head difference of 30.0m wherein blasting was prohibited. Conducting Initial pile load test in breaking zone was another major challenge. The dia of Intake well was about 21m and steining thickness about 1.2m. A provision of 12 nos of annular space was kept within the steining thickness for cables anchored into rock. Based on the Hydrographic , oceanographic, model studies, required water requirements the location of Intake well in the sea was identified at about 800m from the shore and 30 Nautical miles from the sea port . The location of the Intake well in the sea , the Hydrographic , oceanographic, model studies, required water head ,the shape, size, loading details ,fabrication of steining, towing of caisson from the yard to the intended location etc are beyond this paper

2 Geotechnical Investigation

2.1 Approach jetty

The detailed geotechnical investigation along approach jetty location consisted of 13 bore holes . One borehole at each bent location and five boreholes at intake location. Dia of bore hole was 150mm using double tube coring in rock with hydraulic feed. SPT was conducted at regular depth interval within the bore hole.The termination of each bore hole was based on meeting specified percentage of RQD. One of the challenges faced was to access the location of the intake well and installing the rig for geotechnical investigation due to high tidal variation and strong currents. The problem got aggravated in the breaking zone which was about 200m from shore . The existing facility of the fixed jack up platform meant for execution was utilised for installing the rigs for investigation. Due to insufficient draft from the shore at this location the access was thru a motorized boat from the sea port. The typical rig for GTI on the jackup is shown in figure 3.

Fig. 3. Hydraulic rig for geotechnical investigation on Jack up platform .

2.2Sub Strata Profile along approach Jetty

Thirteen bore holes at a spacing of about 50m centre to centre distance was carried out along approach jetty. . Bore hole depth was carried out upto 5 m in rock with RQD more than 50% .. The sea bed from chart datum was varying from 0.0 m at shore end to about 12 to 15m towards sea side along the jetty. The sub strata consisted of Silty Sand underlain by highly weathered khondolonite rock and moderately weathered rock up to termination depth of borehole. The depth to rock was undulating below sea bed. The variation of the sub strata along the approach jetty is presented in figure4.

