FOUNDATION SOLUTIONS ™

USER MANUAL

VER 1.1

7/15/2013

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1. INTRODUCTION

Ram Jack's FOUNDATION SOLUTIONS™ computer software is a special-purpose program for estimating the axial (tension and compression) capacity of Ram Jack Helix Foundations installed in soil and the torsional resistance that will be experienced during installation. The software is an internet based program which stores all projects that are created in an online database.

The software utilizes the Individual Bearing Method for calculating ultimate axial capacity of the helix plates. The bearing capacity of each individual helix plate is calculated with the Terzaghi bearing capacity equation. Soil behavior is modeled using the Standard Penetration Test "N" blow count value and the soil type. Consequently, the Coulomb cohesion, angle of internal friction strength parameters, unit weight, and Bearing Capacity factors Nc and Nq for deep local shear are automatically estimated based on built in correlations. However, these values may be overridden by the user. Frictional/adhesive shaft resistance is calculated with an equation that lends itself to the use of either the alpha, beta or lambda method, at the user's discretion. Shaft resistance may also be completely ignored at the user's option. Automatic truncation of helix plate capacity and total anchor capacity based on Ram Jack's product strength ratings is built into the software, but may be turned off at the user's option. English units are required as noted on the software input screens.

In providing estimates of axial capacity and incorporating mechanical strength ratings of Ram Jack Helical Foundations, Ram Jack FOUNDATION SOLUTIONS™ software aids the user in addressing strength limit state issues. It also incorporates some warning pop up messages when there is a potential limitation on the helical pile based on the blow count values. However, it does not address shaft buckling issues under compressive loads. These issues may be addressed through the separate use of other analytical methods such as finite element or finite difference analysis. Software implementations of the latter include L-PILE, COM624 and GT STRUDL.

2. SOFTWARE LICENSE AGREEMENT & DISCLAIMER

Since this program could be used to design deep foundation helical piles which support structures that protect human life, it is "CRITICALLY" important that the user fully understands the intended use and capabilities of the program. Only experienced and licensed professional engineers should use this software and the results thereof.

The authors of this software have tried to the best of their ability, to combine the principles of soil mechanics and typical analysis processes into the software program code. Regardless of how thoroughly any software is designed and tested errors may and PROBABLY WILL occur, and it is the responsibility of the Licensee or user (designer, engineer, engineer-of-record, etc.) to thoroughly review the results and must take responsibility for the use of the final values and statements prepared by the software. Therefore, this software should be considered only as an aid to performing numerical calculations.

The software was developed and owned by Ram Jack. Therefore, you must treat the software in a legal manner like any other copyrighted material. The registered email address and the associated current password should be kept confidential at all times and not be shared with any person within the firm or outside the firm. If more than one person in a particular company desires to use the software then each person should get a unique User ID and Password from Ram Jack to utilize the software.

The software may not be reviewed, compared or evaluated for publication in any manner in any publication media without expressed written consent of Ram Jack.

While Ram Jack has taken precautions to assure the correctness of the analytical solution and design techniques used in this software, it cannot and does not guarantee its performance, nor can it or does it bear any responsibility for defects or failures in connection with which this software may be used. In no event will Ram Jack, its officers, owners, employees or consultants be liable to anyone for any unfavorable conditions occurring from the use of this software. The user acknowledges and accepts all of the above statements when choosing to use this software.

If Ram Jack's owners, employees or consultants are licensed professional engineers there is no relationship between their professional licenses and the software. Such licensed professionals have provided their labor to develop or advise on the software design only and are not performing services in connection with their professional licenses or any legal requirements related to their licenses.

Ram Jack warrants that the software will operate but does not warrant that the software will operate error free or without interruption. The user shall not provide duplicated printed documentation, printed electronic documentation or electronic program or documentation files to any person or entity other than employees or consultants of the authorized user with a "need to know" without Ram Jack's written permission.

3. GETTING STARTED

In order to start using the Foundation Solutions™ software the user would have to first register at www.rjfs.ramjack.com. Once the registration information has been received by Ram Jack, the user would be provided with a Login ID and an initial password to log into the software. The Login ID would typically be the e-mail address that was used at the time of registration. It is critical that a valid e-mail address be used during registration since all correspondence regarding the software would be via e-mail to the e-mail address provided. The user can access the "My Profile" link to change the password and personal information other than the e-mail ID any time after the first login.

It is required that the login ID be unique to each individual user and not be shared among different users within a company/firm. Since the final output report contains the user information it would be an advantage to maintain unique login ID's within a firm so that it would be easier to track projects.

Once the user navigates to the software website, they would arrive at the Login screen as shown in Fig.1.

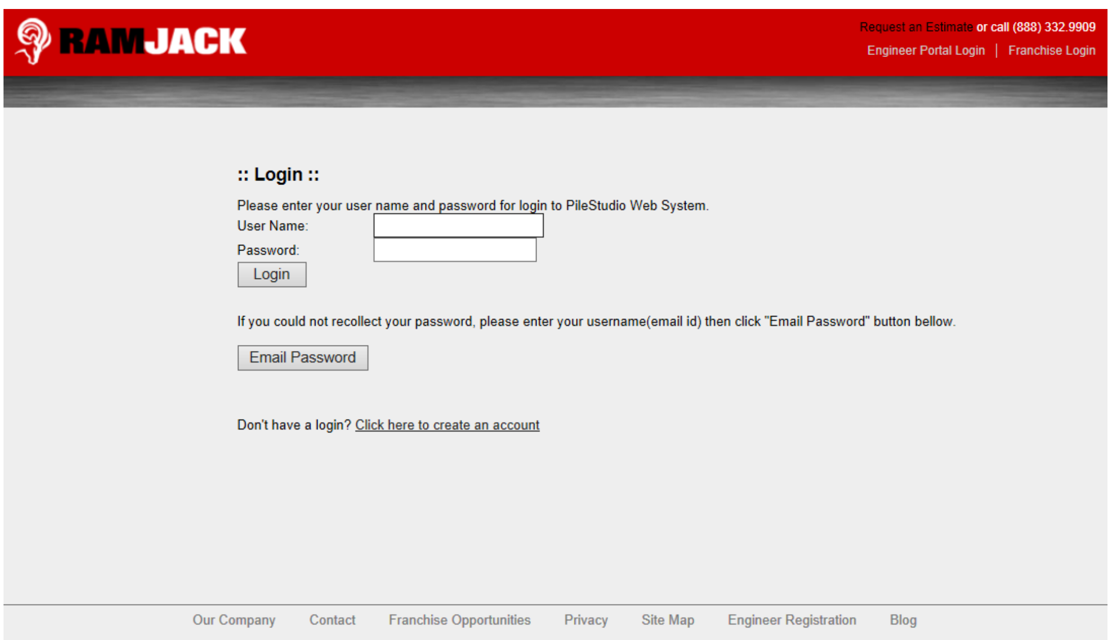


Figure 1. Login Screen

3.1 New User Registration:

First time users should click on the "Click here to create an account" to register. Once the registration information is received by Ram Jack the user would be provided with a Login ID and Password within 2 working days. Please e-mail info@ramjack.com to report any problems or delays with registration.

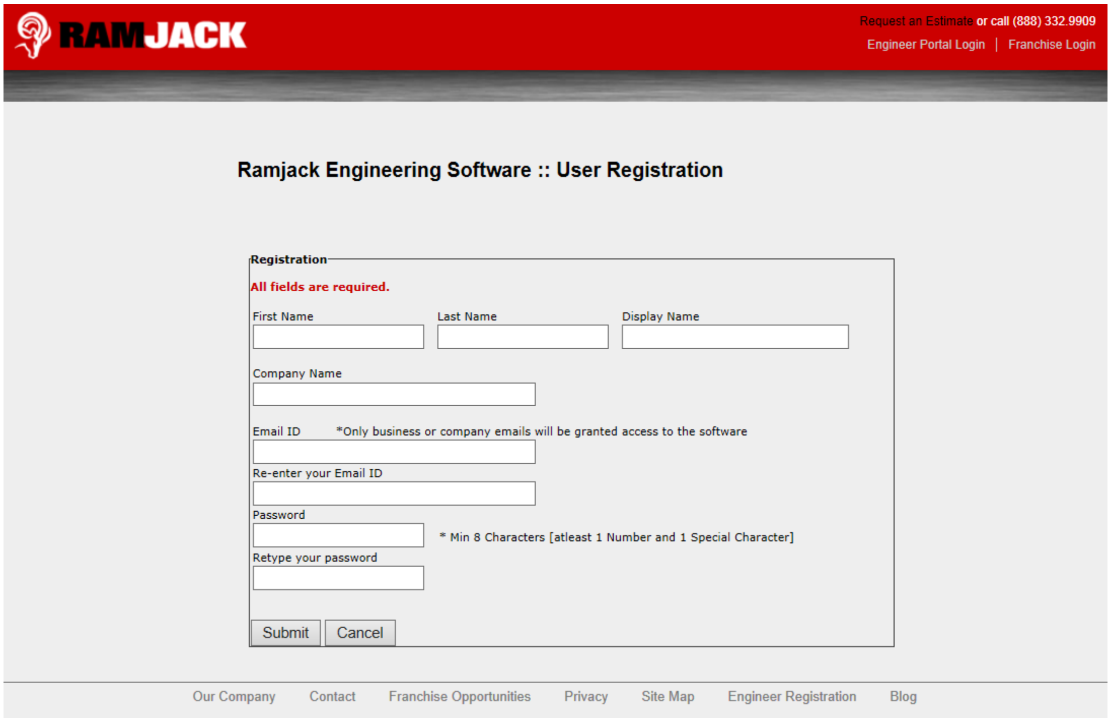


Figure 2. New User Registration Screen

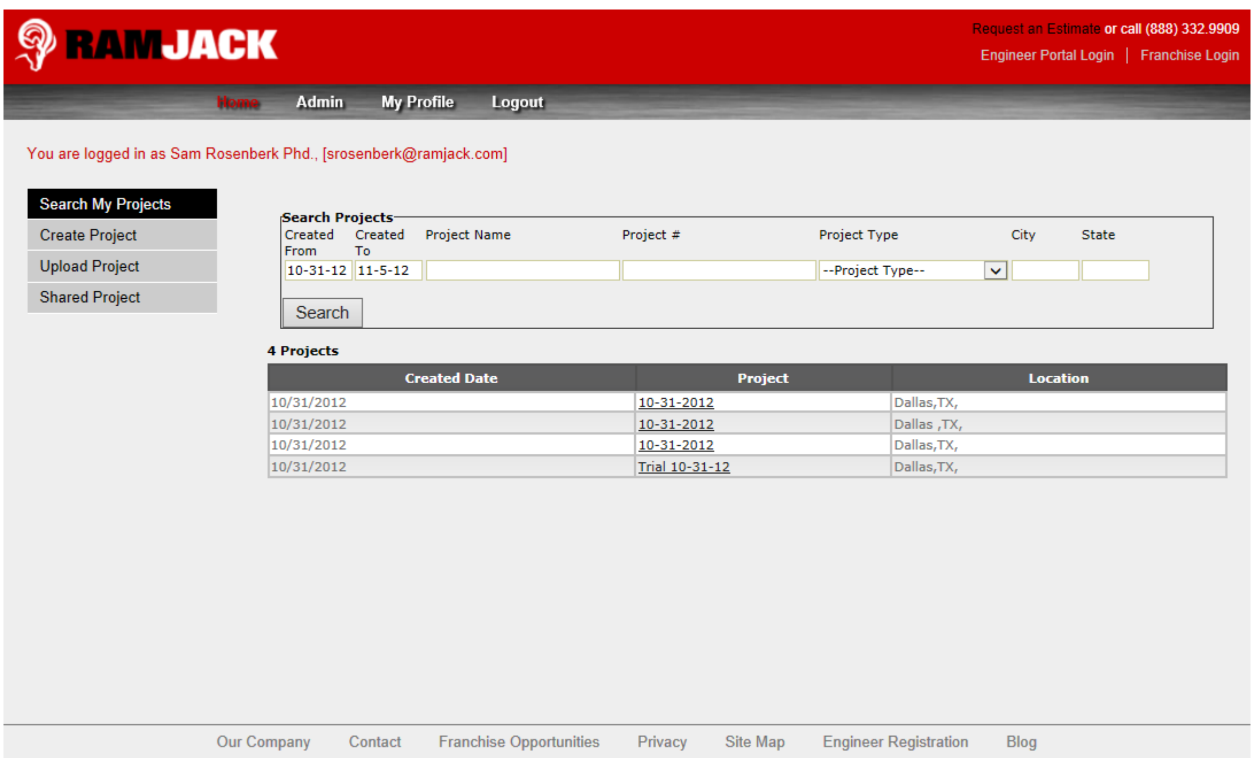


Figure 3. Search Engine

3.2 Search My Projects:

Once the user login's and agrees to the terms and conditions, the software automatically directs the user to the search engine page as shown in Figure 3. Here all the projects that were created by the user are displayed with the most recent at the top. There are also several fields such as project name, date created, project number, project type, city and state that can be used to search or categorize existing projects. All the projects that are created by the user are stored in a centralized data bank. The software does not allow the user to save a project to the computer's hard drive. However, a PDF of the project output report can be saved as per the user's convenience.

4. USING FOUNDATION SOLUTIONS™

4.1 Create Project:

Click on the create project tab to create a new project file. This tab contains input parameters such as the project name, project address, soil report #, Boring #, etc. as shown in Figure 4. The City and State are mandatory input parameters that has to be filled in order to proceed with the software. This allows the user to use the location of the project in the search engine.

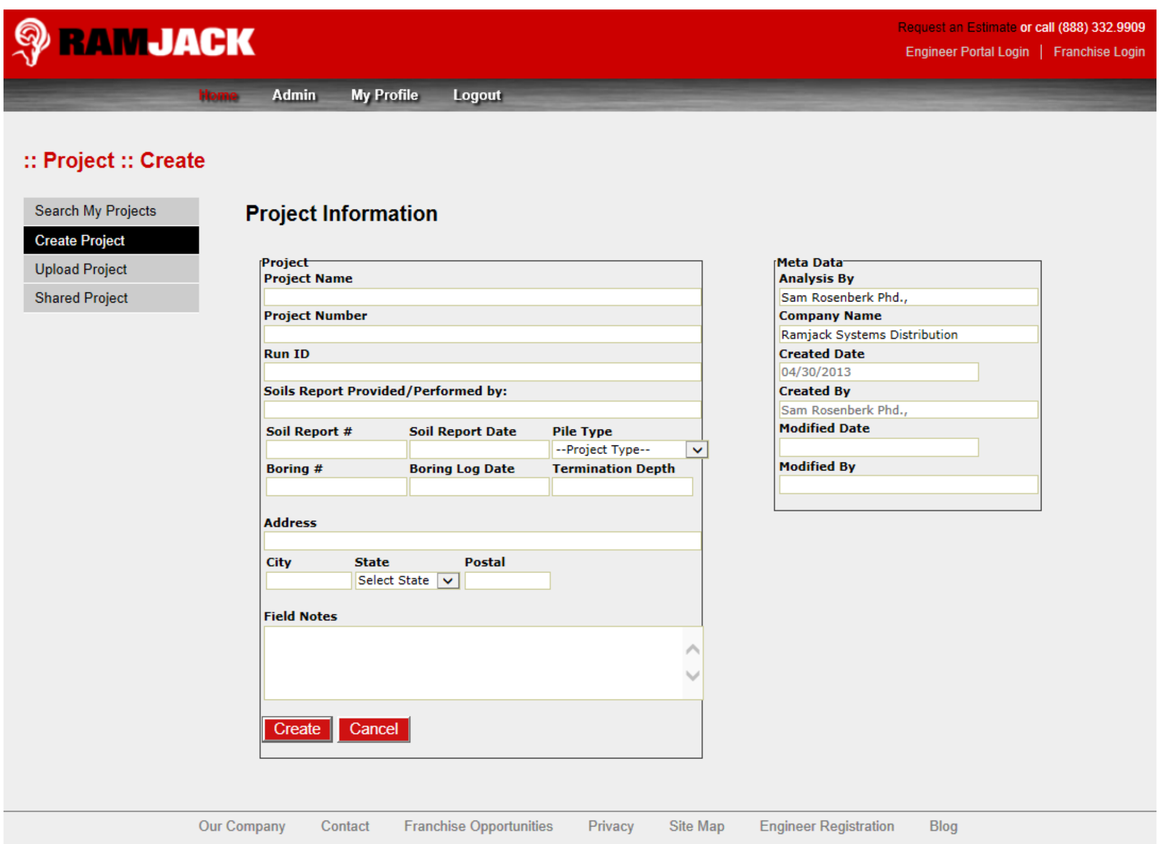


Figure 4. Create Project Screen

4.1.1 Pile Type:

The user can select a specific type of pile application that the simulated helical pile is intended for in the project. The different pile types included in the drop menu are guy anchor, new construction pile, slab pile, tie back anchor, and underpinning pile.

