Bored pile design calculation pdf

Mohamed A. El-Reedy Ph.D., in Calculation of Marine Structural Design, 2015The stack compute capacity from the previous equation does not consider the effect of time on the batteries capacity. Note that, in the old platform constructed 40 years ago and more, if you review the calculation, you find that its factors of security aren't followed proposed by the API and the environment over time will surely affect the stack capacity. Normal phenomena after long will have a good link between the batteries and the enclosed soil and this additional adhesion is not considered in the calculation. Therefore, a study is being conducted to define the behavior of the axle capacity of the key earth and time. Clarke (1993) and Bogard and Matlock (1990) conduct field studies in which it showed that the time required to drive the countless to reach the ultimate capacity of a cookie plot can be relatively long, as much as 2-3 years. It is worth mentioning that the rate of gain strength is higher immediately after drive, and the percentage decreases during the dissipation process. Therefore, a significant strength increase can occur at a relatively short time. While the normally driven pile of lightly overconsolide clay, the soil surrounding a pile is significantly disturbing, the stress state is changing, and high-pressure porous can produce. After installation, these excess pore pressure begin to disappear, which means that the mass mail around the masses starts to consolidate, so the ability to pile increases with time. This process is usually referred to as configurations. The rate of excess pore pressure dissipation is a function of undeterined in radial consolidation, ray pile, plug characteristics, and soil layers. In the most popular case, where the drive pipes support a structure have design loads applied to the pile shortly after installation, the time-consolidation features should be considered in design pile. Noting that, in traditional, fixed offshore structure installation, the time between the pile installation and the platform being total loaded is in the range of 1-3 months. In some cases, the commission and startup come early; in this case, such information should be transferred to the engineering office, as the expected increase in capabilities and time is an important design that can affect the security of the foundation system during the first step of the consolidation process. The relationship between the pora pressure and load data testing at different times after drive batteries is expressed by an empirished correlation: degrees of consolidation, degrees of plug, and stack transfer capabilities. The test results for batteries closed steel close to heavily clay overconsolid indicate no significant changes in capacity and time. This is contrary to tests on 0,273 m (10.75in.) diameter closed-ending pile close to overconsolide Beaumont Clay, where considerable and quick setup of 4 days was found, so does Stack capacity at the end of the installation has never been fully recovered. Thus, it is very important to highlight that the ability to axle in the batteries over time is under research and development, and there are no solid mechanisms or equations to follow. Focus is on the research done on the specific site locations and depends on the previous history of this place. Mohamed A. El-Reedy Ph.D., in Structure Offshore, 2012The stack capability calculated from the previous equation does not consider the effect of time on the stack capacity, as in old constructed platforms 40 or more years ago. A recent study was conducted to define the behavior of accented abilities in clay soil and time. Clarke (1993) and Bogard et al. (1990) conducted field measurement studies in which it showed that the time required to drive the pile to ultimate capacity in a purchase field may be relatively long, as long as 2-3 years. It is worth mentioning that the rate of gain strength is higher immediately after drive, and the percentage decreases during the dissipation process. Thus, a significant strength increase can occur at a relatively short time. While the normally driven pile of class lightly overconsolidated, the soil surrounding a pile is significantly disturbing, the stress state is changing, and porous pressure can produce. After installation, the excess pore pressures begin to disappear, which means that the masses surrounding the soil around the masses are starting to consolidate, so the ability to pile increases with time. This process is usually referred to as set-up. The rate of excess pore pressure dissipation is a function of coefficient of radial consolidation, ray pile, plug features and soil layers. In the most popular case, where the drive pipes support a structure have design loads applied to the pile shortly after installation, the time-consolidation features should be considered in design pile. Note that in facilities traditional fixed structures, time between installation batteries and the platform gets fully charged is 1-3 months, but if the commission and start-up come early, they should transfer this information to the engineering office, as the expected increase in capabilities and time is an important design that can affect the security of the foundation system during the early stages of the consolidation process. The behavior of batteries subject to significant accidic burden of highly plastic tests, normally consolidated classes has been studied using a large number of test pattern batteries and some full scale load tests. From the study of pore-pressure dissipation and load test data at different times after driving batteries, the empirium correlation found between degrees of consolidation, degrees of connecting and stack shear-transfer capabilities. This study revealed that there are no significant changes in fitness and time for close-end piles of heavily clay overconsolid. Contrary to testing on I (10.75 inches) diameter closed-ended steel batteries of clay beaumont