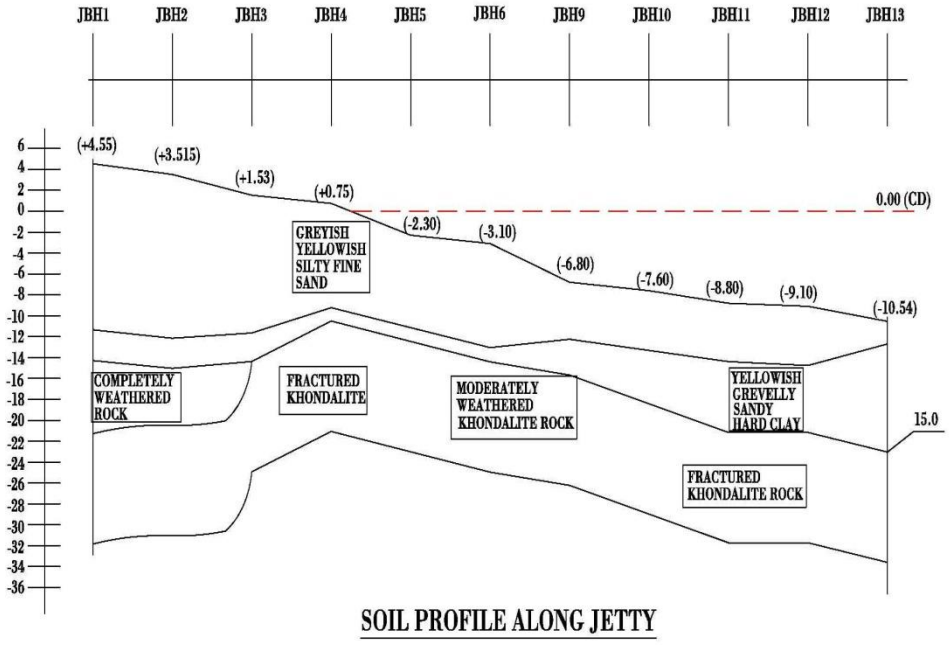

Fig. 4. Soil Profile along approach jetty

2.3 Sub strata profile at intake well

Four bore holes were done along the perimeter of the intake and one borehole at the centre of intake. While One of the challenge during coring the core was getting crumbled . This may be due to presence of plastic clay sand witched in the crown of the rock. To overcome the above ,coring by triple tube core barrel was introduced. This enabled to identify the presence of plastic clay in the rock mass. The stratum 10.m below Chart Datum (CD) comprises of medium sand underlain by dense silty sand thickness varying from 2 to 5m .This is underlain by stiff clay with pebbles

sandwitched with cemented sand 2 to 4m .This is underlain by highly weathered rock of varying thickness 3 to 7m and moderately weathered rock upto depth of investigation.The soil profile at the Intake well is presented in figure 5. The well is proposed to be terminated in weathered rock having required UCS .

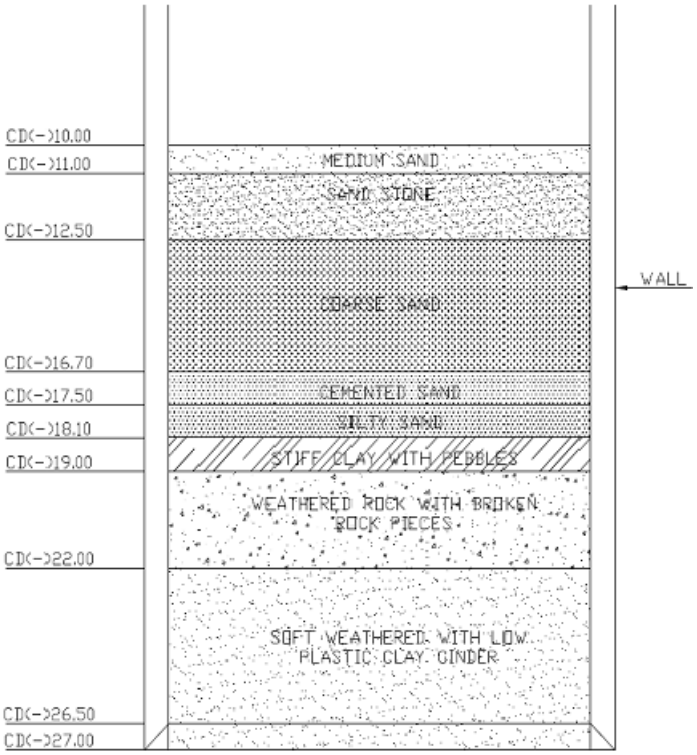

Fig. 5. Soil profile at In take well location

To confirm the strata rock parameters ,during execution the rock mass samples were collected while sinking the caisson and tested at laboratory to establish the well termination level and the well was at 27.6m below (CD) .

The cutting edge of the caisson steining and the rock anchor thru the steining of well is shown in figure 6. The rock strata and jointing pattern as obtained during investigation matches with the strata during execution . In view of presence of joints within rock mass one has to be careful in dewatering since water may gush through the jointsmaking unsafe condition at the termination of Intake well.

Fig.6. Rocky strata at Intake well location

To obtain the strata even in jointed rock, tripe tube core barrel was introduced. Rock cores were tested for uniaxial compressive strength (UCS). Based on the test results the well is proposed to be terminated in moderately weathered khondonolite stratum. However various factors like shape, water depth, forces, scour, effect due to sea quake etc. were accounted while arriving at termination depth, which are beyond the present paper.