4.1.2 Field Notes:

The user can enter any assumptions that were made or note down any unusual soil conditions that were encountered in the boring logs. These notes would be reported in the final PDF output generated.

4.2 Ram Jack Specialist Information:

The name and address of the authorized Ram Jack dealer who would be working on this project is entered in this page. Information such as the name of the Ram Jack specialist, e-mail, telephone, and physical address can be entered in this section as shown in Figure 5. Any remarks that are required to be communicated to the dealer may also be entered in this section.

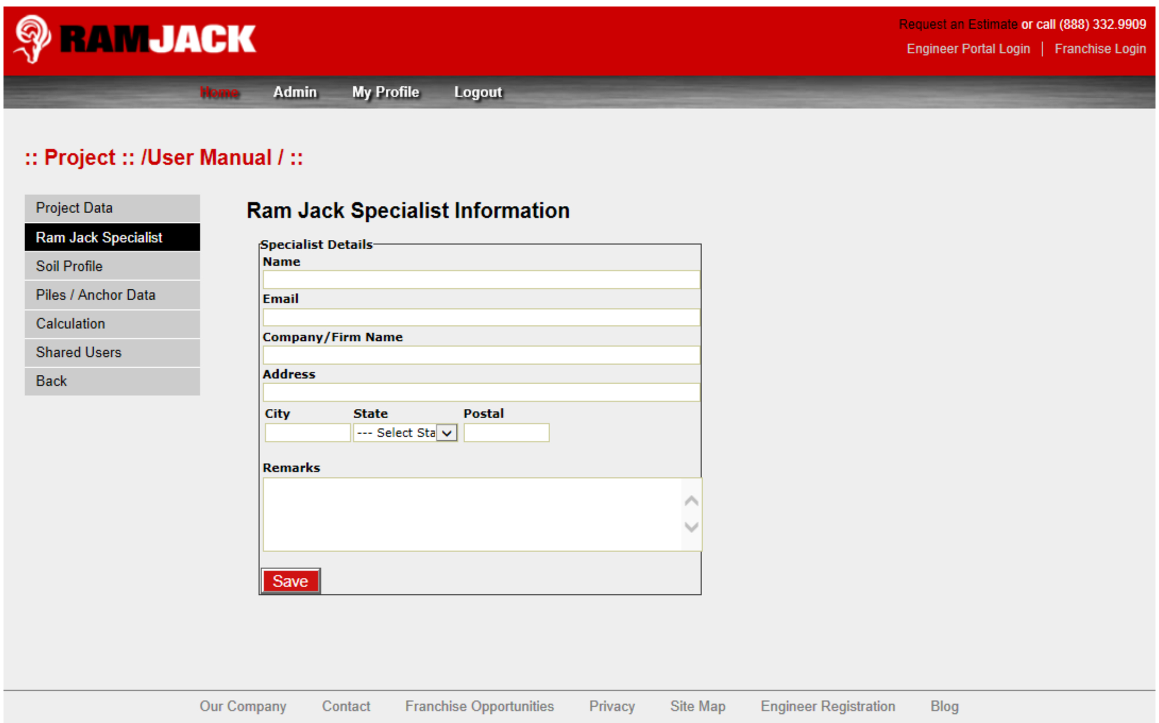


Figure 5. Ram Jack Specialist Information Page

Once the user completes entering the desired information on this page and clicks the “save” button, the software saves the respective data and automatically displays the “Soil Profile” page.

4.3 Soil Profile:

This page is used to create and simulate the soil condition at the project site to be used in the calculations as shown in Figure 6 & 7.

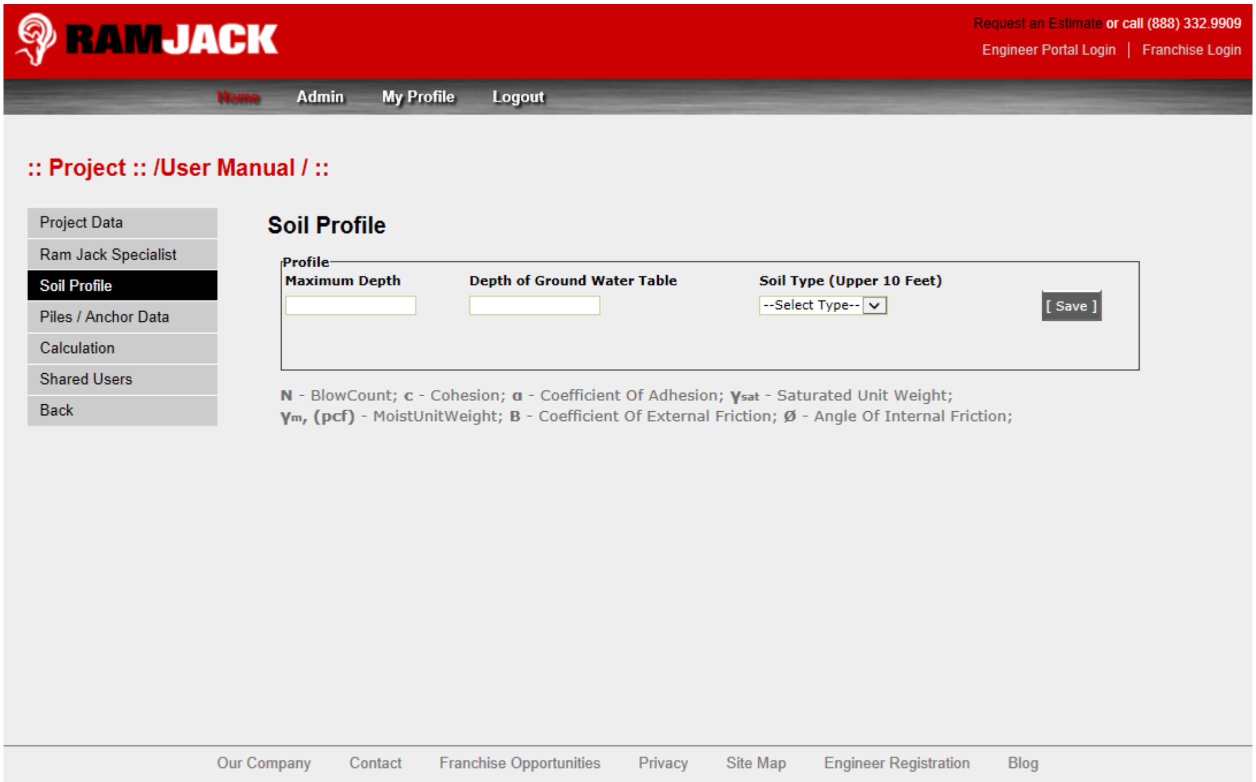


Figure 6. Soil Profile Screen

4.3.1 Maximum Depth:

Maximum Depth tells the software where to stop calculating capacity and torsional resistance. It is a required input. Soil data will be taken as a constant from the input Start Depth of the last defined soil stratum to the input Maximum Depth.

4.3.2 Depth of Ground Water Table:

Depth of ground water is the datum level at which pore pressure is atmospheric and below which pore pressure is hydrostatic. It may or may not be the same as the depth of the ground water table determined during a boring. This depth can also be obtained from the geotechnical engineer based on their experience in the absence of geotechnical borings. Please note that the ground water table will fluctuate and is dependent on seasonal variations. Therefore, it might be conservative to enter the shallowest anticipated ground water table depth in that region based on prior experience.

4.3.3 Soil Type (Upper 10 feet):

The drop down menu for this field consists of two options namely cohesive and non-cohesive. Clayey soils are typically classified as cohesive soils while, sand and gravelly soils are classified as non-cohesive soils. This selection determines the minimum embedment depth of the shallowest helical plates from grade level. At less than this minimum embedment length, the equations used to calculate axial capacity are considered unreliable. The embedment depth varies with helix configuration and the type(s) of soil overlying the last helix. The user should choose the option that best describes the soil encountered within the top 10 feet below grade level/pile head.

This should not be confused with the required minimum embedment depth criteria provided by the Geotechnical Engineer of Record (EOR).

Once all the above fields have been filled in clicking the "save" button would direct the user to the next section where the physical/mechanical properties of the soils would be entered.

4.4 Soil Stratum Information:

4.4.1 Start Depth:

Start Depth is the depth of the upper boundary of a soil stratum below the point where the anchor enters the ground. It is a required input. Soil data will be taken as constant from the input Start Depth of each defined stratum to the input Start Depth of the next defined stratum or, in the case of the last defined stratum, to the input Maximum Depth.

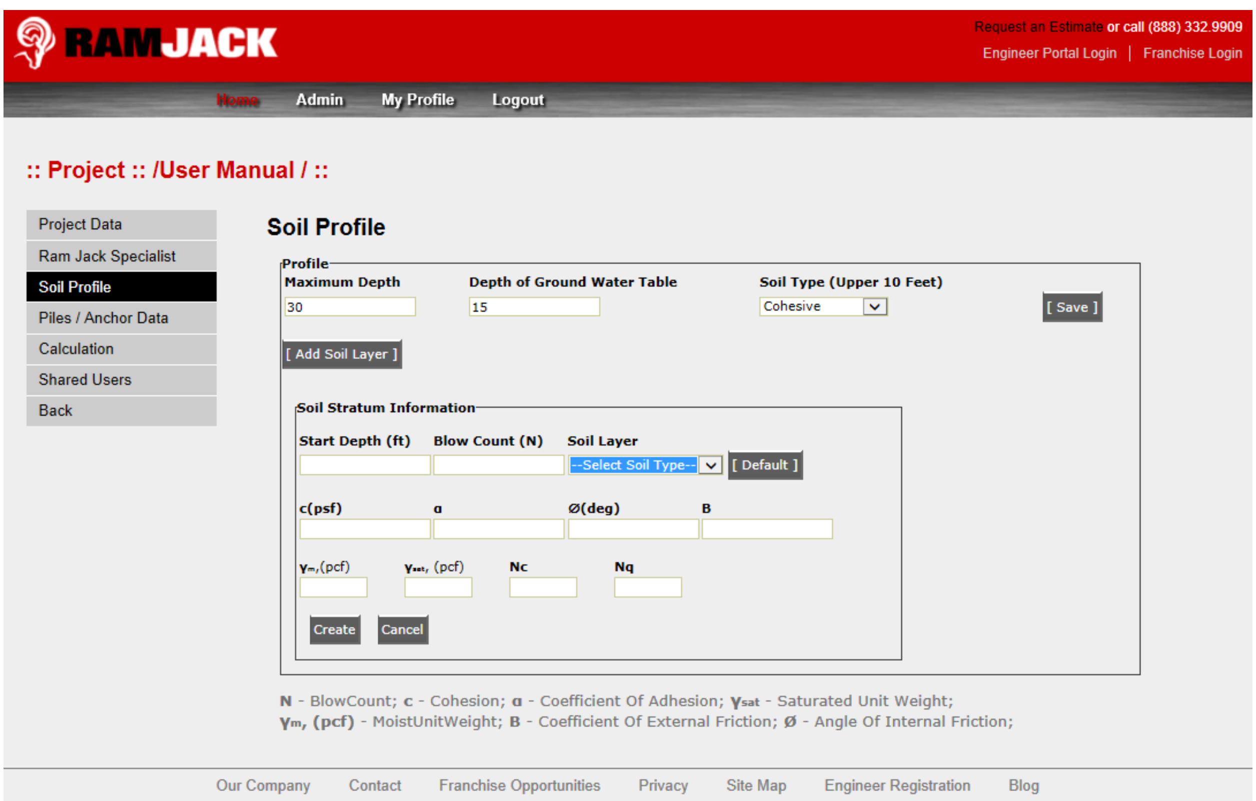


Figure 7. Soil Stratum Information Screen

4.4.2 Blow Count (N):

The blow count values represent the Field "Standard Penetration Test" blow count values "N". The number of blows required to penetrate 12 inches into the soil using the Standard Penetration Test equipment (split spoon sampler) is defined as the "N" value. The sampler is driven into the soil by providing a standard amount of energy. This energy is developed by dropping a 140 pound hammer. For each blow, the sampler is dropped through a distance of 30 inches and the number of blows required for a spoon penetration of three 6 inch intervals are recorded. The number of blows required for the last two intervals are summed up together to give the standard penetration number, N at that respective depth.

4.4.3 Cohesion:

Cohesion is the shear strength intercept of the Coulomb strength envelope for the soil in a stratum. The cohesion value is automatically interpolated from Table 1 based on the SPT input value. However, the user can manually revise the values as determined to be appropriate for the analysis. Cohesion will be taken as constant from the input Start Depth of each defined stratum to the input Start Depth of the next defined stratum or, in the case of the last defined stratum, to the input Maximum Depth.

Other direct-measurement tests for cohesion include the triaxial test, direct shear test, vane shear test and borehole shear test. In some cases, cohesion values obtained by these other methods may differ sufficiently from those automatically interpolated by the software to warrant manual adjustment of the cohesion value for improved capacity estimates. Cohesion can also be estimated by correlation with the standard penetration test, cone penetration test, California Bearing Ratio, liquidity index, plasticity index and pocket penetration test. The following information is presented to help the user estimate an appropriate cohesion value for his project with whatever information may be available. Wherever possible, the use of several methods together is recommended.

CBR (California Bearing Ratio) = 0.09c
(Carter and Bentley, 1991)

Table 1. Fine-Grained Soil Condition and Strength Parameters vs. SPT Blow Count (ASCE, 1996).

Blow Count N (blows/ft)	Consistency	Unconfined Compressive Strength (psf)	Saturated Unit Weight γ_{Sat} (pcf)
0 – 2	Very Soft	0 – 500	<100 – 110
3 – 4	Soft	500 – 1,000	100 – 120
5 – 8	Medium	1,000 – 2,000	110 – 125
9 – 16	Stiff	2,000 – 4,000	115 – 130
17 – 32	Very Stiff	4,000 – 8,000	120 – 140
> 32	Hard	> 8,000	> 130

Table 2. Typical values of undrained shear strength for soils compacted to maximum dry density per AASHTO T99, 5.5 lb rammer method (Carter and Bentley, 1991).

Soil Description	USC Class	Undrained Shear Strength (ksf)	
		As Compacted	Saturated
Silty sand, sand-silt mix	SM	1.0	.42
Clayey sands, sand-clay mix	SC	1.5	.23
Silts and clayey silts	ML	1.4	.19
Clays of low plasticity	CL	1.8	.27
Clayey silts, elastic silts	MH	1.5	.42
Clays of high plasticity	CH	2.2	.23

4.4.4 Adhesion Coefficient:

The adhesion coefficient A is a factor that is multiplied by the soil's cohesion strength parameter to yield the adhesive component of skin resistance. The software automatically interpolates the adhesion coefficient α from Fig. 8. However, the adhesion coefficient can be manually revised as per the user's discretion. In the Tomlinson α *model* of skin resistance, A is equal to the Tomlinson factor α. In the β *model* of skin resistance, A is equal to 0. In the λ *model* of skin resistance, A is equal to 2λ.

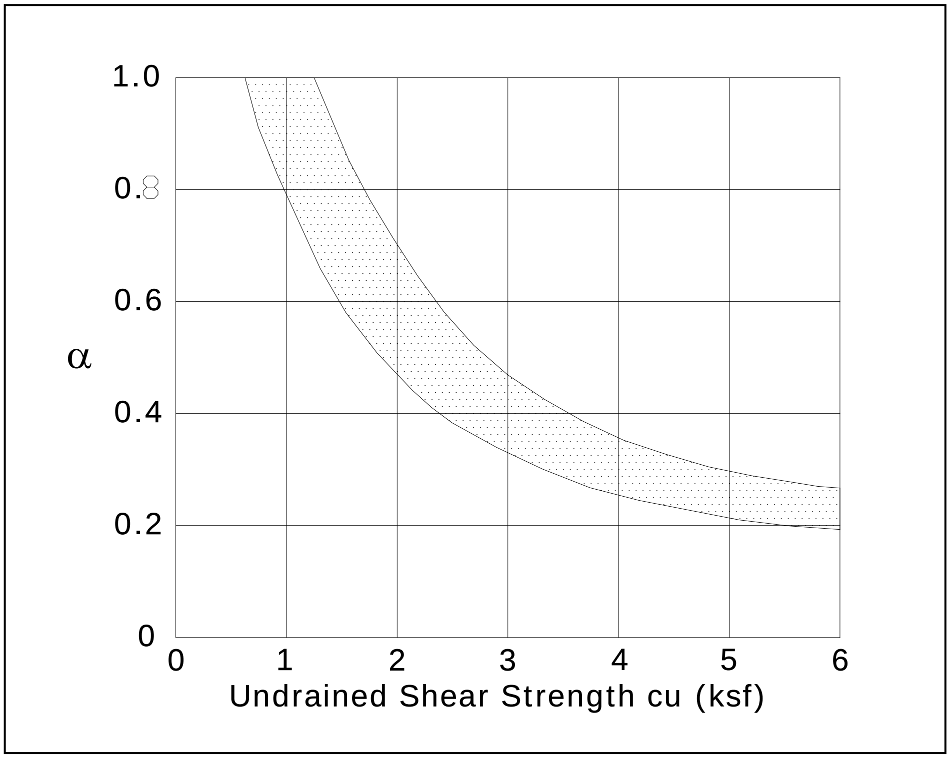


Figure 8. Adhesion Coefficient α vs. undrained Shear Strength C_u (after Das, 1984).

