HELICAL ANCHOR FOUNDATION FOR STREET LIGHTS

A PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

Dr. Saurabh Rawat

(Assistant Professor)

By

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT, SOLAN – 173 234

HIMACHAL PRADESH, INDIA

May-2021

DECLARATION

I hereby declare that the work presented in the project report entitled **"HELICAL ANCHOR FOUNDATION FOR STREET LIGHTS"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Dr Saurabh Rawat**. This work has not been submitted elsewhere for the reward of any other degree. I am fully responsible for the contents of my project report.

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"HELICAL ANCHOR FOUNDATION FOR STREET LIGHTS"** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Saurabh Tomar (171644)** during a period from January 2018 to May 2018 under the supervision of **Dr. Saurabh Rawat**, Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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All projects no matter how big or small they are, they are only successful mainly due to the efforts of various number of amazing people, They have always given their constant advices and provided a helping hand to me in order to complete my project. I sincerely appreciate and respect the guidance of all those people, who have been instrumental in making this project an element of my success

It is my radiant sentiment to place on record my best regards, deepest sense of gratitude to Dr. Ashok Kumar Gupta, Head of the Department Civil Engineering, Jaypee University of Information Technology for the precious and valuable guidance which was extremely helpful and crucial for my study both practically and theoretically.

Much gratitude goes to the project supervisor, Dr. Saurabh Rawat, who have provided me with such a great exposure that has helped my project to bloom. I also owe an appreciation to the guidance given by other supervisors as well as the panel especially in our project presentation that helped us improve my presentation skills.

ABSTRACT

On 16th May, 2020, Cyclone Amphan sustained winds above 240 kmph in eastern parts of India. This toppled over 4,000 electric poles and street lights, leaving much of the city in dark and without power. Similarly during other such natural disasters, conventional foundations of street lights and electric poles owing to their low pullout capacities usually undergo failure during storms of such high wind speeds.

Thus, the present study investigates replacement of convention street light foundation by an innovative helical anchor foundation with respect to strength, cost, durability and serviceability. Presently, in India, the erection of street lights is mainly carried out by excavation of bore hole, placing of electric pole and subsequent concreting around the electric pole. The only mechanism of strengthening the pole stability is to increase the depth of embedment. The shortcomings are usually associated with pole alignment within the concreted borehole, pole – concrete bonding, concrete – surrounding soil bonding, and longer construction duration due to concrete curing. The current idea of using helical anchor foundation for street lights involves using a hollow tube section embraced circumferentially by helical screw. The installation consists of screwing in the helical anchor foundation to desired depth using drive heads attached to a mini back hoe. The top platen of the anchor is bolted to the base of the electric pole. The bearing from helical plates minimizes the bonding, alignment and installation time issues.

Since screw – in mechanism is required only, hence the idea facilitates install and ready to use concept. The hollow foundation also provides passage for electric wire fittings and protects it from long term damage. Further, helical anchor foundation’s uplift capacity necessary against natural hazards such as typhoons, hurricanes and high velocity winds is observed to be significantly higher than the conventional foundation system. The helical anchor foundation is comparatively more environment friendly than the conventional foundation as the overall waste (excavated soil, carbon generation and material wastage during concrete preparation) almost negligible from procurement of raw material to installation.

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LIST OF ABBREVIATIONS AND ACRONYMS

Ds Diameter of shaft of nail

Dh Diameter of helical plate on the nail

L Length of nail

H Depth of the top helical plate from the nail head

s Spacing between the helical plates

A Area of helical plate

T installation TORQUE

V downward vertical (compression) load on

Vt upward vertical (tension) load on

unit weight= $\gamma - \gamma w$

CHAPTER 1: INTRODUCTION

1.1 General

Helical anchor foundation for street lights involves using a hollow tube section embraced circumferentially by helical screw. The installation consists of screwing in the helical anchor foundation to desired depth using drive heads attached to a mini back hoe. The top platen of the anchor is bolted to the base of the electric pole. The bearing from helical plates minimizes the bonding, alignment and installation time issues.

Since screw – in mechanism is required only, hence the idea facilitates install and ready to use concept. The hollow foundation also provides passage for electric wire fittings and protects it from long term damage. Further, helical anchor foundation's uplift capacity necessary against natural hazards such as typhoons, hurricanes and high velocity winds is observed to be significantly higher than the conventional foundation system. The helical anchor foundation is comparatively more environment friendly than the conventional foundation as the overall waste (excavated soil, carbon generation and material wastage during concrete preparation) almost negligible from procurement of raw material to installation.

