Journal of Civil Engineering and Architecture 18 (2024) 12-16
doi: 10.17265/1934-7359/2024.01.003

Construction of Rail Connectivity from Idapalli to International Container Transhipment Terminal (ICTT) at Vallarpadam, Kochi

Prakash Bansod
AFCONS Infrastructure Ltd, Mumbai MH 400053, India

Abstract: Cochin Port is an all-weather port situated within a protected natural harbour, just 11 km away from mainland shipping route. Total draft of 15m-16m is available and it is a natural choice for setting up transhipment hub. The International Container Transhipment Terminal (ICTT) at Vallarpadam was developed by DP World and M/s Cochin Port Trust (CPT). As a part of this project, the new Rail connectivity from ICTT at Vallarpadam to Idappalli station is 8.60km, including the construction of 4.62 km elevated bridge was awarded to AFCONS by M/s Rail Vikas Nigam Limited (RVNL), in 2007 with a scheduled completion by 2009. This bridge is constructed for single railway track and piling was done for the provision of a second railway track in future. The 4.62 km long bridge was successfully completed and Trial Loco run was done in March 2010. This paper includes details of sub-surface profile, engineering properties of soils, details of construction of pile foundations and Challenges faced during construction.

Key words: Transhipment, transportation hub, railway, construction.

1. Introduction

Cochin Port is located strategically on the main east-west global shipping lines and is offering a draft of about 16m. Cochin is destined to develop as the premier gateway to southern India. Cochin is well connected by 3 national highways viz: NH-17 to Goa and Mumbai, NH-47 to Salem and Kanyakumari & NH-49 to Rameswaram. It is also well connected by Konkan railway to Mangalore, Goa, Mumbai and southern railway to Chennai and Southern India. ICTT was developed by M/s Cochin Port Trust (CPT) and DP World at Vallarpadam.

2. Project Alignment

Rail connectivity starts from Idappalli station and runs 4km parallel to existing tracks up to Vaduthala. In this portion, rail track of around 3km is constructed over earthen embankment and including minor bridges /culverts. The major 4.62km long bridge has been constructed between CH 2880 and CH 7500.The elevated bridge takes off near Vaduthala area at CH 2880 and it passes through inhabited area up to CH-3580. It passes across shallow backwater up to Edyakara Island at CH 4300 and then it crosses navigation channel at CH-4820 (PW) reaching Mulavukadu Island. It travels across over land portion from CH 4900 up to NH Crossing at CH-5337. Thereafter it travels along the intertidal portion a major stretch of 2.16Km reaching edge of bank at CH-7500 at Vallarpadam [1, 2].

3. Subsurface Soil Profile

As observed in other areas of Kochi, the subsurface soil profile consists of recent, unconsolidated clays.

A layer of very soft to soft clay is observed up to about 10-12m below bed level. SPT values in this layer are less than 4. Between -10m and -15m, stiff clay layer is observed with SPT values varying between 6 and 10. Between -15m and -30m, marine clay is very stiff, with

Corresponding author: Prakash Bansod, Assistant General Manager, research fields:

Table 1 Details of Piling & Foundation.

Section	V.padam	Bolghaty	Edayakara		V.latha	Other
	B.Water	Land	B.Water	Filled Land	Land	Land
L,m	2200	400	520	760	740	60
Location	A2-P68	P68-P58	P58-P46	P46-P27	P27-P2	VR1/4
No. of Piers	68	10	13	19	25	6
No. of Piles	654	80	129	190	185	36
Average Length of Pile	55	55	55	55	55	55

SPTN values varying between 16 and 30. Between -30 m and -40m, clay layer is hard in nature with SPT N values varying between 30 and 50.

A layer of hard clay with decayed wood is found at levels near -40m. Below -40m, clay is hard with N values exceeding 50. Occasionally thin layers of sand are observed in between clay layers. Beyond -50m, hard clay layer with SPT N values more than 50 is observed.

4. Typical Properties of Soft Clay

1. Grain size distribution
Gravel Content – 0%
SAND - 10 to 18%
SILT - 20 to 35%
CLAY - 57 to 70%
2. Liquid Limit – 68 to 89%
3. Plastic Limit – 27 to 33%
4. Plasticity Index- 41 to 53%
5. Shrinkage Limit – 12 to 16%
6. Textural Classification- CH
7. Natural Moisture Content- 80 to 86%
8. Natural Bulk Density- 1.6 to 1.7 g/cc
9. Specific Gravity- 2.45 to 2.60
10. Optimum Moisture Content – 31 TO 36%
11. Maximum dry density- 1.30 to 1.43 g/cc
12. Unconfined Compressive Strength – 0.15 TO 0.20 Kg/cm^2
13. Initial Void Ratio – e0- 1.5 to 1.6
14. Compression Index Cc- 0.6 to 1.0

5. Scope of Work

The scope is briefly summarized in Tables 1-6.

6. Construction Methodology

Construction methodology of Piling carried out viz –

- Two Conventional Rigs each mounted on Five Temp Platforms.
- One Conventional Rig each mounted on two Barges.
- Ten Conventional rigs on land and One Piling rig Casagrande B-250.

In backwater portion / marine area, piling work was carried out by erecting a temporary working platform of 10m x 16m in size. This was done by driving 1200mm diameter temporary MS liners up to refusal or about 15m depth below bed level. These liners were driven with PTC Vibro. By use of structural steel sections a working platform was erected at each pier location consisting 2Nos of piling winches along with Bentonite mixing tanks. Driving of permanent liners up to 16-18m depth / refusal and boring of piles was carried out. Lowering of reinforcement cage was done by 75 T capacity crane, mounted on a separate barge.

And also in marine / backwater portion piling were carried out by using a conventional rig setup erected & fixed permanently on the barge along with guide for Liner Driving / Boring etc.