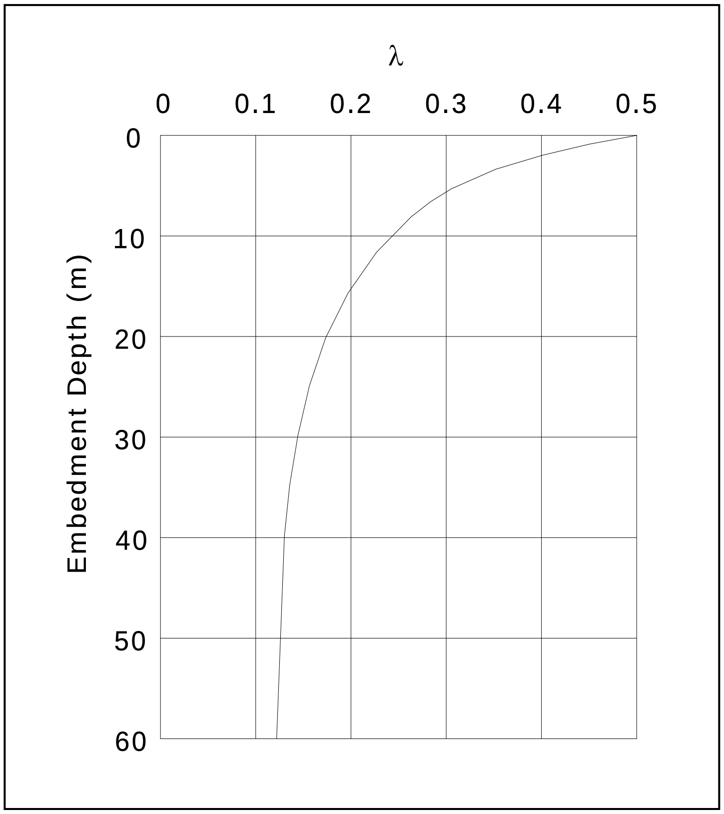


Figure 9. Coefficient λ vs. embedment depth (after Bowles, 1982 from Vijayvergiya & Focht, 1972).

The user is cautioned that none of the three methods for which information is included here were developed for use with helical piles, and most of the information presented below relates to driven piles. In comparison, helical piles typically produce lower lateral soil displacement, higher soil disturbance and a different stress distribution near the pile toe. These differences between driven piles and helical piles should be considered when selecting skin resistance factors for input to RAM JACK FOUNDATION SOLUTIONS™ software. The user should become familiar with the method of choice, particularly its idiosyncrasies and limitations, before use.

4.4.5 Nc:

Nc is the bearing capacity factor that is multiplied times the cohesion strength parameter to obtain that part of the soil's unit bearing capacity that is related to soil cohesion. Values appropriate for deep local shear should be used. The software will use a default value of 9.0 unless the user enters a different value in the soil profile table. The software's default value of 9.0 has been found to work reasonably well with natural (un-remolded) cohesion values taken as one-half the unconfined compressive strength.

4.4.6 Angle of Internal Friction:

The angle of internal friction is the slope of the Coulomb strength envelope for the soil in a stratum. The software automatically interpolates the angle of internal friction from the SPT input values based on Table 3. However the angle of internal friction value can be manually revised by the user as determined to be appropriate for the analysis. Although it does not appear directly in either the bearing capacity or skin friction equation, it is used by the software to determine the default value of Nq. The angle of internal friction will be taken as constant from the input Start Depth of each defined stratum to the input Start Depth of the next defined stratum or, in the case of the last defined stratum, to the input Maximum Depth.

The software's default values of Nq (Figure 10) have been found to work reasonably well when selected on the basis of undisturbed angle of internal friction deduced from the Standard Penetration Test. Correlations have also been developed between the angle of internal friction and the cone penetration test, plasticity index of cohesive soils and relative density. Direct-measurement tests include the direct shear test and borehole shear test. Wherever possible, the use of several methods together is recommended.

Table 3. Coarse-Grained Soil Condition and Strength Parameters vs. SPT Blow Count (after Teng, 1962).

Blow Count N (blows/ft)	Compactness	Density Index I_D (%)	Angle of Internal Friction ϕ (deg)	Moist Unit Weight γ_m (pcf)	Submerged Unit Weight γ_{sub} (pcf)
0 - 4	Very Loose	0 – 15	< 28	< 100	< 60
5 – 10	Loose	16 – 35	28 – 30	95 – 125	55 – 65
11 – 30	Medium	36 – 65	31 – 36	110 – 130	60 – 70
31 – 50	Dense	66 – 85	37 – 41	110 – 140	65 – 85
> 50	Very Dense	86 - 100	> 41	> 130	> 75

4.4.7 Coefficient of External Friction:

The coefficient of external friction B is a factor that is multiplied by the effective vertical stress to yield the frictional component of skin resistance. In the Tomlinson α model of skin resistance, B is equal to K$\tan\delta$. In the β model of skin resistance, B is equal to β. In the λ model of skin resistance, B is equal to λ.

Table 4 gives some typical angles of external friction δ and friction coefficients $\tan\delta$ for steel against various non-plastic soil types. According to ASCE (1996), the ratio of the angle of external friction to the angle of internal friction may be taken as 0.54 for sand, silt and clay. The software uses this ratio to calculate the angle of external friction δ from the estimated angle of internal friction as described in section 4.4.6. Consequently the coefficient of external friction B is estimated as $\tan\delta$ based on NAVFAC, 1986 (Table 4).

Table 4. Angle of external friction δ and friction coefficient tanδ for steel against various types of soils (NAVFAC, 1986).

Soil Type	Friction Angle δ (º)	Friction Coefficient tanδ
Clean gravel, gravel–sand mixtures, well-graded rock fill with spoils	22	0.40
Clean sand, silty sand-gravel mixtures, single size hard rock fill	17	0.30
Silty sand, gravel or sand mixed with silt or clay	14	0.25
Fine sandy silt, non-plastic silt	11	0.20

The skin resistance coefficient β has been found to vary from about 0.25 to 0.40, with an average of about 0.32. A correction factor may be appropriate for embedment depth to shaft diameter ratios exceeding 15 to 20.

Except where noted otherwise, the following information and figures come from Bowles (1982). The user is cautioned that none of the three methods for which information is included here were developed for use with helical piles, and most of the information presented below relates to driven piles. In comparison, helical piles typically produce lower lateral soil displacement, higher soil disturbance and a different stress distribution near the pile toe. These differences between driven piles and helical piles should be considered when selecting skin resistance factors for input to RAM JACK FOUNDATION SOLUTIONS™ software. The user should become familiar with the method of choice, particularly its idiosyncrasies and limitations, before use.

In the α method, the coefficient of lateral earth pressure K is often taken as the at-rest coefficient K_0 and the effective angle of external friction δ is often taken as the effective angle of internal friction φ' (Bowles, 1982).

K_0 for piles is most commonly computed as (Bowles, 1982)

$$K_0 = (1 - \sin\phi')\sqrt{OCR}$$

K_0 can also be calculated from plasticity index as (Carter and Bentley, 1991)

$$K_0 = 0.44 + 0.0042 I_p$$

4.4.8 Nq:

Nq is the bearing capacity factor that is multiplied times the effective vertical stress to obtain that part of the soil's unit bearing capacity that is related to soil internal friction. Values appropriate for deep local shear should be used. By default, the software will interpolate a value from the table below unless the user enters a different value in the soil profile table. Figure 10 provides the default values of N_q with respect to the internal friction angle.

Angle of Internal Friction, ϕ (deg)	Nq
0	1.0
5	1.6
10	2.5
15	3.9
20	6.4
25	11
30	18
35	33
40	64
45	130
50	320

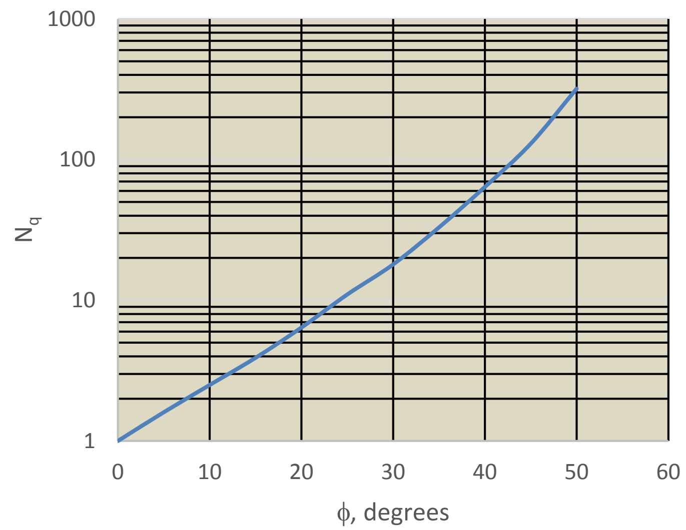


Figure 10. Default values of N_q vs. angle of internal friction ϕ

4.4.9 Soil Layer:

The drop down menu for this field consists of four options namely sand, clay, peat, and other.

Once the "Depth" and "Blow Count" values have been entered and the "Soil Layer" type selected, the software automatically estimates the cohesion, co-efficient of adhesion, internal friction angle, co-efficient of external friction, moist unit weight, saturated unit weight, and the bearing capacity factors (Nc, Nq) based on a built-in data bank.

Although the values are automatically estimated they can still be revised manually according to the user's preference. Clicking the "create" button would then result in the creation of the simulated soil stratum. If no other soil stratum is created after the initial layer, then the software assumes similar soil conditions as the first stratum continues to extend till the "maximum depth" value entered in the previous section. Additional soil layers may be added as shown in Figure 11.

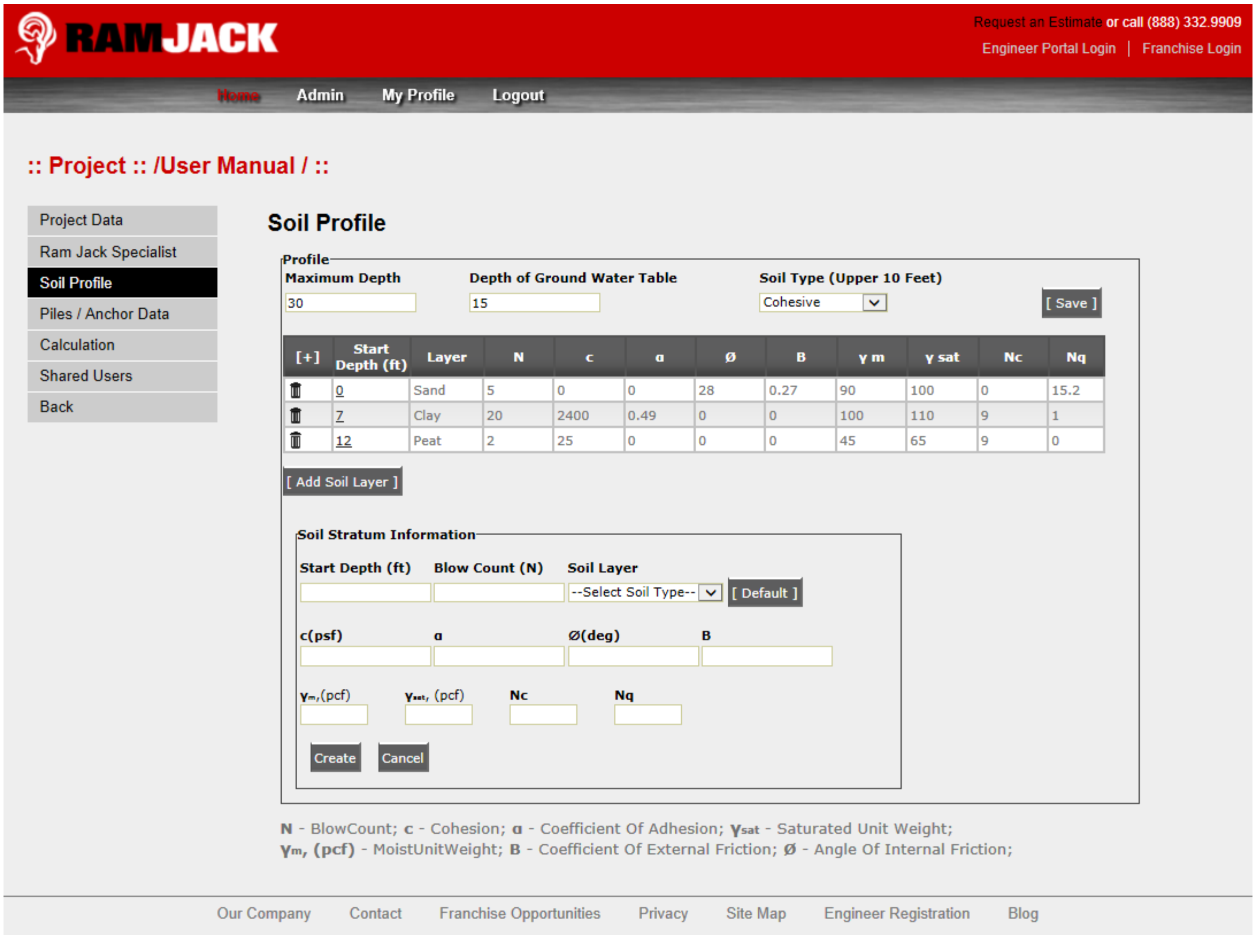


Figure 11. Screen Shot Showing Additional Soil Layers

A second or consequent soil layer can be created by clicking on the “Add Soil Layer” tab as shown in Figure 11.

Once the “Soil Stratum Information” section opens up the starting depth of the next stratum that is desired to be modeled should be entered into the “Depth” field. Similarly, the software automatically estimates the soil strength parameters based on the blow count and soil type selected.

After the required number of soil layers has been created, clicking on the “Piles/Anchor Data” tab would take you to the next section where the helical pile and helix configuration is simulated.