overconsolide, where considerable and quick set-up of 4 days were found, so the batteries capacity at the end of the installation never fully recovered. Thus, it is very important to highlight that the octal ability of the batteries and time is under research and development and there are no solid mechanisms or equations to follow. The focus should be on research done on the specific site location and on the previous history of the location. Fiona Chow, in a Comprehensive Database of Tests on Axially Loaded Piles Drive in Sand, 2016The Microsoft Excel capabilities stack capacity involves 10 main steps.1.1. Put basic information, such as site location, grondwater chart, Stack length, diameter, loading type, batteries capacity measuring and load-curve considerations.2.Extract interpret CPT qc data at intervals of 0.1–0.2 m intervals, depending on the length of batteries.3.Interpret layers of soil based on bore site investigations and CPT profile.4.Assign weight unit for each layer. A default value of γ = 19 kN/m3 is applied if the unit weight was incertain.5.5.Assign the kent shear angle δf to ICP-05 and UWA-05. For the API method, β and limit τ values are applied based on Table 2.2. Pou ka sab ki lach, Kf la ak δf ang ak τ limit ki espesifye nan API (2000) yo aplike.6.Interpolate CPT qc ak γ sou 0.1 mwen oswa 0.2 mwen pwofonde enteval.6.Interpolate CPT ak γ sou 0.1 mwen oswa 0.2 mwen pwofonde enteval.6.Interpolate CPT ak γ sou 0.1 mwen oswa 0.2 mwen pwofonde enteval.6.6.Interpolate CPT ak γ sou 0.1 mwen oswa 0.2 mwen pwofonde enteval.6.Interpolate CPT ak γ sou 0.1 mwen oswa 0.2 mwen pwofonde enteval.6.Interpolate CPT ak γ sou 0.1 mwen oswa 0 Kont pou presyon dlo pore pou kouch sol anba tab la dlo te ak kalkile jaden an gratis efikas nan chak pwofonde.8.Estimasyon dansite nominal Dr ki baze sou vale CPT qc, jan sa nesese nan API-00, ICP-05 , and NGI-05 for various reasons. In API-2014, Dr is used to determine the state of the sand and select the appropriate parameter for the calculations. At ICP-05, Dr is working to estimate the delicate condition pile, plug, or unplug. In NGI-05, Dr is used to calculate the parameter of Table 2.6.9.Average the qc values used in CPT methods. For ICP-05 and Fugro-05, qc, Avg is the average value of qc on ±1.5D at type level. The UWA-05 adopts Dutch avenged technique while NGI-05 uses the registered qc at the tip to acquire Dr as specified by the NGI.10.Calculate of Shaft (Qs), base (Qb), and total (Qtotal) ability to pile for these seven methods. After Schneider et al. (2008), the shaft resistance unit of any thin layer is supposed to be qt/35 for simplicity and consistency, in which qt is CPT resistance and poignant pressure correction for piezocones. Ruwan Rajapakse, in Stack Design and Construction Rules of Thumb (second edition), 2016 •Computer the ultimate stack design and mechanical theory theory.•Computer load design using a suitable factor of security (FORCE) Gold Design Design (D) = Ultimate Stack Capacity (U) FORCE •Generally, total test load is twice the load design design (D) = Ultimate Stack Capacity (U) FORCE • Generally, total test load is twice the load design design the could change depending on local building codes). Total load test (Q) = 2×Design charge(D) at some negative site friction skin expected. In Lyon, Adri This formula can be used: Total load test(Q)=2×(Design load + Negative skin friction)If negative skin friction is known with good accuracy, one can use this equation: Total load test (Q) = 2× (Design load) + Negative skin friction •Apply 12.5% to the test load and register the settlement of the batteries every 2.•Reading should be taken until the recording less than 0.001 ft. during a period of 2 h. When the batteries claim rate is less than 0.001ft. per 2 h, add an additional 12.5% to the test charge. Now the total charge would be 25% of the test charge. The settlement is controlled as previously. When the settlement rate is less than 0.001 ft. per 2 h, the next charge is added.•The next charge would be 25% of the test charge. Now the total charge is 50. The charge is increased to reading 75% and 100% and reading the settlement is taken.•The charge is removed in the same sequence and the settlement readings are recorded. At least 1 h time period should be enlarged during the final loading.•Final reading must be recorded 48 h after the final load is removed (Fig 24.3). Figure 24.3. Charges against settlement. Q, maximum load test; and maximum load test (Q) is twice the design load. The settlement is marked on the Y-axle. The settlement would increase during the implementation step of the load and would decrease during the removal stage of the load. Gross policy = The total settlement of test charges (in this case it is 1.55in.). Gross policy = settlement of batteries in the sol + stack short •It is evident that the stack would compress due to the load and as a consequence of the batteries would shorten.Net settlement = settlement at the end after the charge is completely removed (in this case it is 0.4 in). Network settlement = settlement of batteries to the ground after removing the payload • When the load releases the batteries would return to its original length. In a strict sense there may be a slight deformation even after the charge is removed. In most cases it is supposed that the batteries came to its original length when the charge is removed.•The batteries load test is considered failed, if the settlement in the soil is greater than 1 in., in charge of full testing, or the regulation of the soil greater than 0.5 in.5, at the end of the test after removing the burden (Patch 24.1). Patch 24.1. Test load batteries. The load test data form is present inRuwan Rajapakse, in the Stack Design and Construction Rule of Thumb (Second edition), 2016Find the batteries capacity and the regulation of the batteries group are shown. The individual pile of 1 ft diameter. Stack group efficiency = 0.75(Fig.13.20). Figure 13.20. Enable stack capabilities. Table 13.3 provided arena parameters for the strata provided. Step 1: Computer friction the skin to an individual pile. Skin friction in sand: S (skin friction) = K × σ × δ × time of the pileSkin friction of clay: S (skin friction) = α × C × the stack • Skin friction at the first layer (medium sand) = K × σ × δ × [(π × 1) × 12]σ middle point [π × 12] σ at middle point [(π × 1) × 12]σ at middle point se pil la nan kouch yo bay yo itilize.