In Edyakara B/water, Temporary filling was provided due less depth of water and filled up to an average depth 2m carried out by dredging out existing soil of b/water. Fill was retained by providing Bamboo – Mat arrangement. Additional filling was done at each Location and piles were completed by Conventional Rig method.

At Peak construction time, 12 conventional piling winches were working at different locations. Concrete produced at central batching plant and transported up to convenient location by transit mixer. Thereafter it was pumped with the help of concrete pumps. Tremmie Concreting was done from fixed platform itself. Typical time cycles for construction of a pile with different methods are given for comparison.

Table 2 Time Cycle for Piling on Marine Platform.

Sr.No	Description	Qty	Duration (Hrs)
1	Rig Shifting and Positioning	_	4
2	Survey and Fixing of guide frame	_	1
3	Driving Permanent pile liner	5.0 m	2
4	Welding of 2nd Piece of Liner	3.8 m	1
5	Driving of 2ND Piece	5.0 m	4
6	Boring of 1.2m dia pile	48.0 m	48
7	Lowering of Reinforcement cage	5 T	8
8	Tremie lowering & flushing	_	6
9	Concreting of pile	55 m^3	6
10	Misc. for tide availability & Break down	_	8

Table 3 Time Cycle for Piling on Marine by Barge.

Sr.No	Description	Qty	Duration (Hrs)
1	Rig Shifting and Positioning	_	3
2	Survey and Fixing of guide frame	_	2
3	Driving Permanent pile liner	5 m	3
4	Welding of 2nd Piece of Liner	4 m	1
5	Driving of 2ND Piece	5 m	5
6	Boring of 1.2m dia pile	48 m	60
7	Lowering of Reinforcement cage	5 T	8
8	Tremmie lowering & flushing	_	6
9	Concreting of pile	55 m^3	6
10	Misc. for tide availability & breakdown	_	6

Table 4 Time Cycle for Piling on Land with Winch.

Sr.No	Description	Qty	Duration (Hrs)
1	Rig Shifting and Positioning	_	4
2	Survey and Fixing of guide frame	_	1
3	Driving Permanent pile liner	3.8 m	2
4	Welding of 2nd Piece of Liner	3.8 m	1
5	Driving of 2ND Piece	5.0 m	6
6	Boring of 1.2m dia pile	46.0 m	40
7	Lowering of Reinforcement cage	5 T	6
8	Tremmie lowering & flushing	_	6
9	Concreting of pile	53 m^3	5
10	Misc. for break down etc	_	6

Table 5 Time Cycle for Piling on Land with rotary Piling rig.

Sr.No	Description	Qty	Duration (Hrs)
1	Rig Shifting and Positioning	_	1
2	Survey and Fixing of guide frame	_	1
3	Driving Permanent pile liner	3.8 m	2
4	Welding of 2nd Piece of Liner	3.8 m	1
5	Driving of 2ND Piece	5.0 m	1
6	Boring of 1.2m dia pile	46.0 m	5
7	Lowering of Reinforcement cage	5 T	5
8	Tremmie lowering & flushing	_	4
9	Concreting of pile	53 m^3	5

Table 6 Details of Quarterly Progress of Piling.

Sr.No	Period		No. of rigs	No. of completed piles
	From	To		
1	Jun-07	Aug-07	4-8	37
2	Sep-07	Nov-07	9-11	100
3	Dec-07	Feb-08	11-13	174
4	Mar-08	May-08	13-14	154
5	Jun-08	Aug-08	11-14	133
6	Sep-08	Nov-08	12-13	181
7	Dec-08	Feb-09	15-17	210
8	Mar-09	May-09	10-15	157
9	Jun-09	Aug-09	10-2	62
10	Sep-09	Dec-09	2	66
Total				1274

Typical examples of various techniques of piling are illustrated in Figs. 1-4.

Fig. 1 Piling by Temp Piling platform.

Fig. 2 Piling by Barge.

Fig. 3 Piling by rigs on Land.

Fig. 4 Piling by Rotary Hydraulic Rig.

7. Challenges in Construction

1. Based on overall experience of construction of pile foundations in Kochi, RVNL implemented a major change in design of piles. Total there were 282 piers. As per initial tender design there were 992 piles. By revision, one extra pile was included in centre of each pile group. Thus final number of piles constructed became 992+282=1274 piles.

2. One initial pile load test was done on 1299mm dia pile. Test Load was 930 Tonnes. Under this test load the following were observed.

Total Settlement 9.48mm

Net Settlement 6.02mm

Elastic Rebound 3.46mm

3. In order to save time one High Strain Dynamic Pile Load Test was proposed and executed at 55-P3 locations on a working pile as a substitute to static axial pile load test (routine). In this test 10.5 Tonnes Hammer was dropped on piles with height of drop varying between 1m-3m. CAPWAP analysis of this test indicated:

Skin Friction 904.2 Tonnes

End Bearing 143.3 Tonnes

Total Pile Capacity 1047.6 Tonnes

This showed that against a design requirement of 620T capacity, pile had developed 1.68 times design capacity.

8. Conclusions

The complete bridge construction was completed in March, 2010 and inaugurated by honourable Prime Minister in Feb 2011. Upon completion, this 4.62Km long railway bridge surpasses the 3.065km long Nehru Setu Bridge on Sone River in Bihar, the second longest railway bridge in India.

Concrete pumping technology has been successfully used over a length of 1800m during construction of bridge foundations. On an average piles have been constructed up to 55m depth below bed level and the total pile length is 64,100m. This consumed about 72,500 m^3 of concrete for piles and 6,250 Tonne steel for reinforcement of piles.

References

[1] Job Completion Report of RVNL Bridge.

[2] IS: 2911 – Design and Construction of Pile Foundations.