A Case of Change in Pile Foundation By Construction Condition in Site
현장상황을 반영한 말뚝기초의 변경 사례

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개 요 : 기초의 지지방식 중 깊은 기초로 분류되는 말뚝기초는 일반적으로 고강도의 기성강관(Spiral Steel Pipe)을 재료로 한 말뚝을 사용하는 것이 설계 및 시공측면에서 유리하나, 현재 국내·외의 치솟는 건설원자재 비용 및 고유가에 따른 장거리 운반비용의 증가와 더불어 건설현장에서의 경제적 부담이 상당부분 증가되고 있는 실정이다. 특히, 개발후진국을 비롯한 건설 산업의 국제적 진출에 대한 활기와 더불어 해외현장 변동상황(원자재의 수급 문제에 따른 공기지연 및 경제성) 등을 고려하면 이에 대한 능동적인 대처가 절실할 수 있다. 본 사례는 중동지역 ○○조선소의 이러한 현장여건을 고려하여 중·소하중 규모의 크레인 기초에 적용된 말뚝의 구조 해석적 검토와 지역 지반조건을 반영하여 안정하고 현지조달이 가능한 말뚝 재료의 변경을 제안한 경우이다.

본 검토에서는 기초 말뚝의 정역학적 허용지지력과 기초지반 조건을 고려한 항타관입 분석 및 크레인 이동하중을 고려한 응력해석을 실시하여 최대연직력, 모멘트, 전단력, 응력비 등을 비교하였으며, 동일한 검토조건하에서 결과를 바탕으로 변경 가능한 말뚝을 선정하였다.

기초지반에 대한 적정안전율을 갖는 허용지지력 및 구조적 안정성의 확보가 가능한 콘크리트 말뚝으로의 변경이 가능하며 상부하중 규모에 따라 설치간격에 따른 파일본수의 증·감이 발생되었다.

Key words : Deep Foundation, Spiral Steel Pipe, Pile Materials, PHC, RC

1. Introduction

The Pile foundations are almost always designed to used steel material for safety. however, These days construction raw materials price and transport charges cost of long distance going up cause international petroleum market condition was bad.

In this paper has been done for reasonable and economical pile foundation which will be installed under mid & small crane load condition. This case was proposed to pile foundation thru the analysis of pile structure and the consideration of ground condition in site. The allowable capacity of pile foundation shall be confirmed by analysis of bearing capacity.

This case area is examing alteration possibility about crane foundation pile applying and installing in the middle east ○○ shipyard.

2. Description of Site

Most of the regions of this project area is located in the middle east, in the past, geological areas subjected to extensive carbonate sedimentation.

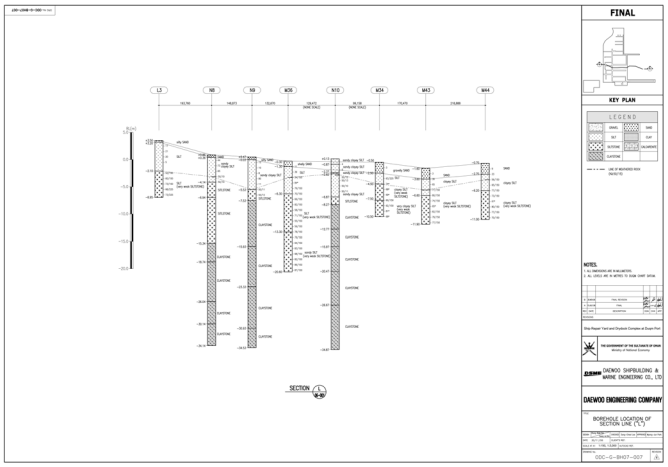
This area is relatively low lying with near surface geology dominated by Palaeocene or Eocene.

The superficial deposits consist mainly of dune sand, loose marine sand and silts or siltstone formation. In general the subsoil encountered in the investigation has been classed into three categories such as follows in Table 1. and Figure 1.

Table 1. General Description of After Soil Investigation

Soil Category	Description of Soil
First	Loose to medium dense, Shelly SAND
Second	Soft to hard consistency Clayey SILT
Third	Very weak SILTSTONE/MUDSTONE

Figure 1. Soil Profile of Crane Foundation area



As a result of soil investigation, three separate soil strata of concern to this paper were identified on the site. The top consisted of loose to medium dense shelly sand, which classified as SM in the Unified Soil Classification System. The next consisted of a soft to hard consistency clayey silt(ML), The last stratum a siltstone/mudstone is extended to a depth of at least from (-)10.5m to (-)35.0m.

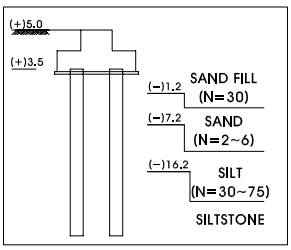
Length of pile shall be long enough to secure the required this depth and bearing capacity as analysis. The piles are controlled to be embedded in the last stratum to a certain depth, assumed N value more than 50/15, (-)2.0m~(-)19.0m.