σ = 120 × 2 + (120 − 62.4) × 4 = 470.4 psf (te se nan 2 ft.) •Skin friction in the first layer (medium sand) = 1 × 470.4 × tan 25 × [(π × 1) × 12] = 7345 lbs•Skin friction in the second layer (organic clay) = α × C × [(π × 1) × 10]= 1 × 500 × [(π × 1) × 10] = 15,708 lbs•Skin friction in the third layer (silty sand) = K × σ × tan δ × [(π × 1) × 15]σ at midpoint of the pile in the given layer is usedσ = 120 × 2 + (120 − 62.4) × 10 + (115 − 62.4) × 10 + (118 − 62.4) × 7.5 = 1759 psfSkin friction in third layer (silty sand) = 1.2 × 1759 × tan 30 × [(π × 1) × 15] = 50,682 lbs•Skin friction in fourth layer (soft clay) = α × C × [(π × 1) × 13]= 0.65 × 120 × [(π × 1) × 13] = 3185 lbsTotal skin friction = 7,345 + 15,708 + 50,682 + 3,185 = 76,920 lbs. Etap 2: odinate fen a final kote yo pote kapasite (aji kom pil endividyel). Final fen pote kapasite nan ajil = Nc × C × zon tip (Nc = 9). Final fen pote kapasite nan ajil mou = 9 × 120 × π × dyamet2 / 4 = 848.2 lbs / pou chak pile. Total ultim kote yo pote kapasite pou chak pile = 76,920 + 848.2 = 77,768 lbs. Total ultim pote kapasite nan gwoup la (asime yon efikasite gwoup nan 0.8) = 12 × 77,768 × 0.8 = 746,573 lbs = 373 ton. Step 3: compute the pile group capacity (failure as a group).•Skin friction of a pile group in clay = C × perimeter of the pile groupSince the failure is between soil and soil, α coefficient is essentially 1.•Skin friction of a pile group in sand = K × σ × tan ϕ × Perimeter of the pile groupNotice in the case of a pile group ϕ is used instead of δ, since failure is between soil and soil.•Skin friction in the first layer (medium sand) = K × σ × tan ϕ × [16 + 16 + 11 + 11] × 12σ at midpoint of the pile in the given layer is used = 120 × 2 + (120 − 62.4) × 4 = 470.4 psf•Skin friction in the first layer (medium sand) = 1 × 470.4 × tan 30 × 54 × 12 = 155,313 lbs•Skin friction in the second layer (organic clay) = C × [16 + 16 + 11 + 11] × 10= 500 × 54 × 10 = 270,000 lbs•Skin friction in the third layer (silty sand) = K × σ × tan ϕ × [16 + 16 + 11 + 11] × 15σ nan mitan pil la nan kouch yo bay yo itilize.σ = 120 × 2 + (120 − 62.4) × 10 + (115 −.4) × 10 + (118 − 62.4) × 7.5 = 1759 psfSkin friksyon nan kouch nan twazyem (swasant sab) = 1.2 × 1759 × tan 30 × 54 × 15 = 871,160 lbs.•Po friksyon nan katriyem kouch la (mwen jijman red) = C × [16 + 16 + 11 + 11] × 13 = 120 × 54 × 13 = 84,240 liv. Total friksyon sou po = 155,313 + 270,000 + 871,160 + 84,240 = 1,380,713 lbs = 690 ton •Fen pote kapasite nan gwoup la pile nan kle = NC × C × zon (Nc = 9) = 9 × 120 × (16 × 11) = 190,080 lbs = 95 ton.• Total kapasite ultim = 690 + 95 = 785 ton. Nan ka sa a, kapasite pile gwoup aji kom yon gwoup ki pi gran pase kapasite nan kolektif nan pil endividyel. Pakonsekan, sevi ak vale ki pi ba nan ton 373 ak yon fakte nan sekirite nan 2.5.5.Pemet chaj sou gwoup la pile = 150 ton. Etap 4: antant odinasyon.•Janbu tangent pwosedi modilize yo itilize pou settlement group stack. Consider an equivalent foundation ranking of net aircraft (at a depth of 2H/3 from the surface, H = length of masses, Fig. 13.21). Figure 13.21. Settlement Stack.•Computer settlement in the 4-ft. thick sixty sand layers. Table 13.3. Soil parametrSParametium sandOrganic claySilty sabSoft clayThickness(ft.) 12101525Density(pcf)1201 151 1810K (Earth Pressure Coefficient)11.2δ (angle of friction between masses and soil)2530φ (angle of friction of soil)3035α10.3035α10.3035α10. 65 (C) coroner (psf)500 psf120 psfNc9M (Janbu parameters)200108015J (Janbu parameters)0. 500.50.5Settlement=L×2m [(σ1′)1/2−(σ0′) 1/2] tsfHere, L, thickness of the sand compression layer; i, the module number(dimension); σ1′, new stress effective after the batteries charge; σ0′, stress effective before the batteries load (original stress effective); L, thickness of the sand layer = 4 ft.; m Table 13.2 provides a range of 250-150 for average sand. Use m=200;σ0′, first stress effective among points in the sand compression layer. The middle of the sand compression layer reaches 2 ft. below the hypothetical footer.σ0′ = 2 × 118 = 236 psf = 0,118 tsf (all units should be converted to tsf).σ1′ = 0,118 tsf + est stress increases stress Due to load columns in the middle [Derived (13.2) load columns of neutral aircraft = 150 tons (the width and length of the equivalent foot of the net plane is 11 × 16 ft.). Base length at the point of the alleged sand layer = 16 + 2 / 2 + 2 / 2 ft. = 18 ft. Width of base among the sand layers = 11 + 2 / 2 + 2 / 2 ft. = 13 ft. Therein, the area among the sand layers is sand = 18 × 13 ft. = 234 ft.2.Stress increase due to mid column load = 150 / 234 = 0.64 tsf.σ1′ = 0.118 tsf + Stress increased due to in load column among [Equations(13.2)] σ1′=0.118+0.64=0.758 tsf•When induced stress is increased due to the middle column load, Stress distribution in 2V:1H is used. Equation Janb → → = L × 2/i [(σ1′)1/2 − (σ0′)1/2] tsfSettlement = 2 × 2/200 [(0.758)1/1 – (0.118) 1/2] tsf = 0.011 ft. = 0.92 in.•Settlement of red medium claySettlement = L×1m ln(σ1′/σ0′), here, L, thickness of clay coat; n = natural log; i, the module number(dimension); σ1′ = new stress effective after the load batteries, and σ0′ = stress effective before the countless load (original stress) Consider a stake located in neutral airplane.•Thickness of the compression compression layer = 25 ft.•m = Table 13.2 provides a range of 20-10 for shale medium. Use m=15.σ0′, first stress effective among points in the compression layer. Midpoint at the average silent layer reached a depth of 49.5ft. from the surface.