A helical anchor can also be called as twisted stack, or helical pile is a base equipment which is made of helical designed metal plates that are attached to a steel shaft using a round or rectangular cross,section in the centre . The steel plate diameter, numbers and thickness and are determined through the supported arrangement's minimum design life, the environmental rust, and geotechnical parameters, along with the design complete demands.

These may be used to renew new foundations or restore the presently used ones. They are used for many engineering structures, especially the offshores one or the ones where soil capacity is very low and in a lot of different construction projects that require rapid installation and structures close to present constructions. This foundation system provides additional tensile forces to the already present compressive forces in the conventional foundation system.

Helical anchoring system also referred to as screw pile system and are built with steel bottoms together with helical plates of various sizes to match the construction site’s specific ground requirements. Helical anchors may be a square steel beam, rotating steel pipe heap or a mixture of both round and square with one or more helical plate(s).

Generally, these helical steel anchors itself are enough to satisfy the load demands of the under takings .

They are mostly preferred in locations where the soil is expansive (very less geotechnical pull-out capacities), Other options for such situations are over-excavation and fill options, but these are expensive and can cost you a lot amount of cash, while helical foundation system is many folds less expensive then them.

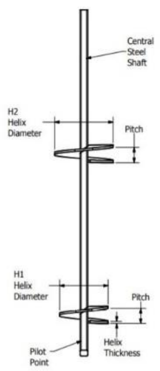


Fig. 1.1 Generic helical pile/anchor

1.1 Applications and benefits

The use of helical piles in construction continues to increase due to product and equipment versatility and the various benefits that the systems offer. Some of the benefits/advantages of helical piles include:

• **High capacity deep foundation alternative –** Allowable torque-rated capacities on the order of 60 kips may be achieved with helical shaft sizes up to 3.5 inches in diameter and even higher capacities may be achieved with larger shaft sections.

• **Predictable capacity –** With adequate soil information and designer experience, system capacities may be estimated very closely to capacities determined from full scale load testing.

• **Low mobilization costs –** Helical piles have in part become a popular deep foundation option because of the ability to achieve moderate to high capacities, yet be installed with smaller equipment. Mobilization costs are then much lower than other deep foundation alternatives, which in turn makes helical piles an economical solution for many projects.

• **Vibration-free installation –** Rotary installation of helical piles does not produce ground vibrations, unlike traditional driven piles or rammed aggregate soil improvement options. • Install quickly without generating spoils – Helical piles do not auger soils to the surface. Therefore, there are no hauling or disposal costs for spoils similar to auger-cast piles or drilled shafts. For contaminated sites, disposal and/or treatment of disturbed material can be extremely costly or make the project cost prohibitive. Helical piles simply pass through contaminated soils and do not bring them to the surface.

• **Support of temporary structures –** Helical piles can be removed from the ground by reversing the installation process.

• **Clean installation** – Installation of helical piles, helical tie-backs and helical soil-nails does not include concrete or grout, thereby minimizing equipment, vehicles and mess on the construction site.

Fig. 1.2 Installation of helical pile foundation

1.2 Limitations

Just like any other foundation system has their advantages and limitations, helical piles too have its own limitations and in that way could be non suitable in some specific projects.

- There are various construction sites where the helical pile wont penetrate easily. Materials such as construction debris, or the soil having higher percentage of cobbles or boulders.
- There is no chance that screw-in foundation will work in hard rocks.

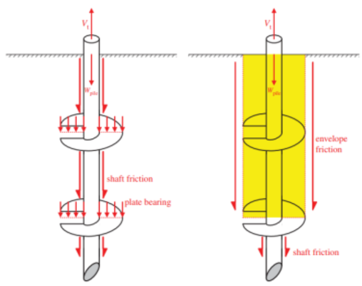


Fig 1.3 Various loads acting on helical piles

CHAPTER 2: LITERATURE REVIEW

2.1 Research work on helical pile foundations

2.1.1 Numerical modelling of pullout of helical soil nail by Saurabh Rawat and Ashok Kumar Gupta (2017)

This research paper consisted of dedicated study about how the number of helical plates in a helical screw nail or pile affect the pull-out resistance/capacity of it. In this research, a finite element program was developed in Plaxis 3D foundation software and an axisymmetric modelling of helical anchor/nail, which simulated various ground conditions to its best. The results were matched with the field results and from the results from the literature. It was concluded that the number of helical plates in a helical anchor/pile/nail is directly proportional to its pull-out capacity. More the number of helical plates, more is the pull-out capacity of the foundation.