4.5 Piles/Anchor Data:

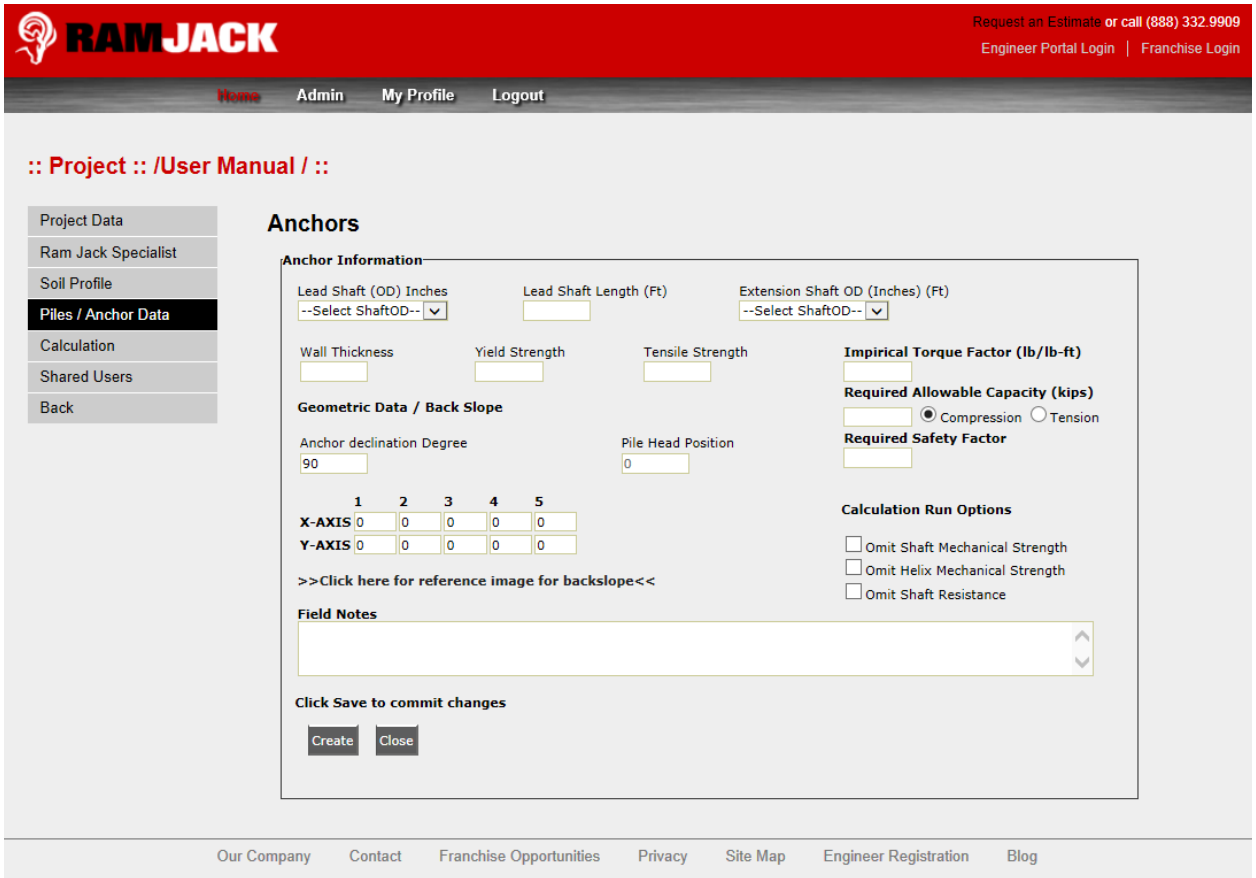


Figure 12. Anchor Information Page

4.5.1 Lead Shaft (OD) Inches:

The drop down menu under the "Lead Shaft (OD) Inches" field lets the user select either a 2⅜", 2⅞", 3½", 4½", or a custom pile diameter for the lead section as shown in Figure 12.

If a custom lead shaft diameter option is selected then the outside diameter, wall thickness (inches), yield strength (ksi), and tensile strength (ksi) would have to be entered in order to calculate the torque rating of the pile shaft.

The wall thickness (inches), yield strength (ksi), and tensile strength (ksi) fields for Ram Jack's standard 2⅜", 2⅞", 3½", and 4½" pile sizes are automatically populated and cannot be edited.

4.5.2 Lead Shaft Length (ft):

The lead shaft length should be simulated in such a way that all helices are locates on the same diameter shaft. Therefore, the lead shaft should be equal to or greater than three times the sum of the helix diameters. The software automatically checks if the simulated helix configuration can be accommodated within the length of the lead section created.

4.5.3 Extension Shaft OD (Inches):

The outside diameter of the extension shaft, in inches.

4.5.7 Back Slope Coordinates:

Back slope coordinates are coordinates of points on the locus of the intersection of the soil's surface with the vertical plane that contains the installed anchor's shaft as shown in Fig.13. If back slope coordinates are not entered, the soil surface will be assumed level for the full extent of the anchor's projection on the horizontal plane. Back slope coordinates are entered relative to the point where the anchor enters the ground, in order of increasing X-value.

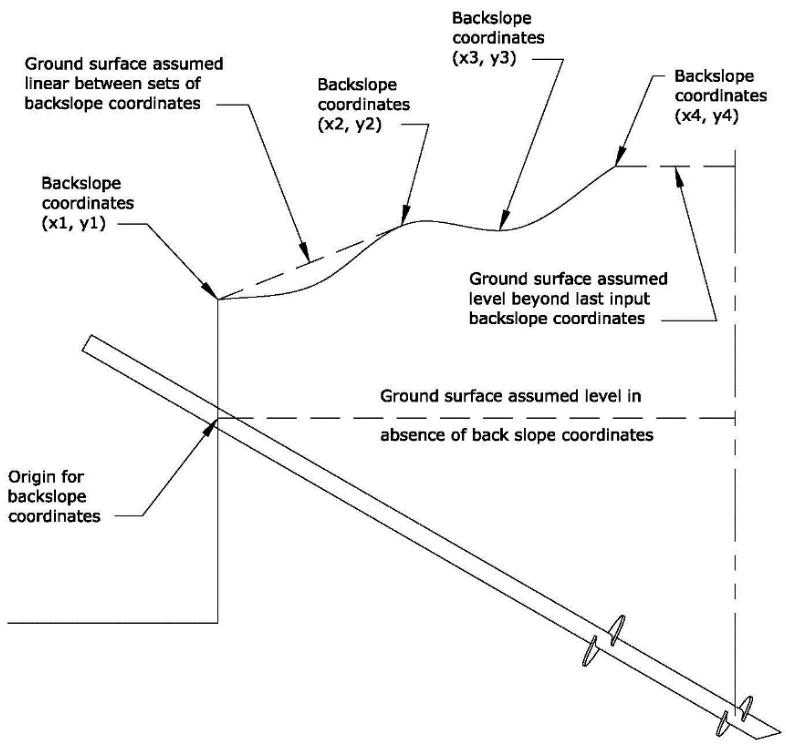


Figure 13. Example Back Slope Co-Ordinates and Origin

The largest Y coordinate value entered in the geometric data/back slope field by the user is automatically selected as the pile head position. The pile head position indicates the depth of the pile head below grade level as simulated. The geometric data/ back slope coordinates are entered typically to simulate a helical tie-back on a retaining wall or situations when the pile head is located deeper than the ground surface. The software automatically estimates the pile head position and this value cannot be edited by the user.

4.5.4 Omit Shaft Resistance:

By default, the FOUNDATION SOLUTIONS™ software computes shaft resistance components of axial capacity and torsional resistance, and adds them to the axial and torsional resistances of the helices. The user may omit shaft resistance by clicking in this check box.

4.5.5 Omit Helix Mechanical Strength Checks:

By default, the FOUNDATION SOLUTIONS™ software compares calculated individual helix capacities to the Ram Jack mechanical strength ratings for the respective helices. If the calculated helix capacity exceeds the helix mechanical strength rating, the helix mechanical strength rating is substituted. The user may omit these checks by clicking in this check box.

4.5.6 Omit Shaft Mechanical Strength Checks:

By default, the FOUNDATION SOLUTIONS™ software compares the calculated total capacity to the Ram Jack mechanical strength rating for the lead and extension shafts. If the calculated total capacity (after any helix capacity adjustments, if they are not turned off) exceeds either shaft mechanical strength rating, the lesser shaft mechanical strength rating is substituted. The user may omit these checks by clicking in this check box.

4.5.8 Empirical Torque Factor:

Hoyt and Clemence (1989) found the installation torque correlation method to be the most reliable method of estimating helical anchor capacity without a load test. In this method the anchor capacity is inferred from a function of the torsional resistance generated during anchor installation. The torsional resistance function used is called the effective torsional resistance.

The capacity estimation equation is:

$$Q_u = K_t \times T_e$$

Where,

K_t = Empirical Torque Factor

T_e = Effective Torsional Resistance

Typical Empirical Torque Factor values for the standard Ram Jack piles are as provided in Table 5.

Table 5. Typical Empirical Torque Factors Applicable to the Ram Jack Piles

Typical Empirical Torque Factors				
Shaft Diameter	**2 3/8"**	**2 7/8"**	**3 1/2"**	**4 1/2"**
Torque Rating (ft-lb)	4,000	8,000	14,000	21,000
K_t Factor	10	9	7	6

4.5.9 Required Allowable Capacity:

The allowable load capacity or the design/working load that is required to be resisted by the helical pile.

Please note that the software does not perform any buckling capacity calculations. Therefore, it is the user's responsibility to select an appropriate pile size based on the required allowable capacity, soil conditions, and pile application.
You can either select compression or tension based on the helical pile application. This selection is then used to calculate the "approximate embedment depth" and the "minimum required installation torque" in the results page.

4.5.10 Required Safety Factor:

The safety factor that has to be applied to the "required allowable capacity" to estimate the required ultimate capacity. This would typically be provided by the Engineer of Record (EOR).

Required Ultimate Capacity = Required Allowable Capacity × Required Safety Factor

Note:

1. The Empirical Torque Factor, Required Allowable Capacity, Required Safety Factor is unique to each helical pile that is created.
2. Therefore a number of piles with different helical pile diameters, helix configurations, required allowable capacities, empirical torque factors, and factor of safeties can be created within the same data file.

Once all the above information has been entered, click on the Create button to create the simulated pile shaft and open the helix section below.

4.5.11 Adding Helical Plates/Modeling the Helix Configuration:

Once the helix plate section opens up, the helix configuration may be simulated by adding the required size and number of plates from the drop down menu as desired. Once the desired helical plate size has been selected and the helix count entered, clicking on the create tab would result in the creation of the respective helical plate(s). To add an additional helical plate with a different diameter simply select the helical plate size from the drop down menu and click create after entering the helix count. This would result in simulation of the most recently selected helical plate size in addition to the already created helical plate(s).

The drop down menu consists of options to add 8", 10", 12", 14", and 16" diameter helical plates. A custom helical plate size may also be modeled by selecting the "custom" option. However, the structural strength of the custom helical plate would have to be estimated based on the material properties, diameter of the shaft, diameter of the helical plate, and thickness of the helical plate. Consequently the maximum load rating of the custom helical plate would have to be entered into the "rating" field to proceed with the calculations.

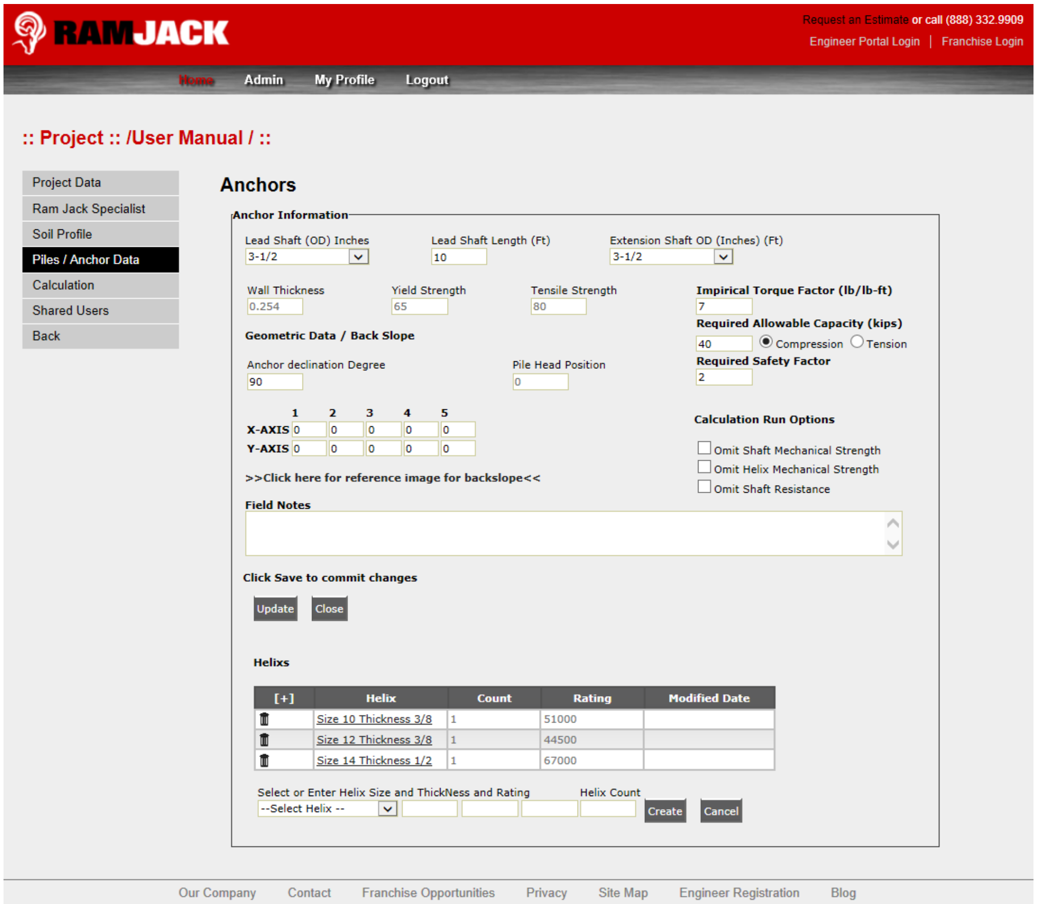


Figure 14. Typical Anchor Page Displaying the Helix Section

Please note that the maximum load rating would automatically be estimated for the standard helical plate sizes once selected.

4.5.12 Delete a Previously Created Helical Plate:

Once a helical plate has been created it would be indicated as shown in Fig. 15. In order to delete an existing helical plate clicking on the button allows the user to click on the Delete button to delete the respective helical plate.

4.5.13 Editing an existing/created pile:

Once a pile has been created it would be indicated as shown in Fig. 15. In order to edit the existing pile, clicking on the respective pile link "Size [2.875], Helix Configuration[8-10]" opens the "Anchor Information" section. Here you can modify any of the helical pile shaft specification such as the pile shaft size, helix configuration, empirical torque factor, required allowable capacity, safety factor, etc. Once the desired values have been modified then clicking on the Update button would then update the helical pile specification.

4.5.14 Delete Existing Helical Pile:

Once a pile has been created it would be indicated as shown in Fig. 15. In order to delete an existing pile, clicking on the button respective to that particular pile opens up the "Anchor Information" section. Here you can click on the Delete button to delete the respective helical pile.

4.5.15 Create an Additional Pile with Different Specifications:

The software allows the user to create as many individual anchors within the same data file as desired. For example the user can model piles for different helical pile applications such as a Helical Tie-Back's, Helical Piles in Axial Compression and Axial Tension, Retaining Wall Anchors, etc. In addition, these piles may have different pile diameter, installed at different declination angles, have different empirical torque factors, required allowable capacities, safety factors, and helix configurations.

In order to add additional piles, clicking on the Add button as shown in Figure 15. would open up the anchor information page where the new helical pile specification can be entered. Once all the helical specification for the new helical pile has been entered, clicking on the Create button would once again create the new additional pile.

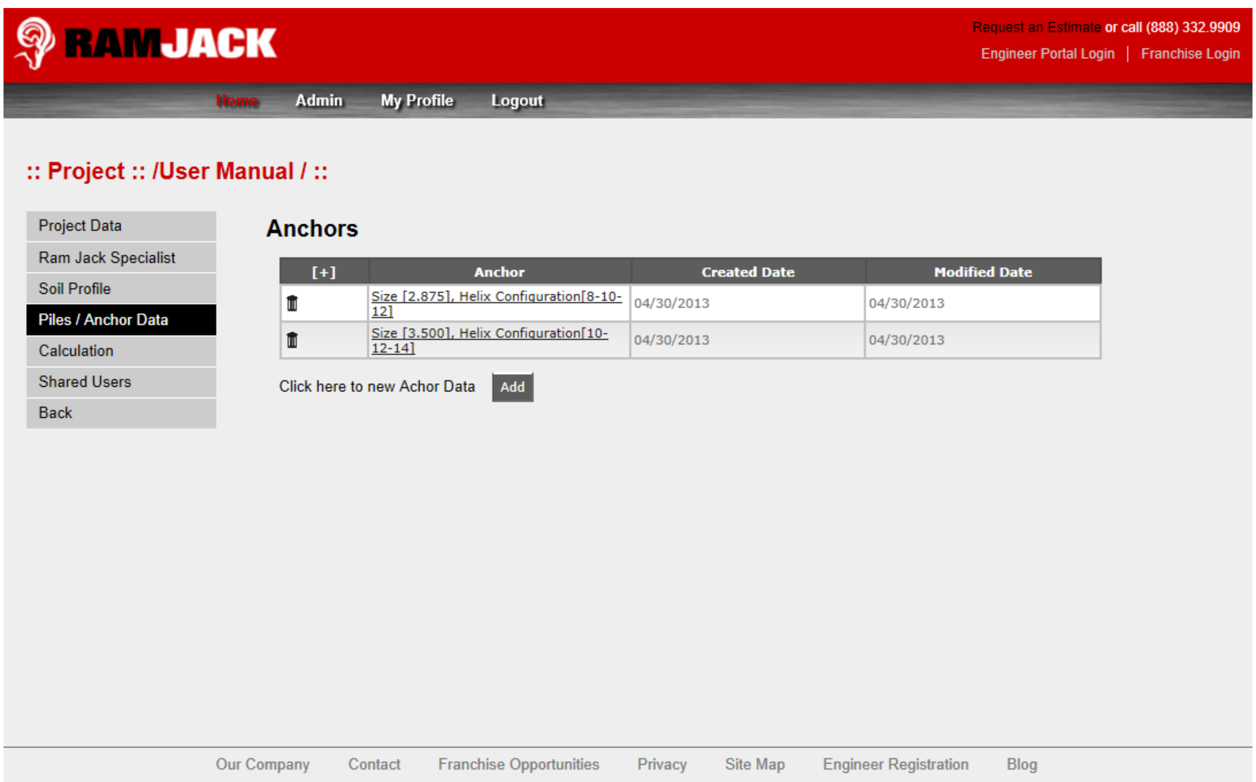


Figure 15. Anchor Page Post-Simulating an Anchor

4.6 Calculation (Results):

4.6.1 Ultimate Axial Capacity:

The software solves for ultimate axial capacity, defined as the load which would cause a Helix Screw Anchor to either pull out of the ground or plunge into the ground. It is important to recognize that, should this load be applied to the anchor, the anchor head would be expected to move without limit. Thus, this software is most helpful in assessing anchor performance relative to the strength limit state. Many foundation engineers choose to define ultimate load in relation to a serviceability limit state, defined by a maximum allowable movement, say ½" or 1", at the anchor head or toe. Because bearing elements like the helices of Helix Screw Anchors typically have to move from 10% to 30% of their diameter before they develop their ultimate axial capacity by the pullout or plunging definition, this software will normally overestimate ultimate loads that are defined in relation to typical values of allowable movement. In such cases, the user should make a separate assessment of expected anchor movement to ensure the anchor will meet serviceability performance requirements.