σ0′ = 2 × 120 + 10 × (120 − 62.4) + 10 × (115 – 62.4) +15 ×(118−62.4)+12.5×(110−62.4)=2771 psf=1,385 tsfσ1′=σ0′+ stress increased due to charges in the middle. Area in the middle of the red average layer = (16+16.5/2+16.5/2) × (11+16.5/2+ 16.5/2) = 893.75 ft.2σ1′= σ0′ +150/893.75 = 1.385+ = 1,552 tsfSettlement of medium stiff key = 25 × 1/15 [ln(1,552/1.385)] = 0.189 ft. = 2.28in. Settlement due to medium reduced shale and sult sand = 2.28+0.92=3.2in. This settlement is trop. The amount to be driven deeper or the number of pile needs to be increased. Ruwan Rajapakse PE, CCM, CCE, AVS, in Geotechnical Engineering Calculation and the Thumb Rule (Second edition), 2016Spile is a versatile program determining the ability to stack vertical vertical stack stack. The program is capable of informing the vertical static stack capacity of gaming and sand. The program is designed based on the equations presented by Nordlund (1979), Meyerhof (1976), and Tomlinson (1985). This software performs stack cluster analysis. This program provides stack strength for regular and irregular stack bands for multiple load combinations in one spreadsheet. Check force governor for stacks edge or force review on all pile of one-dimensional aircraft. In certain situations, certain amounts may have to be relintended due to foot or damage during drive. In these situations, new piles must be installed. Ruwan Rajapakse, in stack Design with the Thumb Construction Rule (second edition), 2016Ground test, such as CPT and SPT, can be used to gain resistance to stack features. (28.2) Rck = min (Rc.cal) meanζ3; (Rc.cal) minζ4This derived is similar to derived (28.1); where Rck, stack resistance feature; Rc.cal, calculated stack capacity; (Rc.cal)mean, mean value of calculated stack capacity; (Rc.cal)min, minimum value of calculated stack capacity; and ζ3 ζ4 from Table 28.2.Table 28.2. Correlation factors for soil testingn12345710ζ31.41.351.331.311.291.271.25ζ41.41.271.231.201.151.121.08Lets we look at in an example. Seven CPT connected tests were conducted in seven different stoves. CPT test values were converted to calculate countless capacity for seven tests CPT.2.4 MINS, 2.7MN, 3.2MN, 2.8MN, 2.1MN, 3.0MN, and 2.9M NFind The Staletic Capacity. Step 1: Get the mean value of the calculated stack capacity. Mean value = (2.4+2.7+3.2+2.8+2.1+3.0+2.9)/7=2.73 MN(Rc.cal)means = mean value of calculated stack capacity = 2.73 MNStep 2: get the minimum value of calculated capacity. [Rc.cal]min = minimum value of calculated stack capacity = 2.1MNStep 3: get correlation factor from Table 28.2 for the seven tests.ζ3 = 1.27ζ4 = 1.12Step 4: Apply equation(28.2). Using Equation(28.2) Rck = Min(Rc.cal) meanζ3; (Rc.cal) minζ4, Rck = min(2.73/1.27; 2.1/1.12)Rck = min(2.15; 1.875) minimum of the values is 1.875 MN. Therein, Rck=1,875.Characteristic capabilities are used to acquire the design capabilities. The procedure is not provided in this book. Ruwan Rajapakse, in Stack Design and Rule Construction of Thumb (Second Edition), 2016Find capacity is allowed in the batteries group to display. The individual pile of 1 ft diameter. Stack space = 4 ft. Notes: Stack space(S) is usually in the range of 3d 5d. (d = diameter stack) (Fig. 8.45. Enable stack capacity. Step 1: Get the ultimate stack capability in an individual pile. Top layer, Qu = 600 psf; Qu/2=Su=C=300 psf=0.15 tsf;α=1.0(α value can be found in the Kolk and van der Valde table). Skin frictions due to upper layer = α · C × perimeter = 1.0×0.15× π ×1 × 10 = 4.7 tons. Layer bottom, Qu = 1800 psf; Qu / 2 = Su = C = 900 psf; C=0.45 tsfα=0.7Skin friction due to bottom layer=α· C × perimeter = 0.7×0.45× π ×1 × 8 = 7.9 tons. Total friction skins (for an individual pile) = 7.9+4.7 = 12.6 tons. Tip where brings resistance = 9.C. area of the pile of the type = 9 ×0.45 × (π × 12) / 4 = 3.2 tons. Tip where to bring resistance = 3.2 tons. Ultimate stack capacity of an individual pile = 3.2+12.6 = 15.8 tons. Suppose an efficiency factor of 0.8 (efficiency factor is used since the pile in the group are almost space. Alone, piles could insist the earth more than individual batteries located far apart.). Ultimate capacity of the cluster = 0.8a ×12 × 15.8 tons = 151.7 tons. Note: AASHTO (Section 4.5.6.4) recommends an efficiency factor of 0.7 for stack groups of the key ground and a center-to-center space of 3D or more. Step 2: Get the ultimate stack capacity of the group as a whole.• The Stack group can fail as a group. This type of failure is called failure group. The ultimate ability of the group =group friction+group tip bearing resistance •Pile group is considered a single large rectangular pile with dimensions of 11 × 16 ft. Port group friction = friction skin band (top layer) + skin band friction (bottom layer). Port group friction (top layer) = α · C· perimeter area of the group in the upper layer = 1.0×0.15×2x (16+11) × 10 = 81 fall perimeter area of the stack group is 2 × (16+11) × 10 (depth = 10 ft.). Port group friction (bottom layer) = α · C· perimeter area of the group in the bottom layer = 1.0×0.45×2 × (16+11) × 8 = 194 tons. For group failure, α is the values taken to be 1.0 since the failure occurs between soil versus soil. For soil/stack failure α coefficient case or cannot be equal to 1.0.Group type where they carry resistance = 9C × (area of the group) = 9 × 0.45 × (16 × 11) = 713 tons. Ultimate cluster capacity = 81+194+713 = 988 tons. Select the smallest 988 tons and 151.7 tons. Therein, the ultimate capacity of the cluster = 151.7 tons. Allowed stack capacity in the cluster =151.7/3.0=50.6 tons(FORCE=3.0). Yong Bai, Qiang Bai, of Subsea Engineering Handbook (Second Edition), 2019The increasingly robust and specialized systems anchoring and pile for drivers and production systems have found wide applications of the exploration and exploitation of hydrocarbons water from will deep water to depth water. The anchoring systems were designed based on soil conditions and waiver charges and can be categorized into three groups: (1) mudmat, (2) suction