3 Simulated Initial Pile load test

3.1 RCC bored cast in-situ pile

The approach Jetty was proposed to be supported on piles. Based on the properties of substrata , bored cast in-situ RCC piles socketed in rock, was proposed. The dia meter of pile, capacities were based on the project requirements. Pile dia 1000mm and 1200mm were considered .The estimated vertical capacity of 1000mm dia was 330t

Free standing length of pile is about 18m.Criteria for termination of pile was to find the rock touch level of required UCS value. Based on the core strength of the rock mass the socket length of pile in rock is estimated as per Indian Standard. For design purpose the socket length estimated was 5D for off shore and3D for on shore for rock mass having UCS 60 – 70 ksc .Where D is the diameter of the pile. The construction

material, cement type , concrete grade , water cement ratio , reinforcement, additional cover to reinforcement was as per chemical content present in sea water . Sacrificial MS liner was also provided to the pile upto rock .

To confirm the estimated pile capacity initial pile load test was required to be conducted for On shore and Off Shore piles. One of the challenge encountered was conducting the test on Off shore pile. During this period few alternatives were explored including statnamic test. However after examining various options and limitations and requirements of each test , feasibility of conducting test and the tight project schedule ,the conventional load test conforming to IS 2911 part4 was conducted. To simulate the Off shore pile with water depth upto about 18.0 m an annular casing was driven the overburden around the pile was removed upto required depth creating equivalent free standing pile above sea bed from start of socket in rock .The scheme is presented in figure 7.

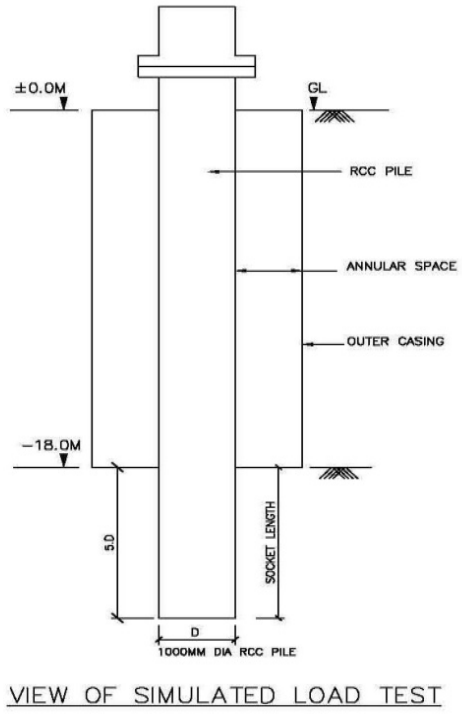

Fig.7. Sketch for conducting similated pile load test .

The test load is three times the estimated pile capacity which was 990t and another 10-15 % is also provided for reaction. For this purpose the entire reaction is taken by four rock anchors. The annular casing and typical test set up is shown if figure 8.

Fig.8 . Test arrangement of simulated initial pile load test

The testing procedure, load increments ,measurements were as per IS 2911 part 4. The final test load was maintained for 24 hours. The load versus settlement is presented in figure 9.

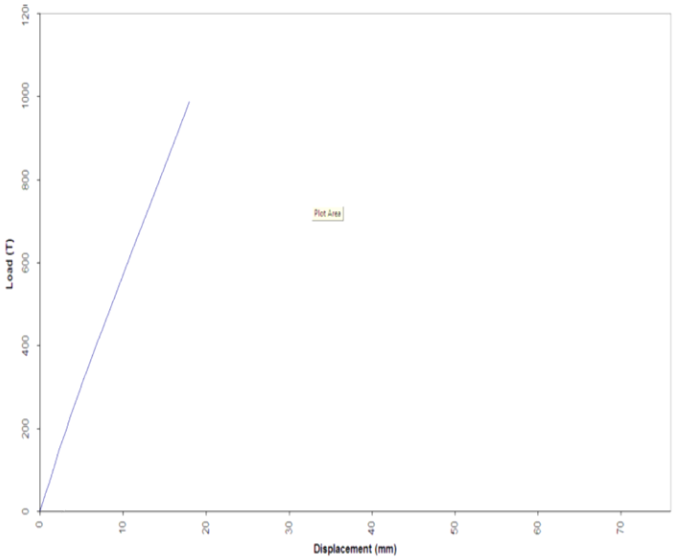

Fig. 9. Load test vs Settlement curve of 1000mm dia Simulated Initial load test .