Moreover, this study also concluded that the pull-out capacity of helical piles increases with the spacing between two helical plates. But this increase in pull-out capacity is observed till a critical value of spacing is achieved. After the critical value of spacing is achieved, the increase in the pull-out resistance is very insignificant. The critical spacing ratio was observed to be $s/D_h = 3$ (helical plate spacing to nail shaft diameter = 3).

2.1.2 Technical Design Manual Edition 4 by Hubbell Power Systems, Inc. (2018)

This dedicated manual contains various helical anchors/piles as products and the details of every product is available in great details. From design process to design examples, this manual is a complete guide for any beginner who wants to get well acquainted with the world of helical anchors as foundations. Hundreds of experiments and tallied results are present in this manual with detailed observations and calculations.

Fig 2.1 Technical Design Manual by Hubbel Power Systems, Inc. (2018) cover page

2.1.3 Helical anchors as wind tower guyed cable foundations by R. T. VICTOR and A. B. CERATO (2008)

This study presented dedicated installation charts and design parameters for the use of helical anchor foundation in guyed and free-standing turbines (1 to 10 kW). The main aim or topic of interest of this research were:

a) The effect of dynamic loadings on the helical anchor foundation.
b) The effect of varying ground water table conditions on the pull-out capacity of helical anchor foundation.

The conclusion of this study were:

i) While doing the torque calculations to get holding capacity of the soil, worst ground water conditions should be considered.
ii) The calculations were under predicted when the ground water table rose.
iii) Cyclic loading for long term loading conditions affects the static uplift capacity.
iv) Anchors with lesser helix plate are supposed to advance to deeper depths for achieving similar torque as anchors with more number of plates.

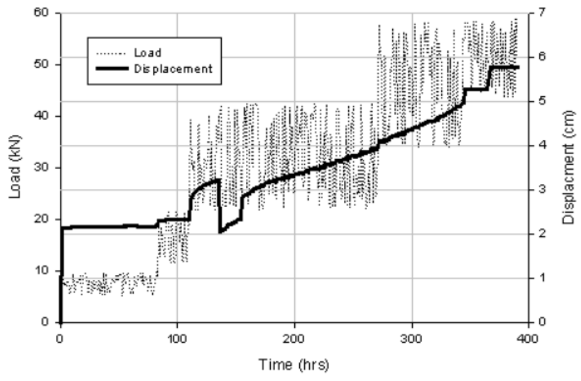


Fig 2.2 Hourly values of 16-day dynamic tests on anchor (2-Helix).

2.1.4 Helical piles: An innovative foundation design option for offshore wind turbines by B. W. Byrne and G. T. Houlsby (2015)

In this research paper, various types of dynamic loads were simulated in the offshore wind turbines. It concluded that the large diameter helical piles can be used in other various offshore structures, for which it has many applications and advantages.

It also outlined how multiple footings (as screw piles) can enhance the pull-out capacity of the foundations for very huge structures or the ones whose self-weight is large.

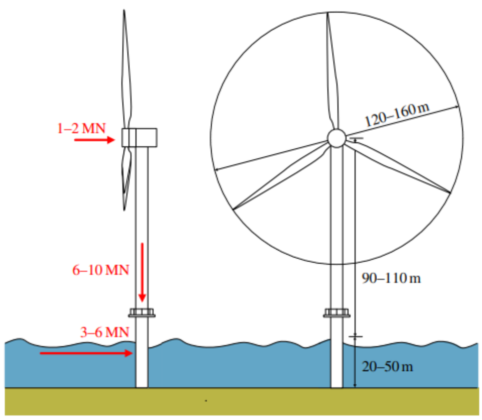


Fig 2.3 Various loads on offshore wind turbines

2.1.5 Helical Screw Piles Performance – A Versatile Efficient Foundation System Alternative for Rehabilitation, New Sustainable Structures Construction and Infrastructure Delivery by Yasser Abdelghany and Hesham El Naggar (March, 2016)

Full-scale field load testing was performed to evaluate the performance of screw-in piles under axial and lateral loadings. Using Plaxis 3D foundation software, 3D FE model was developed to create a design method for the considered piles.

2.1.6 Uplift Capacity of Single Pile with Wing in Sand-Numerical Study by Mohamed A. Sakr , Ashraf K. Nazir , Waseim R. Azzam and Ahmed F. Sallam (March 2019)

To study the ultimate uplift capacity of single pile with wing in sand, numerical modelling was done on full scale. The primary focus of the study was to determine the effect of dw/dp (wing to width ratio). Winged pile embedded in different sand densities and regular pile without wing were compared on the grounds of ultimate uplift capacity.