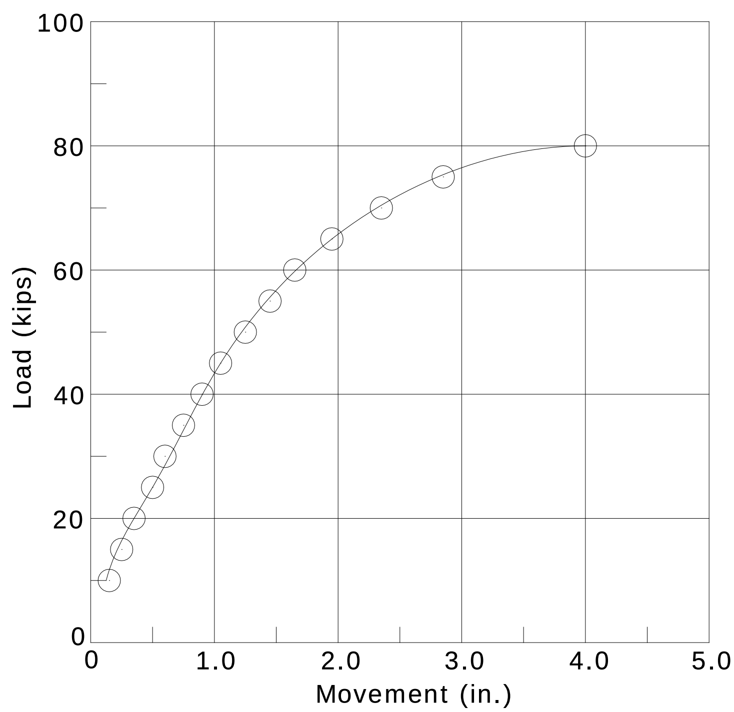


Figure 16. Load movement curve for 12-12-12 helical anchor in medium dense, fine to medium sand (Clemence, et al, 1994).

Figure 16 shows a typical load vs. movement curve for a helical anchor. The anchor consisted of three 12" helices on a 2" round-cornered square bar shaft and was embedded 10 feet in medium dense, fine to medium sand (Clemence, et al, 1994). The ultimate pullout capacity was 80 kips, attained at a head movement of 4 inches (0.33 times the largest helix diameter). Note that if the ultimate capacity were defined as that load which produces a head movement of, for instance, 1 inch, the ultimate capacity would only be 42 kips. The shape of the load/movement curve indicates that if 80 kips were applied to the anchor in a stress-controlled test, head movement would continue without limit. In many cases, continuing a strain-controlled test beyond the ultimate pullout or plunging capacity will result in a reduction of load resistance to a residual value.

4.6.2 Terzaghi Bearing Capacity Equation

The Terzaghi bearing capacity equation has been used for decades to estimate ultimate capacities of bearing-type foundation elements. The Terzaghi equation is

$$qu = c\,N_c + q_v\,N_q + \tfrac{1}{2}\,\gamma B\,N_\gamma$$

where qu = unit ultimate bearing capacity

c = cohesion soil strength parameter

Nc = bearing capacity factor

qv = effective vertical stress

Nq = bearing capacity factor

g = soil unit weight

B = least lateral dimension of bearing area

Nc = bearing capacity factor

This equation applies to shallow foundations. It is often used with modifying factors that account for load, slope or foundation inclination, foundation shape and/or foundation depth.

For deep foundations, the bearing capacity equation is usually modified to

$$qu = c\,N_c + q_v\,N_q$$

because the $\tfrac{1}{2}\,\gamma B\,N_\gamma$ term proves to be negligible. "Deep" foundations are foundations like piles and drilled shafts having bearing areas located at sufficient depth to cause local shearing of the soil without propagation of the shear surface to the ground surface. With helical anchors, deep local shear occurs when the distance from the ground surface to the last helix exceeds some limiting number, reported by various investigators to be as little as four times the helix diameter (Trofimenkov and Mariupolskii, 1965, Sowers and Sowers, 1970) and as great as 16 times the helix diameter (Ghaly and Hanna, 1994). Ram Jack recommends Ram Jack FOUNDATION SOLUTIONS™ software be used only to estimate capacities of helical anchors where the last helix is embedded at least 4 feet vertically below the soil surface and at least 5 times its own diameter in cohesive, or 7 times its

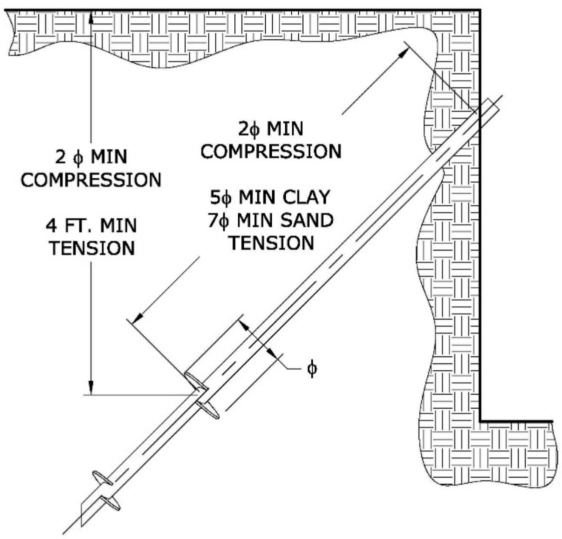


Figure 17. "Deep" anchor criteria.

own diameter in non-cohesive, soil, measured along the shaft from the point where the anchor enters the soil. For compressive loading, the last helix should be embedded at least two times its own diameter vertically below the soil surface and along the shaft from the point where the shaft enters the soil (Figure 17).

Testing experience has shown that typical variations in helix shape and inclination have minimal effect on the capacity of deep anchors as described above, thus no adjustment factors are ordinarily used.

4.6.3 Shaft Resistance

Shaft resistance is the resistance the soil presents to axial or rotational movement of the anchor shaft. The equation used in Ram Jack FOUNDATION SOLUTIONS™ software lends itself to use of either the α, β or λ method of computing shaft resistance.

The α method, proposed by Tomlinson (1971), is characterized by the modified Coulomb strength equation

$$f_s = \alpha\, c + q_v\, K \tan\delta$$

where

f_s ≡ unit skin resistance

α ≡ adhesion factor

c ≡ cohesion soil strength parameter

q_v ≡ effective vertical stress

K ≡ coefficient of lateral earth pressure

δ ≡ effective friction angle between soil and pile

Others propose that unit skin resistance is more closely correlated with effective stress soil strength parameters. Thus

$$fs = \beta\, qv$$

Vijayvergiya and Focht (1972) proposed yet another method for computing unit skin resistance in clays as

$$fs = \lambda(qv + 2c)$$

In all cases, the unit skin resistance fs is multiplied by the contact area to obtain the resisting force Fs.

RAM JACK FOUNDATION SOLUTIONS™ software utilizes a simplified α approach that lends itself to use with α, β or λ factors:

$$fs = A\, c + B\, qv$$

where fs $\equiv$ unit skin resistance

A $\equiv$ adhesion coefficient

c $\equiv$ cohesion soil strength parameter

B $\equiv$ coefficient of external friction

qv $\equiv$ effective vertical stress

Note that with proper interpretation and input of the A and B coefficients, this equation can be used with either the α, β or λ model of skin resistance.

For the α method,

$$A = \alpha$$

$$B = K \tan\delta$$

For the β method,

$$A = 0$$

$$B = \beta$$

For the λ method,

$$A = 2\lambda$$

$$B = \lambda$$

Although the software automatically interpolates the A and B coefficients as described in sections 4.4.4 and 4.4.7 the user can manually revise those values based on the desired model. Regardless of whether the input values of A and B are derived from the α, β or λ model, the software will compute the shaft resistance the same way. The shaft is first divided into two sections, a lead section and an extension section, at the point indicated by the user's input value of Lead Shaft Length. Then the lead section is subdivided at the helix locations. For load capacity analysis, the lead shaft section ends are re-defined to allow for a one-helix-diameter "dead" zone on the bearing side (upper side for tension, lower side for compression) of each helix. Then all sections are further subdivided at points where they cross the phreatic surface and soil stratum boundaries. For each of these sections, the unit skin resistance is computed as detailed above for the section midpoint, and multiplied times the surface area of the section to obtain individual section resistances. Finally, the individual section resistances are summed to obtain the total shaft resistance.

Shaft torsional resistance is computed much the same way, with the single exception that no "dead" zones are considered.

4.6.4 Graphical View:

Once all the pile shaft and helical plate specifications have been entered, clicking on the Calculation tab initiates the calculation to estimate the required minimum installation torque and the approximate embedment depth to achieve the required allowable capacity.

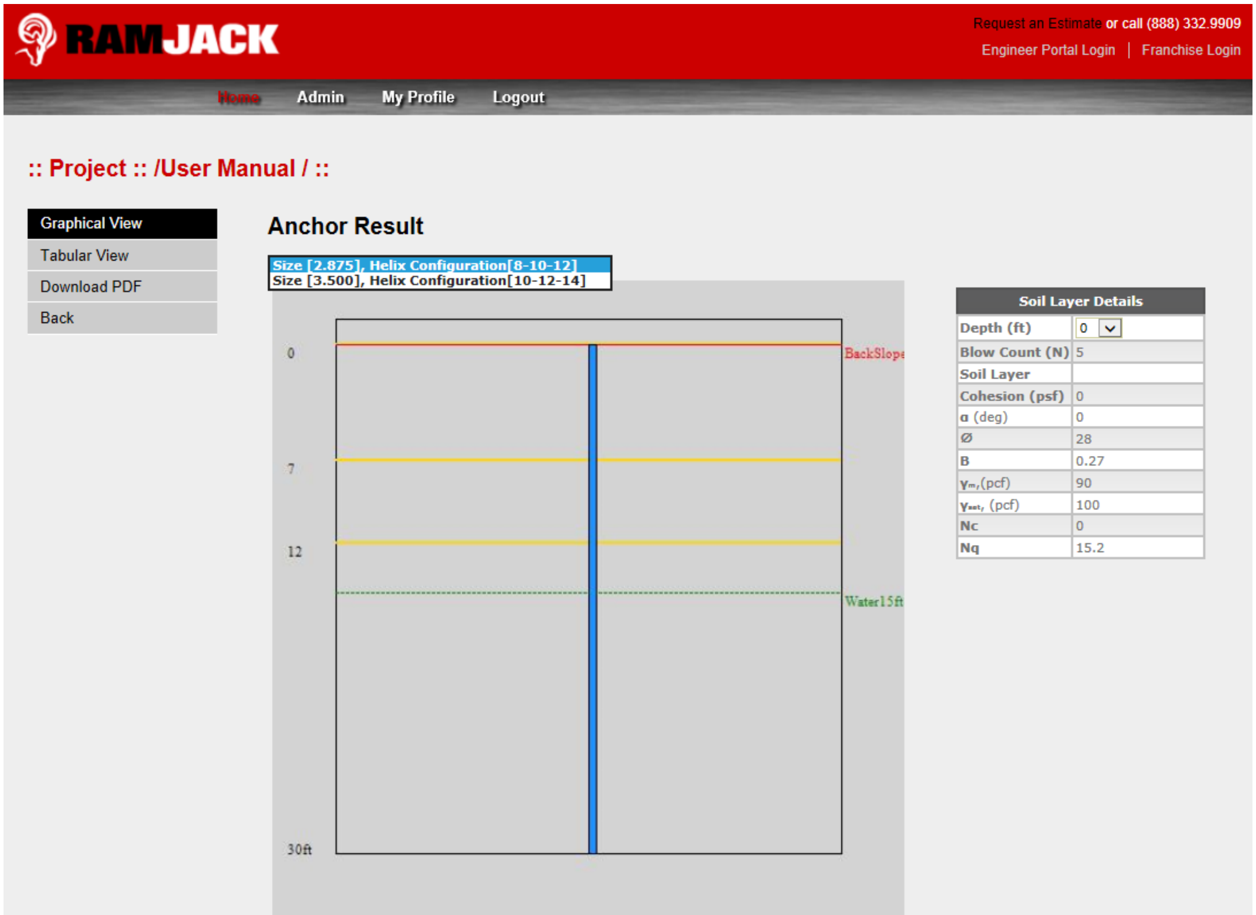


Figure 18. Typical Anchor Results Page Displaying the Graphical View

Typically, the calculation (anchor results) page is displayed as shown in Fig. 18. The Graphical view page also displays a soil profile view which serves as a useful tool to validate the model created. The “Soil Layer Details” table next to the soil profile image displays the soil parameters that have been entered for a particular soil stratum. The soil properties for the different soil stratums created may be viewed in the table by selecting the appropriate start depth value from the “Depth” drop down menu. Similarly, the back slope profile, depth of water table, and anchor declination angle is also indicated in this image.

It can also be noted that the top left corner of the page has a drop down menu to select the different helical piles simulated. The selected pile orientation would be displayed respectively in the soil profile image.

The “Graphical View” tab also presents a graph which displays the ultimate allowable capacity with embedment depth and installation torque as shown in Fig.19.