It is applied to lateral subgrade reaction modulus(k_h) is calculated by NAVFAC DM-7.2, Davisson(1970), Hukuoka, JSCE(Yokoyama chart), Eo & Kh method 2.266 ~ 2.461(kg/cm^3)

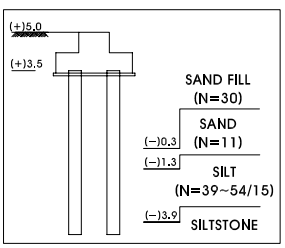
3. Proposal of Pile Foundation

3.1 Original Pile Design

Figure 2. Ground Condition of Crane Pile Foundation



<a. 40ton Crane Foundation>



<b. 60ton Crane Foundation>

Design for PHC pile of original crane foundation is designed penetration under the Siltstone layer. However PHC pile is not produced in oman and near by in-stie around countries as of now, thus total quantity of PHC piles will be imported. the source of PHC piles will be Malaysia, China or Korea.

This reason alteration design has been done for reasonable and economical crane pile foundation which will be installed changing RC piles.

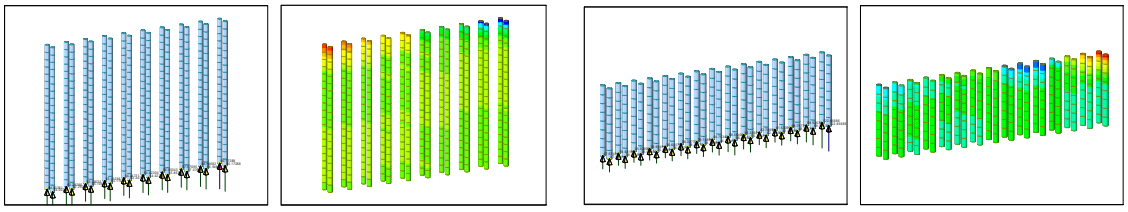
3.2 A Case Study of Structure Analysis

Structure analysis analyzed by each case type, as a result of calculation is Max. reaction, bending moment, shear stress, maximum head deflection and allowable capacity. And Terzaghi and Braja, M Das formula is using. Structure analysis is considering live load to obtain maximum reaction, bending moment and using the universal purpose FEM program MIDAS.

Table 2. Analysis of Foundation as Case(I)

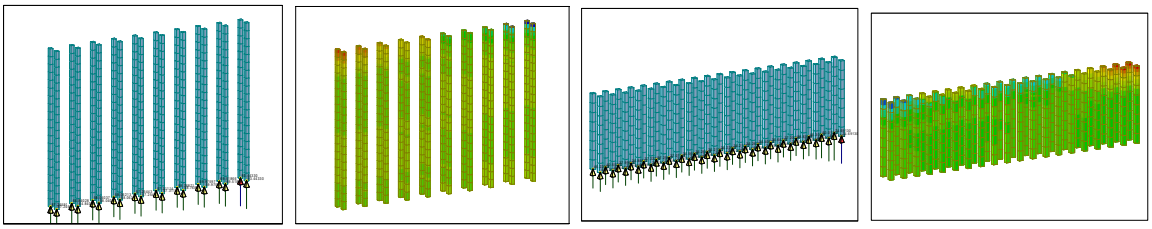
Case	Crane	Max. Reaction (tonf/EA)	Bending Moment (tonf·m)	Shear Stress (tonf)	Deflection (mm)	Stree Ratio	Remarks
PHC Pile	40ton	90.17	3.51	4.90	0.571	0.34	CTC 3.0m
	60ton	122.85	6.58	4.42	0.850	0.21	CTC 2.0m
RC Pile	40ton	93.44	2.37	4.93	0.546	0.12	CTC 3.0m
	60ton	74.96	1.57	3.30	0.277	0.08	CTC 1.5m

Figure 2. Analysis of PHC pile Foundation



<Reaction/Moment on 40ton Crane> <Reaction/Moment on 60ton Crane>

Figure 2. Analysis of RC pile Foundation



<Reaction/Moment on 40ton Crane> <Reaction/Moment on 60ton Crane>

Table 2. Dimension of Pile

Type	Pile Dia. [m]	Allowable Stress [kg/cm^2]	External Dia. [m]	Inside Dia. [m]	End Area [m^2]	Net Area [m^2]	Girth(U) [m]	Pile Length [m]
PHC Pile	0.5	800	0.5	0.34	0.197	0.10556	1.571	7.0~23.0
RC Pile	0.406	350	0.406	0.406	0.165	0.165	1.6252	7.0~23.0

4. Drivability Analysis

Pile drivability analysis confirmed that can be obtain predicted allowable bearing capacity overcoming driving resistance of ground that is not pile damage chosen drivability equipment system, and choose adequate combination of equipment that can be adequate predicted penetration resistance(maximum axial reaction) on the ground condition. If pile drivability is not secured, the bearing capacity which gets using static formula is insignificant and the bearing capacity that is forecasted by supposing the soil survey of site data about pile penetration depth as basis without drivability analysis can be different with the real value.

If when design application of drivability analysis and use of pile material are achieved properly, more economical design may be possible.

5. Conclusions

In general of pile foundation that classify deep foundation in support method of foundation is profitable advantage design and construction using spiral steel pipe, but now inside and outside of the country is being boosted construction material cost and high oil price by increasing long distance carriage together with economic burden in construction field. In this study, it is analyzed stress analysis PHC and RC pile considering allowable bearing capacity and ground condition of pile foundation. As a result of the analysis of RC pile, it is shows that more advantage than PHC pile in safety security and economic, and as possible as transfer to PHC pile. Allowable bearing capacity and structural safety security that has reasonable safety ratio is possible changing concrete pile, increase of pile number is happened installation space by upper load condition.

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