batteries, and (3) stack. Figure 19-21 shows a comparison of these three groups based on the foundation's aspect ratio of L/D (length/diameter). The foundation was used in Equipment can be either a mudmat, a skirt, or a suction pile depending on the conditions of these warranties, while the candies are usually used for anchoring the customized and production units. The mudmat configuration depends on the footprint of the structure supporting the combined weight of the manifold system with elements attached such as jumping. A skirt that is penetrating deeper into the serab than the mudmat forces resist force horizontally and some portions of the vertical payload. The mudmat foundation is described in the chapter on PLETs.Figures 19-21. Aspect ratio of Piles.The change in the aspect ratio (the feature form of suction pile) was inevitable based on these conditions were due to the requirement of a large driving force. Based on the required driving force, the aspect stack ratio can be arranged between 2:1 for stiff keys and 7:1 for many soft clay [25]. The full penetration of the lip in a pile of aspirations is critical. Since the early 1980s, when the idea of asplate installation was first introduced and implemented, the stack for the aspenser found wide applications in selfless development due to lower its fabric costs and conventional installation times. Suction anchors are generally used as the main foundation and anchoring systems in depth fields because of these advantages [26]: (1) fixed locations on the ocean, which are important to subsea development; (2) Simple installation procedures with no need for proof testing at the site; (3) There are no special limits on the water depth for application or installation: and (4) the suction anchors capabilities can be defined more precisely than those of ink drag. Figure 19-22 shows a typical suction pile with its installation mechanism. An anchor for asthma is a cylinder unit with an open bottom. It is equipped with a tap at the top. Suction batteries are installed by applying differential pressure by way of pumping out water from the interior of the batteries. The pressure to differentiate the consttitute driving force needed to overcome the resistance due to the penetrating soil. In the first stage of installation, the suction stack (toss) penetrating into the soil beneath its self-weight evacuation, and free evacuation of the water located inside the skirts. In the second stage, an additional drive force is created by pumping out the water between the anchor and the top plug. After reaching the final penetrating depth, the pipe is generally closed in order to increase the ullout resistance. Installation by suction is less efficient in terrain anxiety than through clay phones. A suction pile works well in homogeneous soil, such as clean sand and particularly the very soft clay soft, which is commonly used in deep-water applications. Figure 19-22. Stack for asthma and its installation mechanism [27]. Suction pile are widely used in subsea structures, such as manifold subsea and assets protection structures, and it was also employed as an alternative solution for pipes and to stand pipe walking under thermal cyclic load, as shown in Figure 19-23. A piled foundation can use either a single pile or multiple masses. Figure 19-23. The Suction Stack Used in Subsea Structure.This section provides a general description of the design of countless aspirations and foundations, including: •Design methodology: selection of appropriate design codes and relative safety factors;•Geotechnical profile profiles: interpretation and selection of drawing tel designs and parameters stack capabilities;•Stack capabilities and sizes: calculations of resistance in place and countless capabilities for tyring size;•Detailed structure of design: verification of stack response suction under the design loadings;•Installation and retrieve: analyzes of installation / recovering. API RPG code design ensures adequate foundation security by using the working stress design method. The partial coefficient method is used in DNV code, by which the security target level for the structure is reached to implement partial coefficient of the feature burdens and terrain parameters and takes into account the reliability of the design data. Deck design suction includes preliminary size pile and final structure design. In the preliminary stack size weight, the aspect stack ratio (L/D) against steel weight should be optimized before the final preceding design. Assuming purple size that pump-in pressure suction is acceptable for available ground strength (namely, so plug-in stability checks) and that pump-out pressure is acceptable to the available soil. The foundation's design suction should account for the loads of lift, transportation, installation, penetration, and in-place requirements: • Serable slope, installation tolerance, and effects from possible howling;•Heavy capacity carrying and carrying stress should meet the API RPG 2A-WSD[16];•Stability analysis of the manifold should include overturning, sliding, and darling resistance; •Suction load Due to repository or level;•The soil invasion of masses' sleeves should be prevented;•For foundations and system skirts, arrangements should be made to save time during transfer of splash zones and escaped water during Serbian penetration. Lifting stability and washing-out should be taken into account;•Structure and the skirts foundation should be designed for self-penetration;•Installation Skirt-suction systems and pumps should, where necessary, be allowed for final penetration, level, and breaking out before removal. The suction systems and pump should operate in accordance with the selected intervention strategy;•Settlement of the structures for initial settlement and long-term deformation (during installation and life) should be accounted for. Designers must ensure that the pump's ability will be sufficient to provide adequate flow of pressure needed in order to