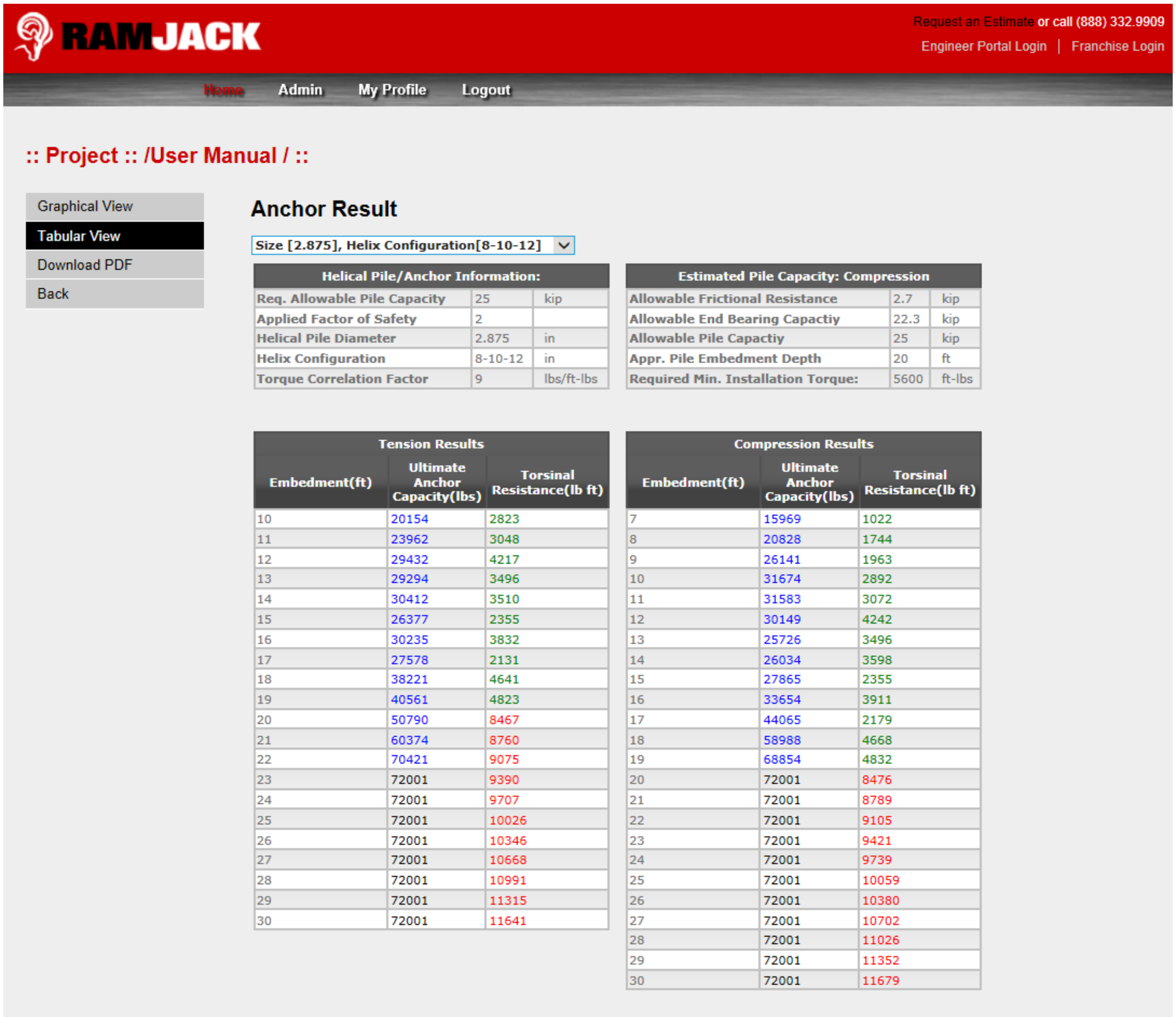
Figure 19. Typical Pile Capacity Graphs

4.6.5 Tabular View:

The "Tabular View" consists of three tables. The top left hand side table displays the helical pile/anchor information such as the required load capacity, safety factor, empirical torque factor, pile diameter, and helix configuration. The top right hand side table consists of the estimated pile capacities that are reported in the output generated. This table contains the Allowable pile capacity, approximate embedment depth at which the required capacity is achieved, and the minimum torque at which the piles would have to be installed to achieve the required capacity.

The tension and compression results for the particular helical pile that has been selected are presented below these two tables. The tension and compression results table presents the ultimate capacity that would be developed with depth (1ft intervals) and the installation torque that would be required. The results for a different helical pile that was created can be accessed by selecting the respective pile from the drop down menu on the top left corner above the referenced tables.

Please note that since soil is heterogeneous in nature the estimated embedment depth is only approximate and can vary based on the actual field conditions. Therefore, it is the user's responsibility to model the soil parameters that are representative of the field conditions at the project site. A typical tabular results view is shown in Fig. 20.



Helical Pile/Anchor Information:		
Req. Allowable Pile Capacity	25	kip
Applied Factor of Safety	2	
Helical Pile Diameter	2.875	in
Helix Configuration	8-10-12	in
Torque Correlation Factor	9	lbs/ft-lbs

Estimated Pile Capacity: Compression		
Allowable Frictional Resistance	2.7	kip
Allowable End Bearing Capactiy	22.3	kip
Allowable Pile Capactiy	25	kip
Appr. Pile Embedment Depth	20	ft
Required Min. Installation Torque:	5600	ft-lbs

Tension Results		
Embedment(ft)	Ultimate Anchor Capacity(lbs)	Torsinal Resistance(lb ft)
10	20154	2823
11	23962	3048
12	29432	4217
13	29294	3496
14	30412	3510
15	26377	2355
16	30235	3832
17	27578	2131
18	38221	4641
19	40561	4823
20	50790	8467
21	60374	8760
22	70421	9075
23	72001	9390
24	72001	9707
25	72001	10026
26	72001	10346
27	72001	10668
28	72001	10991
29	72001	11315
30	72001	11641

Compression Results		
Embedment(ft)	Ultimate Anchor Capacity(lbs)	Torsinal Resistance(lb ft)
7	15969	1022
8	20828	1744
9	26141	1963
10	31674	2892
11	31583	3072
12	30149	4242
13	25726	3496
14	26034	3598
15	27865	2355
16	33654	3911
17	44065	2179
18	58988	4668
19	68854	4832
20	72001	8476
21	72001	8789
22	72001	9105
23	72001	9421
24	72001	9739
25	72001	10059
26	72001	10380
27	72001	10702
28	72001	11026
29	72001	11352
30	72001	11679

Figure 20. Typical Tabular View Results Page

4.7 Generating a PDF Report:

In order to print a report for a particular helical pile, that respective helical pile must be selected in the "Graphical View" or the "Tabular View" results page. Once the results for the pile is displayed in the appropriate screen clicking on the Download PDF button opens up a pop up window prompting you to open or save the report in your PC. A typical output report is as follows.

5. SAMPLE PROBLEMS

5.1 Anchor/Tie-Back on a Retaining Wall

<u>Problem 1.</u> Design a Helical Anchor/Tie-Back for a Retaining Wall.

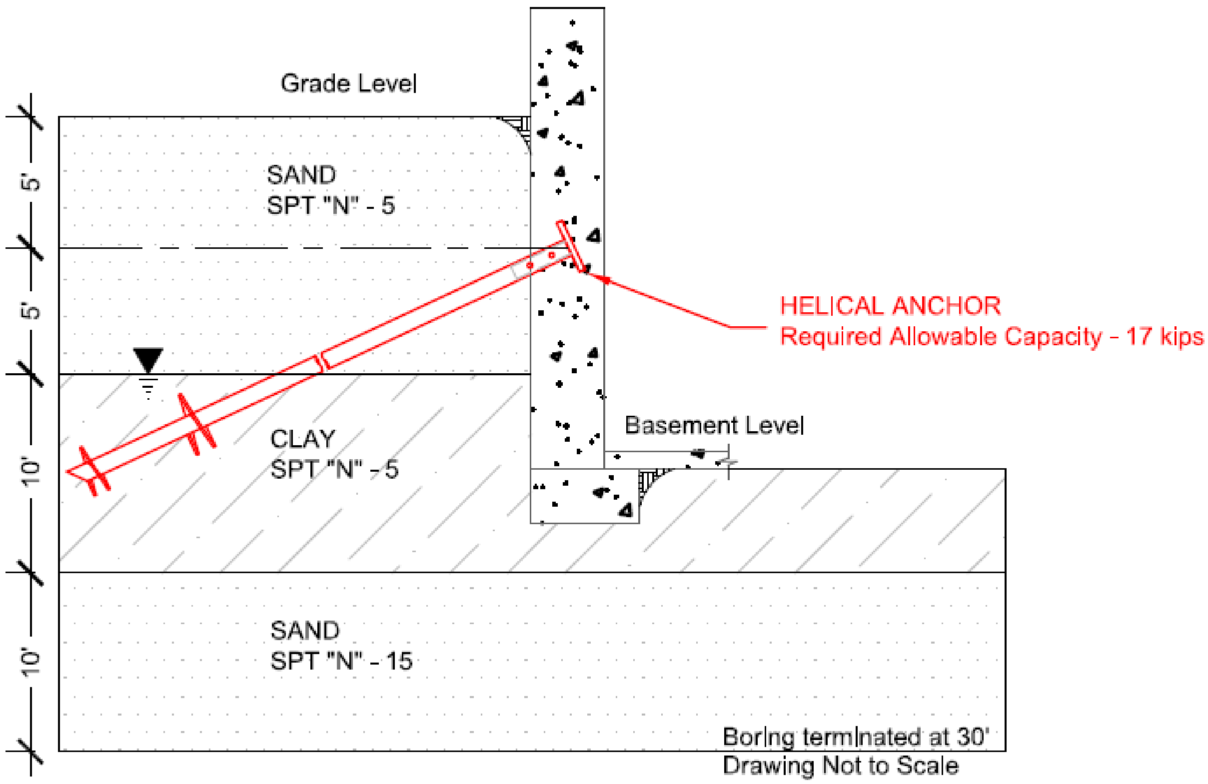


Figure 21. Soil description and anchor layout for problem 1.

Based on Figure 21 it can be seen that a Helical Anchor with a maximum allowable capacity of 25 kips in tension is required. In addition, the soil layers, SPT blow count values, depth of water table, and back slope profile is as shown in the above figure. In order to describe how to simulate the respective soil condition and helical anchor through the software, the screen shots of the different pages have been show as follows. The "Project Information" and "Ram Jack Specialist Information" screen shots are not included since they do not provide any input values for calculation purposes.

Problem 1. Contd.

Step:1
Determination of the actual required allowable capacity accounting for the inclination angle of the helical anchor. Let us assume an inclination angle of 30 degrees from the horizontal for this particular problem. Typically, the inclination angle would be chosen taking in account any field obstructions above and below ground level and space limitation issues.

Actual required allowable capacity of the helical anchor = $\frac{17}{\cos 30} \cong 20$ kips (Tension)

Step:2
In order to start the project the user would have to click on the "Create Project" tab to open the Project Information page. Here all the project information including the project number, soil report information, project address, etc. are entered. In addition, there is a field notes section where any anomalies or important field conditions are entered so that it is printed out in the output report. The city and state are required fields. Once the required information is entered clicking on the Save button takes the user to the Ram Jack Specialist Information page.

Step:3
The next step would be to enter information in the Ram Jack Specialist Information page. In this step the name of the potential Ram Jack dealer/salesman who would install the anchor would be entered. www.ramjack.com has all our dealer information and the user can access this website to find the nearest dealer or contact us by telephone for additional information.

Step:4
The available soils information would be simulated in the software as shown in the screen shot below in step 4. Once all the information is entered, click on the Piles / Anchor Data tab to proceed to the anchor page.

Profile

Maximum Depth: 30
Depth of Ground Water Table: 10
Soil Type (Upper 10 Feet): NonCohesive
[Save]

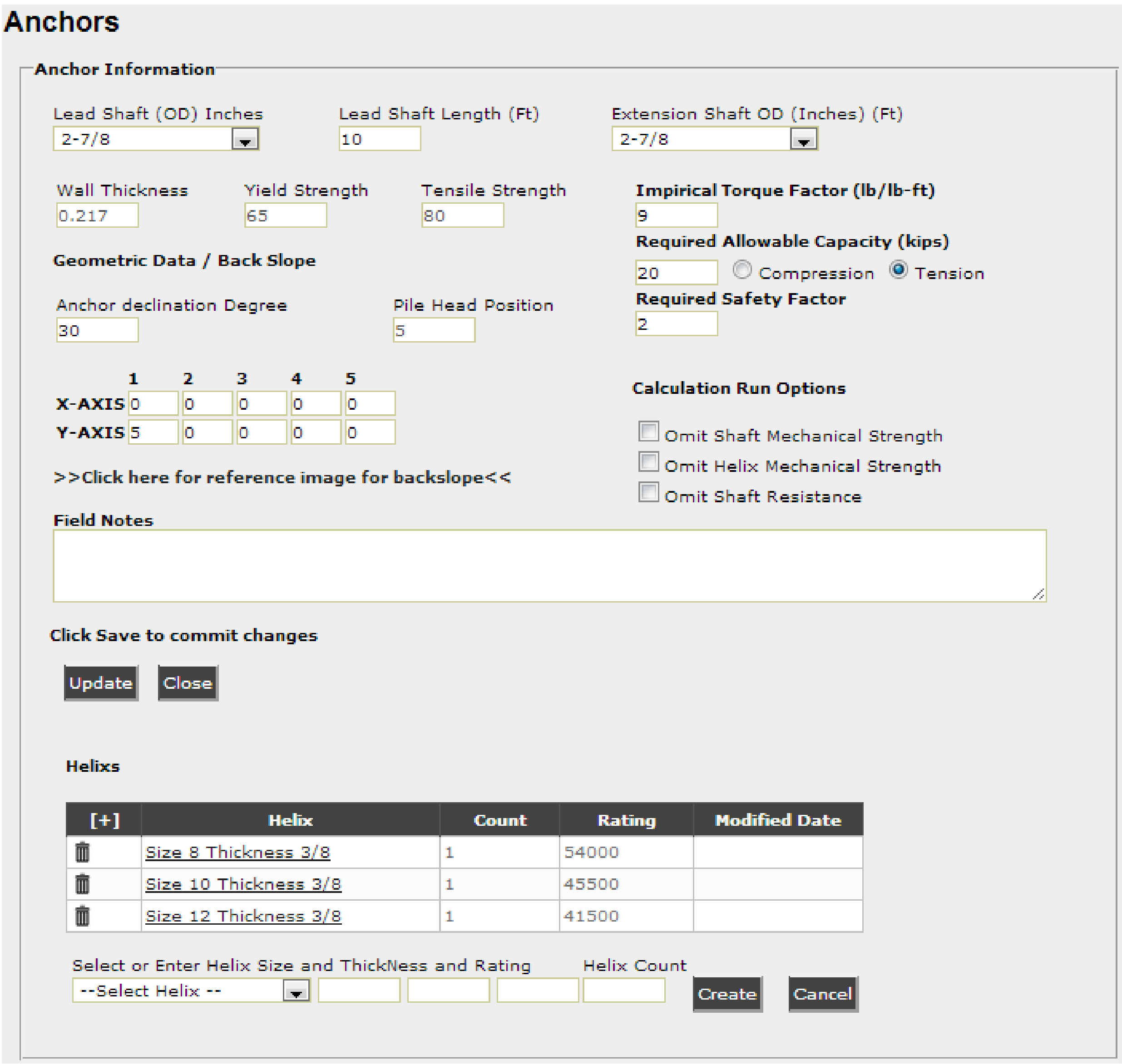
[+]	Start Depth (ft)	Layer	N	c	α	Ø	B	γ m	γ sat	Nc	Nq
	0	Sand	5	0	0	28	0.27	90	100	0	15.2
	10	Clay	5	500	0.9	0	0	100	110	9	1
	20	Sand	15	0	0	32	0.31	100	110	0	24

[Add Soil Layer]

Problem 1. Contd.

Step:5

In Step 5, the desired helical pile would be simulated using the drop down menu's and input fields in the anchors page as shown in the screen shot below. However, before proceeding with this step the user would have to decide on the pile shaft diameter based on the required allowable capacity, pile loading (tension or compression), unbraced length, eccentric loading, and other field requirements.

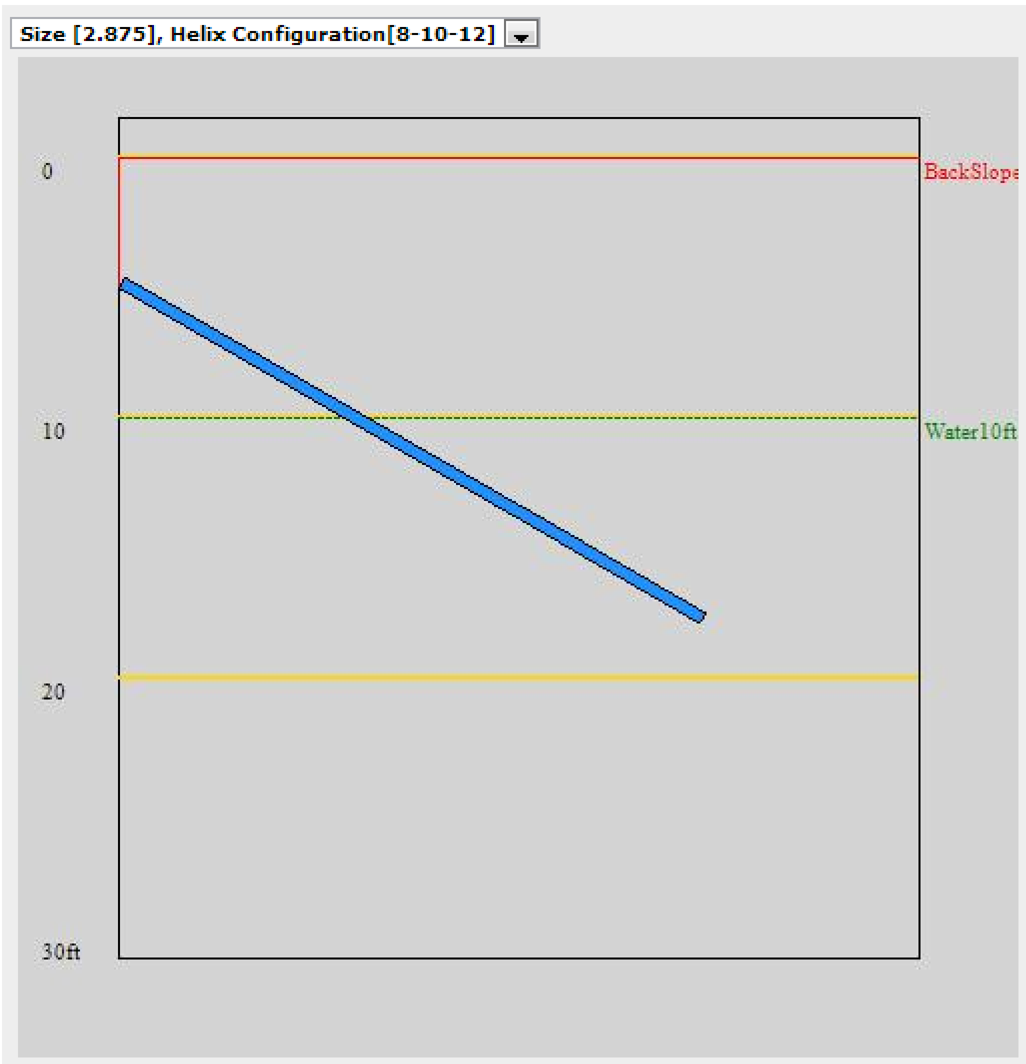


Once all the information is entered as shown above click on the Calculation tab to proceed to the next step.