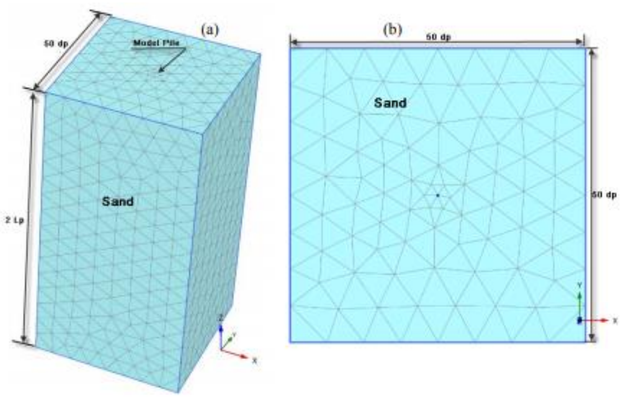


Fig 2.4 Finite element used 3D mesh and plan of the mesh.

Table 1: Summary of literature review

Sr. No.	Authors and year of publication	Title	Critical observations
1	Saurabh Rawat, Ashok Kumar Gupta 2017	Numerical modelling of pullout of helical soil nail	The pullout capacity of helical soil nail increases with increase in number of helical plates.
2	Hubbell Power Systems, Inc. (2018)	Technical Design Manual Edition 4	This dedicated manual contains various helical anchors/piles as products and the details of every product is available in great details.
3	R. T. VICTOR and A. B. CERATO (2008)	Helical anchors as wind tower guyed cable foundations	Anchors with lesser helix plate are supposed to advance to deeper depths for achieving similar torque as anchors with more number of plates.
4	B. W. Byrne and G. T. Houlsby (2015)	Helical piles: An innovative foundation design option for offshore wind turbines	It concluded that the large diameter helical piles can be used in other various offshore structures, for which it has many applications and advantages.
5	Yasser Abdelghany and Hesham El Naggar (March, 2016)	Helical Screw Piles Performance	Develop a three dimensional (3D) nonlinear, coupled finite element model for helical piles.
6	Mohamed A. Sakr , Ashraf K. Nazir , W (March 2019)	Uplift Capacity of Single Pile with Wing in Sand-Numerical Study	Winged pile embedded in different sand densities and regular pile without wing were compared on the grounds of ultimate uplift capacity.

2.2 Objectives

Following are the objectives of my study:

- To study the conventional foundation for street lights.
- To investigate the helical anchor foundation for street lights through numerical modelling.
- Cost analysis and comparative study of conventional foundation system with helical anchor foundation including its environmental assessment

CHAPTER 3: DESIGN PROCESS

The designer has a specific task to perform, or problem to solve to which helical piles can offer a solution. At the beginning of the design process, it is best to keep all options on the table until circumstances dictate one foundation option as being the better choice. As with any deep foundation, helical pile design has several steps. The steps can be summarized as:

Data Gathering:

• The loads applied to the foundation.

• The description and strength characteristics of the project soils.

• The designer must determine load resistance requirements and serviceability based on the application. This includes choosing either ASD with a deterministic factor of safety, or LRFD with probabilistic load and resistance factors.

• The applicability of local, regional, or national building codes. The designer must comply with code requirements depending on the jurisdiction. For example, some codes require helical piles to be tested for every project. Others only require load tests if the pile capacity is above a certain limit. Codes often dictate acceptance criteria in terms of allowable displacement for deep foundations, such as the City of Chicago and New York building codes.

• Location tolerances. The helical pile designer must understand the location tolerances for the piles.

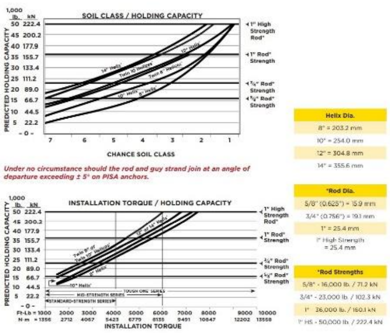


Fig 3.1 Standard holding capacity of helical piles

CHAPTER 4: METHODOLOGY

4.1 Conventional Foundation Model

4.1.1 Geometry and Profile

GEO5 is a three-dimensional finite element program primarily used in the analysis of deformation, stability and groundwater flow in the field of geotechnical engineering. Several advanced constitutive models are available to simulate the non-linear and time-varying soil and/or rock behaviour. In this study, Pile sub-routine of GEO5 was used and a conventional foundation model was created as shown in below figure:

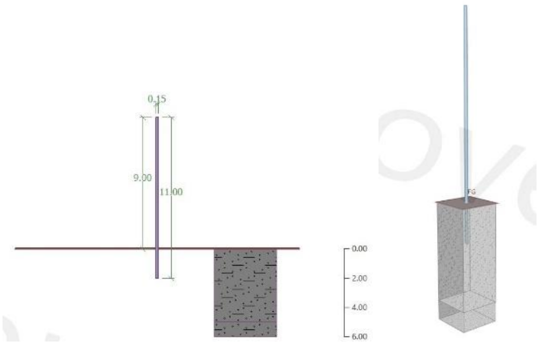


Fig. 4.1 Model of a conventional foundation (metres), plan and 3D mesh

The parameters of street light pole were according to the specifications for street light poles (BIS, 1981). Some adjustments were made accordingly to stimulate the actual ground conditions in the best way possible.

Section	Overall length 11 m + 25 mm (base plate)			Overall length 9.5 m +25 mm (base plate)		
	Outside Dia (mm)	Thickness (mm)	Length (mm)	Outside Dia (mm)	Thickness (mm)	Length (mm)
Bottom section	139.7	4.85	5600	165.1	4.85	5000
Middle section	114.3	4.5	2700	139.7	4.5	2250
Top section	88.9	3.25	2700	114.3	3.65	2250
Planting depth	1800 mm			1800 mm		
Nominal weight of the pole	160 kg			147 kg		
Tolerance on mean weight for bulk supply is 7.5 % Tolerance for single pole weight is 10%						

Table 2: Specifications for street lighting poles (BIS, 1981)

4.1.2 Ground and soil parameters

<u>**Clayey sand (SC)**</u>

Soil parameters	Mar	Unit	Value
Poisson's ratio	n	[–]	0.35
Unit weight	g	[kN/m	18.5
Deformation modulus	Edef	[MPa]	4 - 12
Effective parameters:			
Angle of internal friction	Jef	[°]	26 -
Cohesion of soil	Cef	[kPa]	4 - 12
Design bearing capacity:			
Foundation width < 0.5	Rd	[kPa]	125
Foundation width < 1.0	Rd	[kPa]	175
Foundation width < 3.0	Rd	[kPa]	225
Coeff. of structural	M	[–]	0.3

4.1.3 Wind speeds

Overturning moment for the foundation was calculated for normal wind (40m/s) and extreme wind(70m/s) conditions. The loads on pole were calculated as per IS 802-1995.

4.2 Helical Anchor Foundation Model

4.2.1 Geometry and profile

Farokhi, et al. 2014 Hamid Alielahi, presented a three dimensional FE analysis to simulate an uplift load test using the PLAXIS program. The numerical modelling techniques based on the FE provide versatile tools that are capable of modelling soil continuity, soil nonlinearity, soil–pile interface behaviour, and three dimensional boundary conditions.

Therefore, a series of finite element element analyses on model-regular piles and winged piles subjected to uplift loading and soil conditions as in the model tests were carried out using the 3D non-linear computer program PLAXIS 3D Foundation.

The screw-in foundations were drawn in solidworks, AutoCad can also be used in order to draw the helical anchor foundation. In order to import the drawings to Geo5/Plaxis 3D, the drawings were saved in .dxf or.dwg file format. A 2D mesh of the geometry is created in software environment by means of work-planes. This step is followed by the generation of a 3D mesh.

PLAXIS/Geo5 by default imposes a set of generated fixities to the boundaries of the model.

Different configurations of helical soil nails for Plaxis analysis.

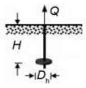
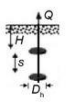
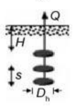
Configuration of helical plates	Notation	Number of helical plates	D_s (mm)	D_h (mm)	s/D_h	H/D_h	D_h/D_s
	1-H	1	19	$4.4D_s$	–	1	1.4
						2	2.4
						3	
						4	3.4
						5	
						6	4.4
	2-H	2	19	$4.4D_s$	1	1	1.4
					1.5	2	2.4
					2	3	
					2.5	4	3.4
					3	5	
					3.5	6	4.4
	3-H	3	19	$4.4D_s$	1	1	1.4
					1.5	2	2.4
					2	3	
					2.5	4	3.4
					3	5	
					3.5	6	4.4