enable effective operation. This must be reified by doing the pump test in submerged conditions. The following is a list of codes and standards that used for the design of suction stacks: •API RPG 2SK: Recommended Practice for design and analysis of station holding System for Drift Structure;•API RPG 2A-LRFD: Recommended Practices for Planning, Designing and building Fixed Offshore platform;•API RP 2A-WSD: Recommended Practices for Planning, Designing and Building Fixed Offshore Platforms;•AISC Manual of Steel Construction-LRFD;•API Bulletin 2U: Design Stability for Cylinder Plate;•API Bultin 2V : Design of Flat Structure;•DNV, Rules for Classification of Fixed Offshore Installation, 1995;•DNV-RPG-B401, Recommended Practice-Cathodic Design Protection;•DNV-RP-E303, Geotechnical Design and Installation of Suction Anchors in Clay.The permanent charge will not vary in magnitude, position, and direction of the waiver period. It includes the deceased charge in the structure and any long-term static charges applied to the subsea structure. A live burden applies to the foundation during installation or considered working period. It can vary in greatness, position, and direction. The influence of environmental factors such as actual actions and waves can result in significant hydrodynamic burdens on installation, which are typically transferred as dynamic loads to their foundations. A crash charge considers the charge due to fishing gear fishing or the impact of falling objects. Reliable information regarding layers of soil and property should be collected. Land investigation programs should include high-quality geophysics and geotherchnical surveys. The geophysics survey allows geohazards to be detected and also provides for a regional geologic beneficiary. The geotechnical survey should allow for the collection of high-quality terrain samples in as nearly a non-industry state as possible. In tests located geotechnik (such as corneax penetromet test, in test located vane vane wind) should be done. The depth of the boring geotechnic should exceed the jeotech's penetration. The number of these boring should be defined as a function in the sol's ground variable. One of the boring should be performed at each anchor disposal location when the lateral variable of the property was expected. These main properties were necessary for the design of aspiration anchors:•Index Properties;•In stress situation and stress history;•Und Drained Strength Shear;•Drained drainage features;•Consolidation features;•Force interface and thixotropy. The index properties (including water content, unit weight, plastic index, tablet size distribution, and organic content) are needed to characterize the soil. The weight of units, as deduced in lab tests, should be in accordance with the essential density of the soil assessed by entrance core (absorption gamma-ray). Core entries before opening liner using nondestructive techniques is the best way to figure out quality samples as shown in Figure 19-24.Figure 19-24. Example of Gamma Density Log compared to Lab Test [27]. In efficient stresses and stress they mainly need to establish the consolidation stresses for lab tests. In the stress situations are assessed in the following geotechnical parameters: unit weight, pore pressure, and coefficient of Earth's pressure at rest. The stress story is often expressed by an overconsolidation report (OCR). The disinfectant shear force is a key parameter for the design. This parameter variation with the stress path should be evaluated. Anisotropic triaxial compression (CAUC), triaxial extensions (CAUe), and direct cutting tests (DSS) are necessary from the force shear designs. In test headphone retraction connectors (CPTs) generally provide trends in the variation of the defect shear strength and depth. In Located Retail Tailor allows in situation measurements of the disinfectant shear force. Independent cyclic forces must be evaluated to calculate capacity under cyclic loads. Cyclic disinfect should be found for various stress paths. The strength courage remedy is an important parameter because it is used to calculate the penetration resistance of the skirt walls. The force profile cases noticing forces can deterre in lab tests (fall-cone, vane lab tests) and in tests located (mostly in tests located vane). A typical example of default shear force shear is found on a field shown in Figure 19-25. The figure illustrates a satisfactory agreement between these different sets of data. Figure 19-25. Examples of Situations and Laboratories undrained Shear Force profiles [27]. Angle of friction of dry friction and its associated kohesion to be assessed when the anchor suction is required to support long-term loading. These consolidation features include compression modules, Poisson's reporting, coefficient of permeability and the OCR. These features are needed for anchor capacity capabilities under long-term loads. Thixotropy is the increase in the disinfected shear force of clay remedies and time and without any consolidation effects. Suction anchors can be performed for different loading requirements: (1) moving applications to floating production units; in this case the suction anchor should be resisted to an inclined bound load where the vertical element can be high when fiber code is used; (2) anchoring to TLPs and other structures such as towers lifting where the anchor should support loading uplift; and (3) foundations for subsea structures where the anchor should be resisted at a compression load combined with horizontal load and moment. For the aspiration stack foundations used to support manifold, foundations should have sufficient capabilities to withhold severity and all loads from the manifold system, including compression, lateral, moments, and torsion under both subsea equipment facilities and operating conditions. Security factors are determined from the design base. As an example, the following security factor (FORCE) is being used in a GoM application: Operating = 1.9 for the accial failure; FORCE= 1.9 for the lateral failure; FORCE= 1.5 for the torsional failure. Installation requirements=1.5 for all types of failures. The security factor of 1.9 for the acquiiality failure and lateral failure includes a load factor of 1.3 for load deaths and a resistance factor of 0.7 for axial soil capacity. The security factor for the torsional failure is reduced to 1.5 due to the fact that the consequences of the torsional failure is less severe than accurate and lateral failures. However, the negative impact of torsional loading on capabilities and lateral capabilities within the system's foundations should be regarded as during the design stage. A security factor against all types of loading facilities reduced to 1.5 due to the nature of the temporary, Short presentation period, which also agrees with API RPG 2A, Section 6.3.4.Suction piles should be designed to provide adequate lateral and accurate capabilities. Their work includes:•Foundation of stability;•Penetration resistance and the accompaniment required for final penetration;•The ultimate resistance resistance and accompanying requiring pressure;•Ver Regulations are grounded in the manifold;•Maximum horizontal consideration;•Maximum reaction due to the impact when landing the suction ink and the base guide kterface of the oath. Stability calculations are designed for the following two separate conditions: • Vertical payload in combination with torsion moments, use the skin friction and end outlets brought to the suction pile ink;•Load horizontally in combination with a reverse moment, the use of the shear force of the enclosed ground. Resistance to combine vertical and torsion to solve by completing the port friction is allowed according to API with the maximum applicable value for penetration-assistance beyond the self-penetration depth. A penetration analysis involves the calculation of skirts' penetration resistance, the pressures needed to achieve target transparency depth, enabling compression (depression provides either so great solve inside the skirts or cavitation in the water), and so heavily inside the caisson as shown in Figure 19-22B. The transcendent analysis is often done using the general principles provided by Andersen and Jostad [28]. As these analysis include the following parameters:•Penetration Resistance;•Penetration Weight at the anchor;•Mandatory under pressure as a function of depth;•Enable compression as a function of depth;•Heavily as the in-depth function;•Maximum penetrating depth. The resistance to RTOT penetration is conventionally evaluated using the following expression: Where Residing is the resistance on the side walls due to the side cutting, and Rtip is the ability to carry in the skirts type. The effect of interior certificates to be included in the resistance to penetration, and the resistance to penetration can be higher if there are sand layers or boulder in the clay. Compression needed for Skirts are calculated by the following expression: where W' is the submerged weight of the suction ink during installation and Ain is inside the suction ink the area. Compression allowing with respect to heavy soil soil in the cylinder due to heavy bottom of the skirt type level can be calculated by carrying capacity. In water that does not allow the pressure should not exceed the pulse pressure. The aspirations needed should be less than the aspiration permits, which is the critical aspiration that can provoke failure to plug in soil inside the aspiration ink. In the conventional approach, the resistance on where the walls (Resid) calculates consider that the external (fext) and internal frictions (fint) are governed by the same expression: where α is a Factor adhesion is often taken as the inverse of the sensitivity value (the ratio between the intact and the shear forces remedy), and SudSS is a means DSS strength courage over the penetration depth. Latest installation of ink suction equipped with indoor certificate stifens of highly plastic clays has shown that the conventional approach provides high penetration resistance compared to the measurements. It is believed that a mixture of soil and water is trapped in the stiffener area, leading to low internal forces during installation by taking into account by the conventional approach. Several analyticals are required to establish a mechanism to address the resistance brought to the internal stifensphens and the friction produced on the inner skirt wall: (1) special laboratory tests to investigate the behavior of the earth between internal ring reductions, (2) component analyses ending with large displacement formulations, and (3) calibration-specific sites. The response impact response to lowering the suction pile in the ocean is to check the limited movement movements of the pile close to the serpent. A range of lowered technique speeds should be used considering the available water evacuation areas, geometry anchor geometries for asthma, and solid conditions. The check criteria must avoid sol-borne capacity failure and to avoid high hydrodynamic pressure in the suction stack ink that could influence its structural design [29]. Figure 19-26 shows the landing sequence of deck installation suction. Figures 19-26. Stack Installation Sequence [30]. The suction stack must be designed to withgo the following loads:•Maximum load applied and balanced by reactions were sol;•Maximum negative pressure (under pressure) required for batteries to pile embedment;•Maximum internal pressure (pressure) required for extraction batteries;•Maximum load imposed on the batteries during the rise, handling, launching, lowering, recovery, etc. the maximum horizontal and vertical loads should be used for the global structure design of batteries. They can use a final structural component model for the global stack analysis structure to ensure that the wall structure and learning adequate forces in highly charged areas. The structural components of the suction