Problem 1. Contd.

Step:6

In Step 6, under the calculation tab the software would automatically display an image of the soil conditions, pile layout, and back slope coordinates as entered by the user. Here the user can verify and review if the input information has been modeled correctly and is representative of the field conditions in which the helical piles/anchors would be installed. Based on the screen shot below it can be verified that the simulated model is satisfactorily close to the field condition as described in figure 21.



Step 7:

Step 7 would be to review the results by clicking on the **Tabular View** tab. The results as estimated by the software is presented as shown in the following screen shot

Anchor Result

Size [2.875], Helix Configuration[8-10-12]

Helical Pile/Anchor Information:		
Req. Allowable Pile Capacity	20	kip
Applied Factor of Safety	2	
Helical Pile Diameter	2.875	in
Helix Configuration	8-10-12	in
Torque Correlation Factor	9	lbs/ft-lbs

Estimated Pile Capacity: Tension		
Allowable Frictional Resistance	1.93	kip
Allowable End Bearing Capactiy	18.07	kip
Allowable Pile Capactiy	20	kip
Appr. Pile Embedment Depth	34	ft
Required Min. Installation Torque:	5800	ft-lbs

Tension Results		
Embedment(ft)	Ultimate Anchor Capacity(lbs)	Torsinal Resistance(lb ft)
12	8184	1034
13	8547	1022
14	9210	1103
15	9394	1031
16	9606	1053
17	9763	1081
18	9801	1110
19	10047	1139
20	10294	1168
21	10538	1196
22	10779	1224
23	11014	1251
24	11244	1277
25	11469	1303
26	11688	1327
27	11901	1351
28	12110	1376
29	12315	1400
30	12521	1424
31	19860	3037
32	23790	3090
33	39385	5744
34	45810	5828

Compression Results		
Embedment(ft)	Ultimate Anchor Capacity(lbs)	Torsinal Resistance(lb ft)
7	5906	502
8	6988	622
9	7791	743
10	8426	865
11	9029	932
12	9222	1035
13	9310	1035
14	9402	1108
15	9378	1037
16	9624	1066
17	9871	1095
18	10117	1124
19	10361	1153
20	10602	1182
21	10834	1210
22	11060	1238
23	11279	1264
24	11493	1291
25	11701	1316
26	11907	1340
27	12112	1365
28	12319	1389
29	19630	1414

Step 8:

Step 8 would be to download the professional PDF output report by clicking on the **Download PDF** tab. The following three pages show a sample of the report that would be generated consequently.

RAMJACK FOUNDATION SOLUTIONS ™

Project Name
User manual 1

Project Address
Garland,TX

Analysis By
Name : Sam Rosenberk Phd.,
Company : Ramjack Systems Distribution
Email : srosenberk@ramjack.com

Pile Information
Project Type : Unknown / Project Number :
Pile Specification : Size [2.875] / Helix Configuration : 8-10-12

Ram Jack Specialist Information
Name :
Email :
Company/Firm Name :

Field Notes

Page 1

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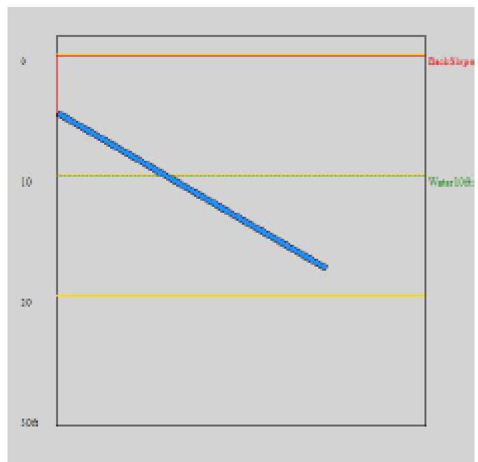
RAMJACK FOUNDATION SOLUTIONS ™

Analysis Options

Omit Shaft Resistance	Omit Mechanical Strength Checks	Omit Shaft Strength Checks
No	No	No

Soil Information

Provided/Performed by :	
Soil Report #	
Soil Report Date	
Boring #	
Boring Log Date	
Boring Termination Depth :	ft
Depth of Ground Water Table	10 ft
Maximum Depth	30 ft
Soil Type (Upper 10 Feet)	NonCohesive



Geometric Data

	1	2	3	4	5
X	0	0	0	0	0
Y	5	0	0	0	0

Inclination Angle 30(deg)

Pile Head Position 5

Soil Profile

Depth (ft)	SPT Blow Count (N)	Layer	Cohesion (psf)	Adhesion Coefficient	Internal Friction Angle (deg)ø	Friction Co-efficient B	Moist Unit Weight (pcf)	Sat Unit Weight (pcf)	Nc	Nq
0	5	Sand	0	0	28	0.27	90	100	0	15.2
10	5	Clay	500	0.9	0	0	100	110	9	1
20	15	Sand	0	0	32	0.31	100	110	0	24

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RAMJACK FOUNDATION SOLUTIONS ™

Helical Pile/Anchor Information:

Req. Allowable Pile Capacity :	20	kip
Applied Factor of Safety	2	
Helical Pile Diameter	2.875	in
Helix Configuration	8-10-12	in
Torque Correlation Factor	9	lbs/ft-lbs

Pile Capacity Theory

End Bearing

$$q_u = cN_c + qN_q$$

q_u - Ultimate End Bearing Capacity, psf
c - Cohesion, psf
N_c & N_q - Bearing Capacity Factors
q - Effective Vertical Stress, psf

Skin Friction

$$f_s = \alpha c + K \sigma_v' \tan \delta$$

fs = ultimate capacity from skin friction
α – Adhesion Factor
c = cohesion, psf
σ_0' = Effective Vertical Stress, psf
δ = Angle of External Friction = 0.54 (φ)

Estimated Pile Capacity:

Tension Results

Allowable Frictional Resistance:	1.93	kip
Allowable End Bearing Capactiy:	18.07	kip
Allowable Pile Capactiy:	20.0	kip
Appr. Pile Embedment Depth:	34	ft
Required Min. Installation Torque:	5800	ft-lbs

NOTE:

1.The reported "Appr. Pile Embedment Depth" is only an approximate estimate of the embedment depth and may vary based on the actual field conditions.

2.It is crucial to install the pile to the reported "Required Min. Installation Torque" value to realize the required allowable load capacity unless approved otherwise by a licensed professional engineer.

Tension Results		
Embedment (ft)	Ultimate Anchor Capacity (lbs)	Torsinal Resistance (lb ft)
12	8184	1034
13	8547	1022
14	9210	1103
15	9394	1031
16	9606	1053
17	9763	1081
18	9801	1110
19	10047	1139
20	10294	1168
21	10538	1196
22	10779	1224
23	11014	1251
24	11244	1277
25	11469	1303
26	11688	1327
27	11901	1351
28	12110	1376
29	12315	1400
30	12521	1424
31	19660	3037
32	23790	3090
33	39385	5744
34	45810	5828
35	60908	9745
36	70339	9869
37	72001	9999
38	72001	10129
39	72001	10260
40	72001	10391
41	72001	10522
42	72001	10654
43	72001	10786
44	72001	10918
45	72001	11051
46	72001	11184
47	72001	11317
48	72001	11450
49	72001	11584
50	72001	11719
51	72001	11853
52	72001	11988
53	72001	12123
54	72001	12259
55	72001	12395
56	72001	12531

Compression Results		
Embedment (ft)	Ultimate Anchor Capacity (lbs)	Torsinal Resistance (lb ft)
7	5906	502
8	6988	622
9	7791	743
10	8426	865
11	9029	932
12	9222	1035
13	9310	1035
14	9402	1108
15	9378	1037
16	9624	1066
17	9871	1095
18	10117	1124
19	10361	1153
20	10602	1182
21	10834	1210
22	11060	1238
23	11279	1264
24	11493	1291
25	11701	1316
26	11907	1340
27	12112	1365
28	12319	1389
29	19630	1414
30	29305	1438
31	39205	3058
32	54223	3103
33	69495	5765
34	72001	5844
35	72001	9760
36	72001	9890
37	72001	10020
38	72001	10151
39	72001	10282
40	72001	10413
41	72001	10544
42	72001	10676
43	72001	10808
44	72001	10941
45	72001	11074
46	72001	11207
47	72001	11340
48	72001	11474
49	72001	11608
50	72001	11743
51	72001	11878

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5.2 New Construction Pile (Compression Loading)

Problem 2. Design a Helical pile to support column loads.

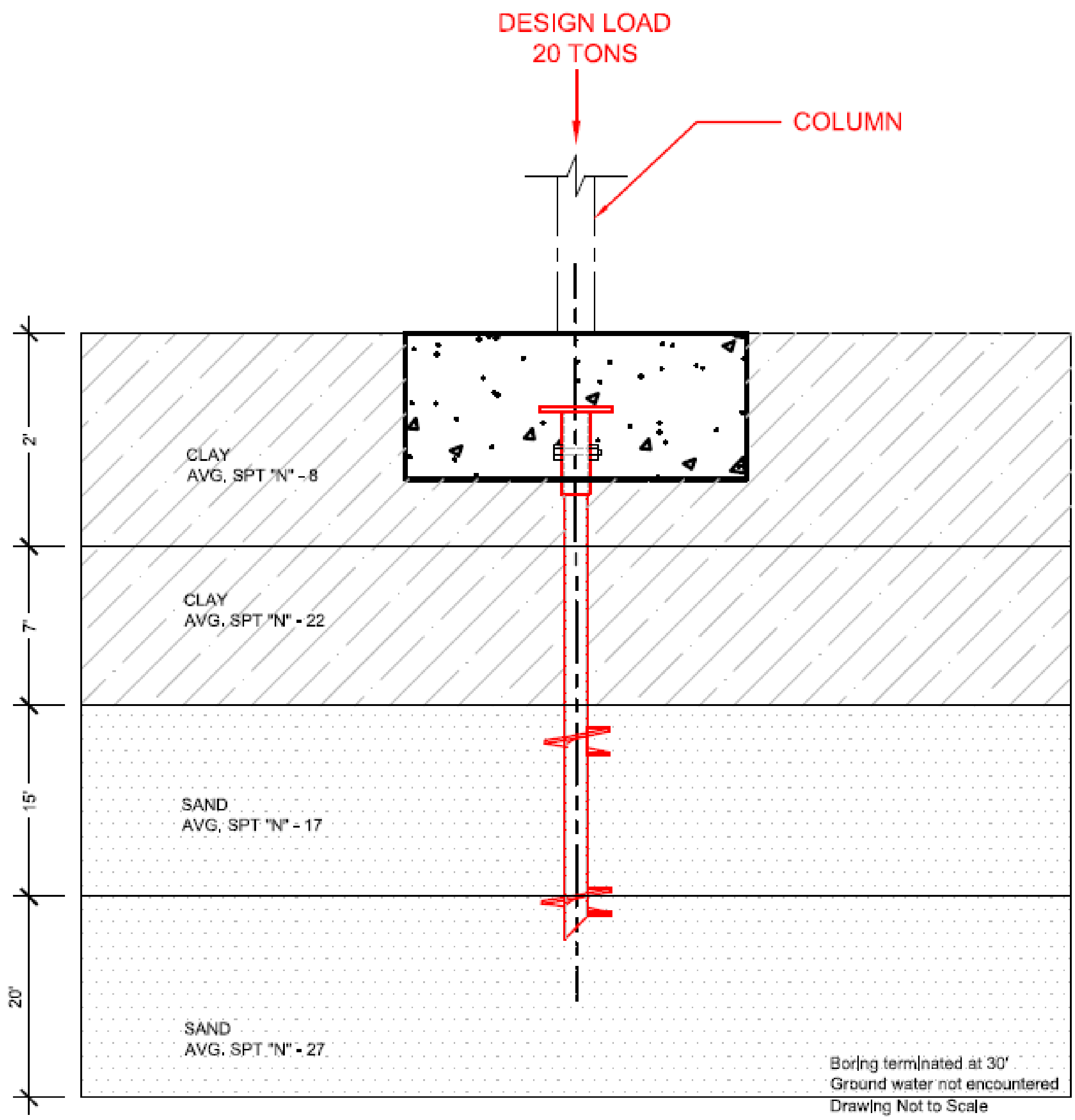


Figure 22. Soil Description and Helical Pile layout

Based on the above figure it appears that a helical pile with a maximum allowable capacity of 40 tons is required to support the column load. In addition, the soil layers, SPT blow count values, depth of water table is as shown in the above figure. In order to describe how to simulate

Problem 2. Contd.

the respective soil condition and helical pile through the software, the screen shots of the different pages have been show as follows. The “Project Information” and “Ram Jack Specialist Information” screen shots are not included since they do not provide any input values for calculation purposes.

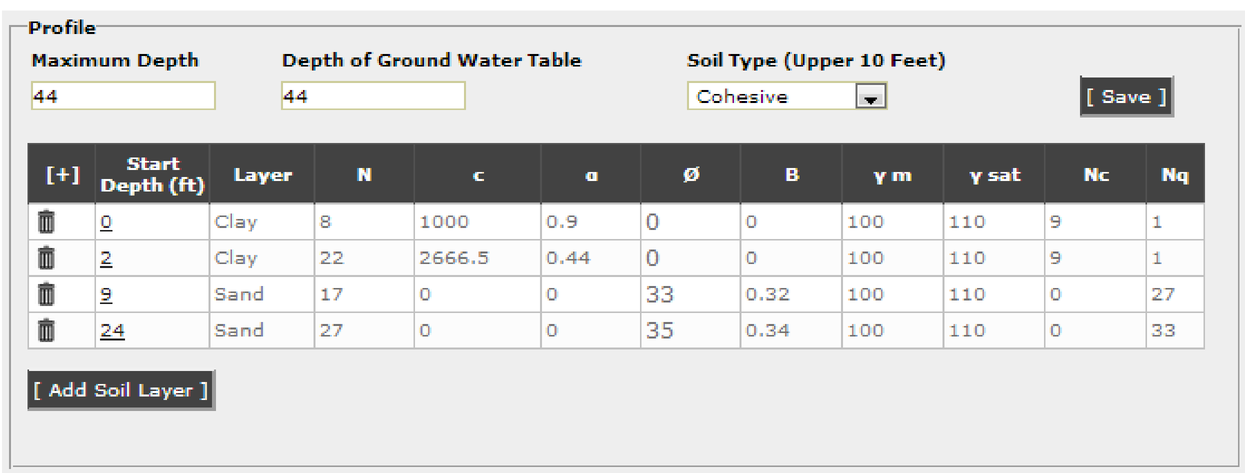
Step:1
Determination of required allowable capacity in lbs.

Design Load = Required Allowable Capacity = 20 ton × 2000 lbs/ton = 40,000 lbs = 40 kip.

Step:2
In order to create the project the user would have to click on the “Create Project” tab to open the Project Information page. Here all the project information including the project number, soil report information, project address, etc. are entered. In addition, there is a field notes section where any anomalies or important field conditions are entered so that it is printed out in the output report. The city and state are required fields. Once the required information is entered clicking on the Save button takes the user to the Ram Jack Specialist Information page.

Step:3
The next step would be to enter information in the Ram Jack Specialist Information page. In this step the name of the potential Ram Jack dealer/salesman who would install the helical pile would be entered. www.ramjack.com has all our dealer information and the user can access this website to find the nearest dealer or contact us by telephone for additional information.

Step:4
In Step 4 the available soils information would be simulated in the software as shown in the screen shot below. Once all the information is entered click on the Piles / Anchor Data tab to proceed to the anchor page.