Table 3 Various configurations of helical piles for Plaxis 3d analysis

4.2.2 Ground and soil parameters

Parameter	Loose sand, Dr=30%	Medium dense sand, Dr=50%	Dense sand, Dr=80%	Pile and Wings
Material model **according to Nasr, 2014**	Mohr - Coulomb soil model	Mohr - Coulomb soil model	Mohr - Coulomb soil model	Linear elastic
Type of material behavior, **according to Nasr, 2014**	Drained	Drained	Drained	Nonporous
Secant elastic modulus, E50 (kPa), **according to Bowles, 1996**	21000	26500	32000	$2.1x10^8$
Unit weight, γ (kPa), **according to Sakr et al 2016**	15.7	16.45	17.68	78
Poisson's ratio, υ **according to Peng et al, 2010**	0.33	0.33	0.33	0.3
Cohesion, C (kPa), **according to Peng et al, 2010**	0.0	0.0	0.0	----------
Friction angle, (Ø) ° **according to Sakr et al 2016**	35.4	37.6	40.2	----------
Dilatancy angle, (ψ) ° **according to Nasr, 2014**	5.4	7.6	10.2	----------
Interface reduction factor, Rinter **according to Nasr, 2014**	0.65	0.65	0.65	----------

Table 4 Material Parameters

4.2.3 Finite element mesh and boundary conditions

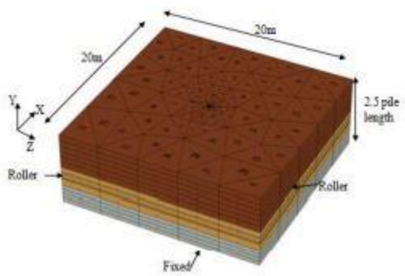


Fig 4.2 3D Mesh generated

Pile	Description	length m (ft)	shaft cm^2	Model boundaries width m^2	Model boundaries Depth m
P-HSP (stage #1) Axial loading	Plain helical screw pile	3.6 (12)	Square, 4.5x4.5	20x20	8.5
P-HSP (stage #3) Lateral loading	Plain helical screw pile	5.2 (17)	Square, 4.5x4.5	20x20	9.0
RG-HSP (stage #3) Axial & lateral loading	Reinforced grouted helical screw pile	5.2 (17)	Diameter = 15	20x20	9.0
FRP-G-HSP (stage #3) Lateral loading	Fiber reinforced polymer grouted helical screw pile	5.2 (17)	Diameter = 15	20x20	9.0

Table 5: Types of helical piles and their configurations

The model was provided for the reinforced grouted helical screw piles (RG-HSP) - which provided the highest axial and lateral capacities.

AutoCad Drawings (.dwg/.dxf)

Fig 4.3 AutoCad Drawings

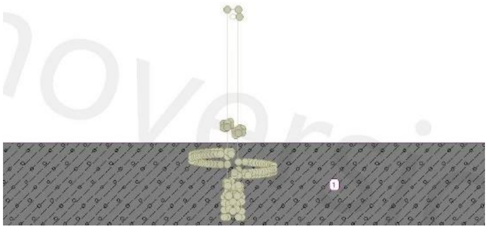


Fig 4.4 Imported drawings

CHAPTER 5: RESULT AND CALCULATIONS

5.1 Conventional foundation

5.1.1 Overturning moment

Normal wind : 40m/s Extreme wind : 70m/s

K_0 = Risk Factor = 1.37

K_1 = Terrain Factor = 1.14

K_2 = Topography Factor = 0.85

Wind load = $0.5\rho Av^2 C_D$

ρ=1.2kg/cum ; A= Area of pole ; v = wind speed C_D = 1 (Drag coefficient)

Overturning Moment = Wind load * 0.5 * height of pole

For normal wind, overturning moment = 9.46kN-m

For extreme wind, overturning moment = 28.98kN-m

5.1.2 Normal wind case output

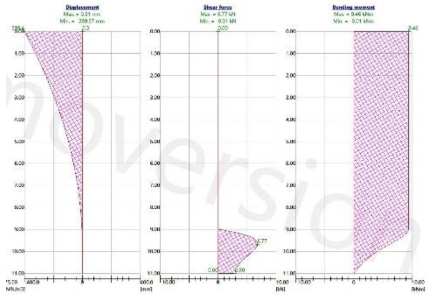
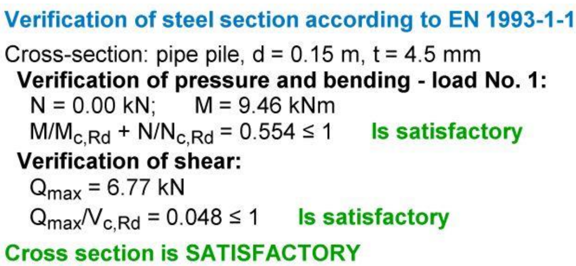