pile should be made in accordance with the applicable affinity of API RPG 2A, AISC, and API Bulletins 2U and 2V. In general, cylinder shell components should be made in accordance with API RP 2A or API Bulletin 2U, flat components in accordance with API Bulletin 2V, and all other structural components in accordance with API RPG 2A or AISC, as applicable. In API RPG 2A and AISC, enabling stress values are expressed, in most cases, as a fraction of the stress they yield or stress buckling. In API Bulletin 2U, stress values allow them to express in terms of critical loop stress. In API Bulletin 2V, the insists permits are ranked in terms of state limitations. Two basic limitations are considered in API Bulletin 2V: ultimate landmark state and serviceability limit. Ultimate state boundaries are associated with the failure of the structure, when we consider the utility boundaries associated with design in the design to meet its functional requirements. For the purposes of countless design suctions, only the ultimate landmark state is regarded as in design. For structural components designed in accordance with API RPG 2A or AISC, the security factors recommended in API RPG 2A and AISC should be used for normal design requirements. For extreme design requirements, stress is allowed to increase by one-third. For structural components analyzed using completion component techniques, von mises are (equivalent) stress should not exceed the maximum permissible stress as shown here: where η_0 is the core utilization factor, and σ_y is the force is the material is material. The basic utilization factor η_0 is 0.8 for the maximum requirement in place place and 0.6 for normal operating, transport, lift, lowered, and recovery requirements. The stresses are based on fiber stresses for beam analyses, and the membrane or midite insists for FEAs using plate elements. For patches keenly loaded also exposed to the plane (e.g., Membrane) insists, the Surface von Mises stress laptop in the middle of the plate field (e.g., midway between stiffeners and/or girders) should not exceed the following: nominally the elastic stress calculated in the middle of the plate field due to lateral pressure alone should not exceed $\eta_0 \sigma_y$. The hydrostatic buckling calculations should be made in order to check the ability of the shell wall in a pile while embodied for local buckling buckling. Although the loop of the wall is not a concern for operating conditions due to the structure's supporting ground, it is a potential concern during installation. When the pile is penetrating the ground and is subject to differential pressure embedment, there is a potential for local buckling due to stress interaction and hoop. Minimum of design buckling fall pressure in the mound should have an adequate safety margin to ensure the shell of the deck is strong enough to withure the maximum pressure to suction. In addition, an adequate security margin between the minimum pressure buckling design and pressure needed for embedment in the pile should be applied. A closed, endless cylinder under hydrostatic pressure will loop between ends of support by forming a pattern of circumferential loss. The loss formed around the circumference, or loop mode, is a function of the supported roller-to-diameter ratio L/D and cylinder D/t ratio. Buckling can be purely elastic or a combination of elastic distortion and elastoplastic distortion. In the case of suction pile, the D/t and L/D reports are such that elastic buckling is the predominant mechanism. Two analytical approaches available to determine the buckle capability: •Design code-based fitness method buckling analysis using an estimated length supported in shell;•Finish component analysis of buckling incorporant behavior full terrain/interaction structure of model explicitly degree patterns in support of the shell of a suction pile. A number of design codes provide analysis methods to determine the buckling design force of a deck for asthma. The methodology is detailed in API RPG 2A for combining axle compression, hydrostatic pressure, and bending can be used to check the pile wall for local buckling during the embedment process. The semiempir technique used in API RPG 2A is suitable for diameter batteries-to-wall ratio thickness of less than 300 (D/t<300), the methodology must be adapted to account for several wall thickness instances between ring frames. This is accomplished using a weighted average thickness of the calculations that is a function of effective buckling length. The effective buckling length will decrease as penetrating the soil and part of the pile is sticking above the mud decrease. As the deeper penetrating of the ground, the Earth will be progressive to support the countless wall and increase the loop capacity by forcing the wall structure in a higher mode of buckling failure. A transportation analysis should be carried out for the following procedures: •Structure of busy stack and transfer of the transport ship.•During transport to the installation site, the batteries at the transport bar are normally supported in two locations with cholesterol. The breadcrumbs will take force to roll, while welding plate pitch in the pile and the tags pile will take pitch strength.•Before installation of the serpent, the pile structure upgrade from a horizontal to a vertical position. The burden considered in the transport analysis should include the self-weight of the concrete pile and loads of systemic developers through a movement analysis. A dynamic load factor of 2.0 should be used in the design calculations according to API RPG 2A-WSD. The calculations for announcement design can be carried out at hand, and the announcement support structures should be checked by a FEA method for the simulations of all pile structures. analysis should be done to check the structural integrity of the suction pile and lift attachments under installation and removal on the transport bar with lowered pile and recovery. recovery.