Profile

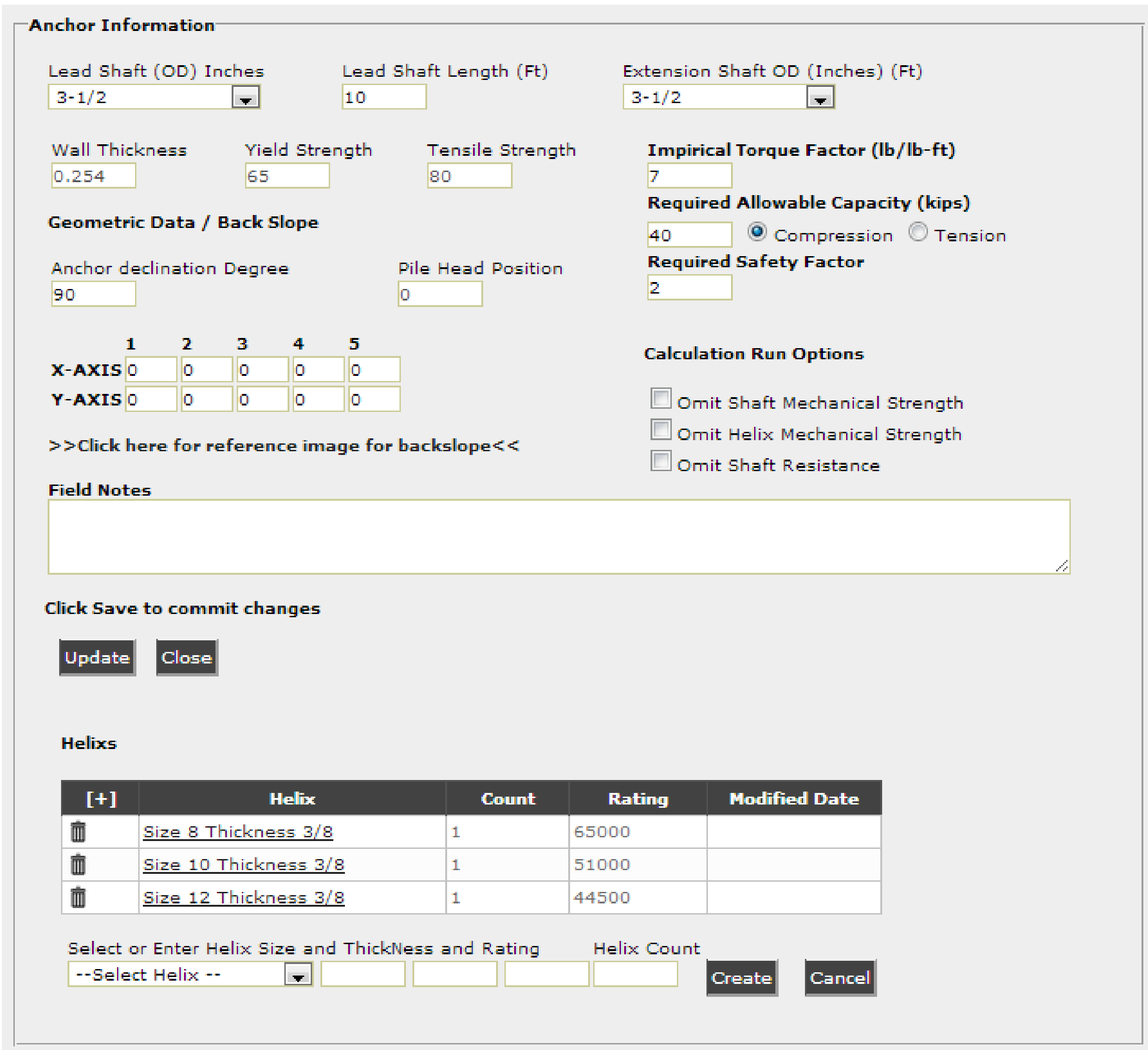
Maximum Depth: 44
Depth of Ground Water Table: 44
Soil Type (Upper 10 Feet): Cohesive
[Save]

[+]	Start Depth (ft)	Layer	N	c	α	Ø	B	γ m	γ sat	Nc	Nq
	0	Clay	8	1000	0.9	0	0	100	110	9	1
	2	Clay	22	2666.5	0.44	0	0	100	110	9	1
	9	Sand	17	0	0	33	0.32	100	110	0	27
	24	Sand	27	0	0	35	0.34	100	110	0	33

[Add Soil Layer]

Problem 2. Contd.

Step:5
In Step 5, the desired helical pile would be simulated using the drop down menu's and input fields in the anchors page as shown in the screen shot below. However, before proceeding with this step the user would have to decide on the pile shaft diameter based on the required allowable capacity, pile loading (tension or compression), unbraced length, eccentric loading, pile rating, and other field requirements.

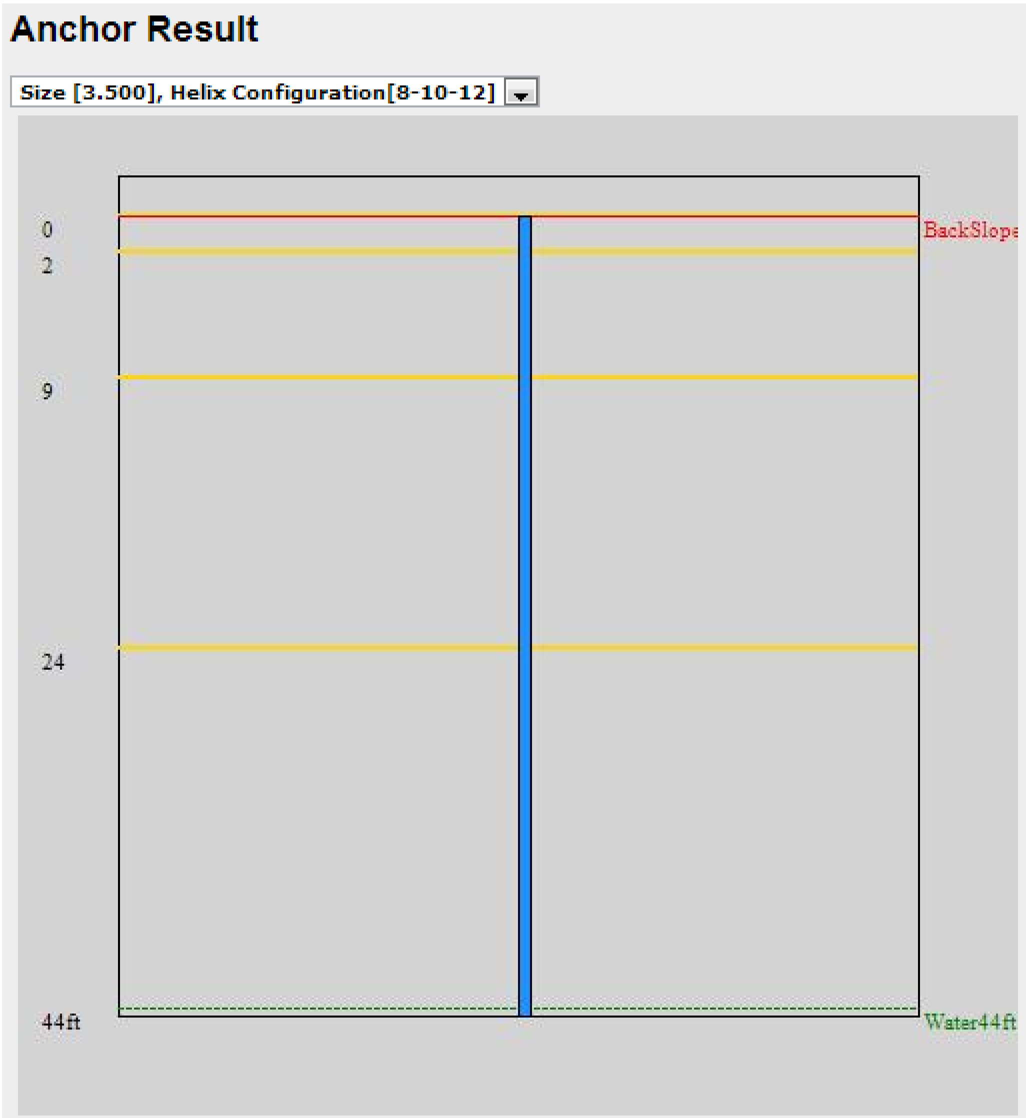


Once all the information is entered as shown above, click on the Calculation tab to proceed to the next step.

Problem 2. Contd.

Step:6

In Step 6, the software would automatically display an image under the calculation tab of the soil conditions, pile layout, and back slope coordinates as entered by the user. Here the user can verify and review if the input information has been modeled correctly and is representative of the field conditions in which the helical piles/anchors would be installed. As shown in the screen shot below it can be verified that the simulated model is satisfactorily close to the field condition as described in figure 22.



Step 7:
Step 7 would be to review the results by clicking on the Tabular View tab. The results as estimated by the software is presented as shown in the following screen shot

Anchor Result

Size [3.500], Helix Configuration[8-10-12]

Helical Pile/Anchor Information:		
Req. Allowable Pile Capacity	40	kip
Applied Factor of Safety	2	
Helical Pile Diameter	3.500	in
Helix Configuration	8-10-12	in
Torque Correlation Factor	7	lbs/ft-lbs

Estimated Pile Capacity: Compression		
Allowable Frictional Resistance	6.08	kip
Allowable End Bearing Capactiy	33.92	kip
Allowable Pile Capactiy	40	kip
Appr. Pile Embedment Depth	20	ft
Required Min. Installation Torque:	11500	ft-lbs

Tension Results		
Embedment(ft)	Ultimate Anchor Capacity(lbs)	Torsinal Resistance(lb ft)
10	43822	6368
11	44706	6536
12	46744	6942
13	48603	7292
14	51381	7778
15	54862	8460
16	58430	9086
17	62493	9716
18	66927	10351
19	71391	10990
20	75885	11634
21	80407	12281
22	84959	12933
23	89539	13589
24	94150	14250
25	100000	15521
26	100000	16221
27	100000	17946
28	100000	18695
29	100000	20955
30	100000	21772

Compression Results		
Embedment(ft)	Ultimate Anchor Capacity(lbs)	Torsinal Resistance(lb ft)
7	41370	5897
8	42754	6075
9	44508	6253
10	46072	6395
11	48864	6663
12	51825	6972
13	55755	7384
14	60159	7869
15	64525	8494
16	68919	9123
17	73344	9757
18	77800	10394
19	82282	11036
20	86794	11682
21	91337	12333
22	95907	12988
23	102597	13647
24	105000	14310
25	105000	15589
26	105000	16286
27	105000	18019

Step 8:
Step 8 would be to download the professional PDF output report by clicking on the Download PDF tab. The following three pages show a sample of the report that would be generated consequently.

RAMJACK FOUNDATION SOLUTIONS ™

Project Name
User Manual 2

Project Address
123 XYZ Rd.
Garland,TX

Analysis By
Name : Sam Rosenberk Phd.,
Company : Ramjack Systems Distribution
Email : srosenberk@ramjack.com

Pile Information
Project Type : New Construction Pile / Project Number : 00-001
Pile Specification : Size [3.500] / Helix Configuration : 8-10-12

Ram Jack Specialist Information
Name : Sam Rosenberk, Ph.D., E.I.T.
Email : srosenberk@ramjack.com
Company/Firm Name : Ram Jack

Ada,OK

Field Notes

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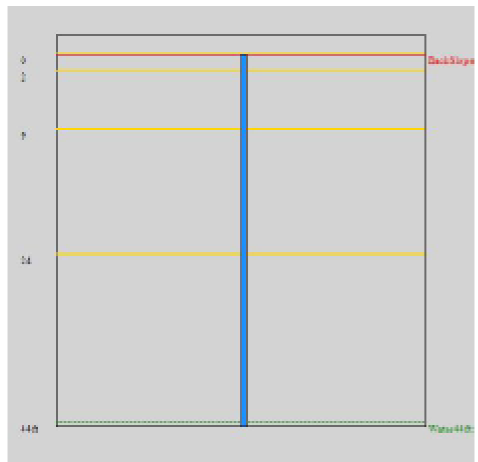
RAMJACK FOUNDATION SOLUTIONS ™

Analysis Options

Omit Shaft Resistance	Omit Mechanical Strength Checks	Omit Shaft Strength Checks
No	No	No

Soil Information

Provided/Performed by :	XYZ Technologies, Inc.
Soil Report #	12-345-12
Soil Report Date	
Boring #	
Boring Log Date	
Boring Termination Depth :	ft
Depth of Ground Water Table	44 ft
Maximum Depth	44 ft
Soil Type (Upper 10 Feet)	Cohesive



Geometric Data

	1	2	3	4	5
X	0	0	0	0	0
Y	0	0	0	0	0

Inclination Angle 90(deg)

Pile Head Position 0

Soil Profile

Depth (ft)	SPT Blow Count (N)	Layer	Cohesion (psf)	Adhesion Coefficient	Internal Friction Angle (deg)ø	Friction Co-efficient B	Moist Unit Weight (pcf)	Sat Unit Weight (pcf)	Nc	Nq
0	8	Clay	1000	0.9	0	0	100	110	9	1
2	22	Clay	2666.5	0.44	0	0	100	110	9	1
9	17	Sand	0	0	33	0.32	100	110	0	27
24	27	Sand	0	0	35	0.34	100	110	0	33

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RAMJACK FOUNDATION SOLUTIONS ™

Helical Pile/Anchor Information:

Req. Allowable Pile Capacity :	40	kip
Applied Factor of Safety	2	
Helical Pile Diameter	3.500	in
Helix Configuration	8-10-12	in
Torque Correlation Factor	7	lbs/ft-lbs

Pile Capacity Theory

End Bearing

$$q_u = cN_c + qN_q$$

q_u - Ultimate End Bearing Capacity, psf
c - Cohesion, psf
$N_c \& N_q$ - Bearing Capacity Factors
q - Effective Vertical Stress, psf

Skin Friction

$$f_s = \alpha c + K \sigma_0' \tan \delta$$

fs = ultimate capacity from skin friction
α = Adhesion Factor
c = cohesion, psf
σ_0' = Effective Vertical Stress, psf
δ = Angle of External Friction = 0.54 (ϕ)

Estimated Pile Capacity:

Compression Results

Allowable Frictional Resistance:	6.08	kip
Allowable End Bearing Capacity:	33.92	kip
Allowable Pile Capacity:	40.0	kip
Appr. Pile Embedment Depth:	20	ft
Required Min. Installation Torque:	11500	ft-lbs

NOTE:

1.The reported "Appr. Pile Embedment Depth" is only an approximate estimate of the embedment depth and may vary based on the actual field conditions.

2.It is crucial to install the pile to the reported "Required Min. Installation Torque" value to realize the required allowable load capacity unless approved otherwise by a licensed professional engineer.

Tension Results

Embedment (ft)	Ultimate Anchor Capacity (lbs)	Torsinal Resistance (lb ft)
10	43822	6368
11	44706	6536
12	46744	6942
13	48603	7292
14	51381	7778
15	54862	8460
16	58430	9086
17	62493	9716
18	66927	10351
19	71391	10990
20	75885	11634
21	80407	12281
22	84959	12933
23	89539	13589
24	94150	14250
25	100000	15521
26	100000	16221
27	100000	17946
28	100000	18695
29	100000	20955
30	100000	21772
31	100000	22597
32	100000	23426
33	100000	24260
34	100000	25098
35	100000	25941
36	100000	26788
37	100000	27640
38	100000	28497
39	100000	29358
40	100000	30223
41	100000	31093
42	100000	31968
43	100000	32847
44	100000	33731

Compression Results

Embedment (ft)	Ultimate Anchor Capacity (lbs)	Torsinal Resistance (lb ft)
7	41370	5897
8	42754	6075
9	44508	6253
10	46072	6395
11	48864	6663
12	51825	6972
13	55755	7384
14	60159	7869
15	64525	8494
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21	91337	12333
22	95907	12988
23	102597	13647
24	105000	14310
25	105000	15589
26	105000	16286
27	105000	18019
28	105000	18768
29	105000	21031
30	105000	21854
31	105000	22682
32	105000	23514
33	105000	24351
34	105000	25192
35	105000	26038
36	105000	26889
37	105000	27744
38	105000	28603
39	105000	29467
40	105000	30336
41	105000	31209
42	105000	32087
43	105000	32969
44	105000	33856

Warning

Torsional resistance numbers in bold red font indicate calculated torsional resistance exceeds Ram Jack rating for the selected lead or extension shaft, whichever is less.

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