Fig. 5.1 Displacement, SFD and BMD (Normal Wind)

Maximum pile displacement = 399.4 mm

Maximum shear force = 6.77 kN

Maximum Moment = 9.46 kNm



Verification of steel section according to EN 1993-1-1

Cross-section: pipe pile, d = 0.15 m, t = 4.5 mm

Verification of pressure and bending - load No. 1:

N = 0.00 kN; M = 9.46 kNm

$M/M_{c,Rd} + N/N_{c,Rd} = 0.554 \le 1$ **Is satisfactory**

Verification of shear:

$Q_{max} = 6.77$ kN

$Q_{max}/V_{c,Rd} = 0.048 \le 1$ **Is satisfactory**

Cross section is SATISFACTORY

Fig. 5.2 Verification as per GEO5 (Normal Wind)

5.1.3 Extreme wind case output

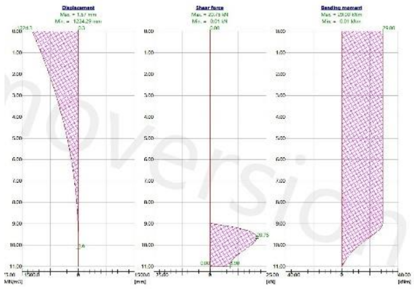


Fig. 5.3 Displacement, SFD and BMD (Extreme Wind)

Maximum pile displacement = 1232 mm

Maximum shear force = 23.09 kN

Maximum Moment = 29 kNm

Verification of steel section according to EN 1993-1-1

Cross-section: pipe pile, d = 0.15 m, t = 4.5 mm

Verification of pressure and bending - load No. 1:

N = 0.00 kN; M = 29.00 kNm

$M/M_{c,Rd} + N/N_{c,Rd} = 1.699 > 1$ **Is not satisfactory**

Verification of shear:

$Q_{max} = 23.09$ kN

$Q_{max}/V_{c,Rd} = 0.165 \leq 1$ **Is satisfactory**

Cross section is NOT SATISFACTORY

Fig. 5.4 Verification as per GEO5 (Extreme Wind)

5.2 Helical foundation

The model was provided for the considered helical screw pile. The field test and numerical results showed favourable match under lateral and axial loadings. The results from the numerical model were used for the verification of the load transfer mechanism for the pile modeled. Firstly, the Finite Element analysis was validated with the experimental study of Azzam and El Wkil, 2016 to ensure the program's ability to solve the geotechnical problems of a prototype regular and finned piles in the field. Second, after ensuring the program's capability through the validation process, the analysis further investigated the behaviour of a large-scale problem model of regular and wing piles under new parameters. Initially, the numerical model was verified via the results obtained from the experimental test program of Azzam and El Wkil, 2016

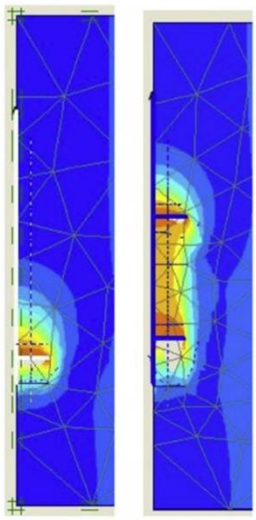


Fig 5.5 Failure envelop for single helix pile and double

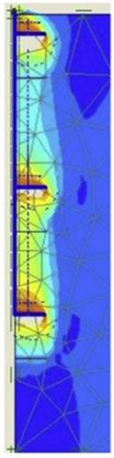


Fig 5.6 Failure envelop for triple helix pile

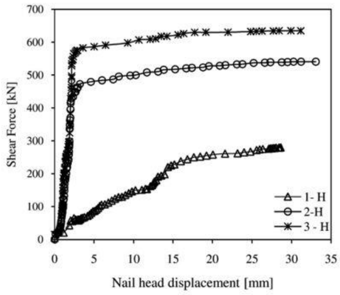


Fig 5.7 SF vs Nail Head Displacement

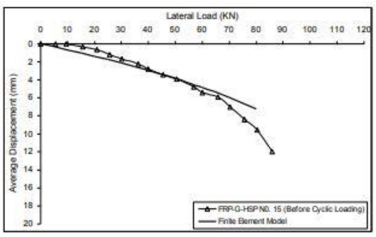


Fig 5.8 Lateral load vs Average displacement

Following two graphs represents comparative load vs displacement results of a regular and helical pile foundation.