As seen from the load vs settlement curve the load at 12mm settlement is 600 mt. The safe load as per IS 2911 Part 4 was 400t which validated the pile design.

End on constuction method was adopted for installing jetty piles. The typical details are shown in figure 10.

The fabrication of caisson on shore, towing to the proposed location ,design, sinking of caisson, jetty, deck slab,construction and post construction tests,atmospheric corrosion etc., are beyond the scope of the present paper. To accelerate the sinking of caisson in rocky formation a combination of Jack down and drag down method was adopted.

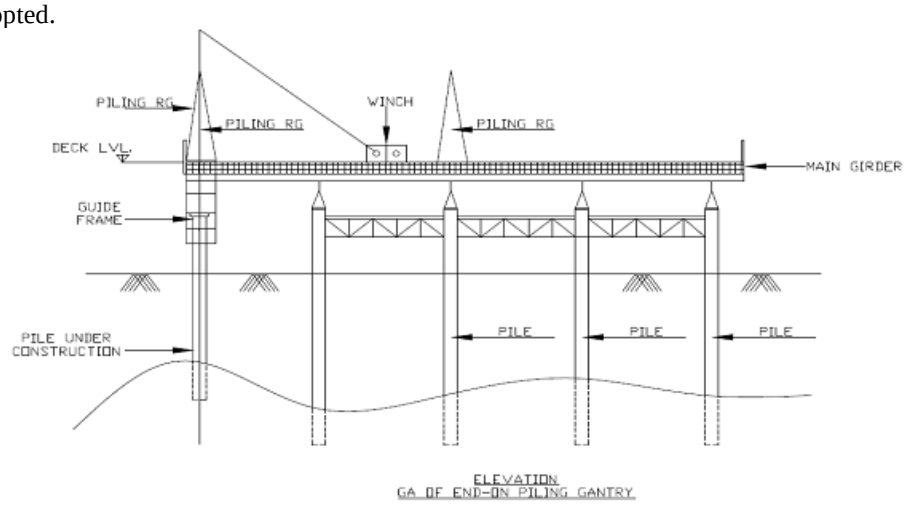

Fig .10. Schematic view of End on Construction

The view of completed structure from sea side is presented in figure 10.

Fig.11. Completed view of the Approach jetty and Intake

4 Conclusions

It may be mentioned that the Geotechnical Investigation and execution was don during the period 1998 - 2000

1. One of the major challenge was tidal variations during investigation and accessing the bore hole location. The tidal variations was overcome by utilising the fixed Jack up platform. . The Tidal table was helpful in planning the investigation. The challenge to access the bore hole location in the sea was overcome by accessing the location from the Sea port thru motorised boat. From the boat , the rig on Jackup was approached thru a ladder..

2. Rock mass at the crown of rock strata was highly weathered . Due to this the core recovery from double tube barrel was affected . Introduction of trible tube core barrel in jointing pattern of rock mass has improved core recovery. This helped in collecting core samples for testing rock properties based on which the start of socket and socket length of pile is arrived.

3. Another challenge was to conduct the initial pile load test Off shore pending full arrangements for testing especially in breaking zone . This was addressed by simulated load test by removing the skin friction upto start of rock socket with estimated socket length.

4. Collection of block sample physically at termination of Intake well is very risky due to opening of joints in rockmass. Since the opening of joints of rockmass will lead to water entering the Intake well due to potential head difference of water inside caisson and outside caisson . To avoid this risk rock samples shall preferably be collected from bailor or any drag equipment .

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References

1. IS 2911-Part 1 sec.2: Code of Practice Design and construction of pile foundations- Bored cast in-situ concrete piles, Bureau of Indian Standards, New Delhi (1983)..
2. IS 2911-Part 4 sec.2: Code of Practice Design and construction of pile foundations- Load test , Bureau of Indian Standards, New Delhi (1983)..
3. IS 14593: Design and construction of bored cast in-situ piles founded on rock-Guide Lines, Bureau of Indian Standards, New Delhi (1983).