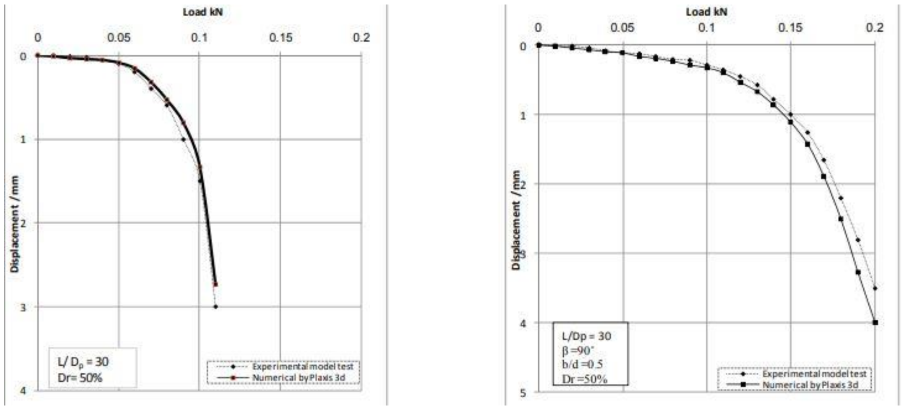


Fig 6.1 Comparison of load vs displacement for regular and helical foundation

5.3 Comparison between concrete foundations and helical foundation

- Concrete foundations require specialized machinery to process, transport , pour, and level, as well as a large team to carry it all out.

- Helical piles don’t require any specializes machinery to install, and the installation can be carried out by a small screw.

- Concrete foundation installation leaves a huge carbon footprint from the machinery, process, and materials required. Concrete manufacturing is one of the leading producers of greenhouse gases.

- Helical piles are very simple to manufacture and install. They are easy to transport because of their size and they arrive ready to be installed.

- Any service or repair that a concrete foundation requires will call for the same specialized machinery and energy output that installation requires.

- Concrete can be reused but the act of removing old concrete and processing it into reusable concrete involves massive carbon emissions from the same specialized machinery.

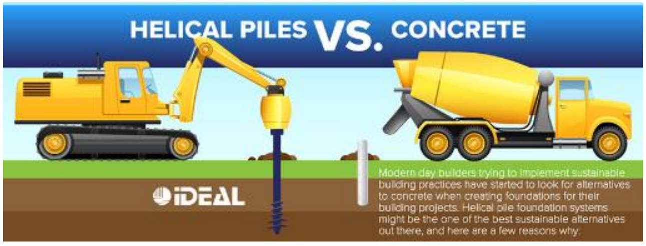


Fig 5.10 Helical piles vs concrete

5.4 Environmental assessment of helical pile

CLASSIFICATION

Health	Environmental	Physical
No Classifiable Hazards	No Classifiable Hazards	No Classifiable Hazards

MIXTURES

Name	CAS#	Wt. Percentage	Comments
Zinc metal	-	1-5	Nil
Steel	-	94-98	Nil
Other	-	Less than 1	Nil

Table 6 Classification and composition of helical pipe

Due to their size and design, helical piles can be easily replaced, repaired, expanded or removed using simple machinery techniques. Helical piles can be removed and refurbished, and reused as foundation at other worksites without the massive impact of the concrete carbon footprint.

CHAPTER 6: CONCLUSION

The bending stresses developed in the pole for all different wind velocities in both theoretical and the model have a close match where the difference in the values is due to inaccuracy of the procedure followed. It can be concluded that conventional street light pole foundations are successful only for normal winds but they fail when subjected to overturning moment produced due to extreme winds as like in cyclones.

In this study the full-scale pile is simulated using Plaxis 3D program in order to avoid the problem of field study and limited investigated variable.

Helical pile foundation or screw in foundation showed remarkably high resistance to pull-out capacities by very much folds as compared to conventional foundation system. The resistance which was observed in conventional foundation peaked to maximum 30kN whereas in case of helix foundation, the results were of the range 200kN (single helix), 400kN (double helix) and 600kN (triple helix). The results clearly depicts the very high pullout capacities of helical anchor foundation system.

SCOPE FOR FUTURE STUDY

Every research, project or study has further scopes for improvement and research. Speaking of the prevailing soil conditions in India especially the deccan plateau and the places which are prone to cyclones and the natural calamities including high wind velocities, we need more geotechnical data of the soil conditions in these areas so that, the holding capacities can be calculated for the torque capacity to be input in the installation machine. These soil data will help in precise calculations and the efficiency of these foundations could be enhanced.

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