IMPROVE THE SHEAR STRENGTH OF SOIL BY USING MICRO- PILES AS FOUNDATION

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Abstract
Micro piles transfer loads through liquefiable soil to competent bearing strata to conform to design requirements. Micro installations can penetrate to hundreds of feet in depth each of pile can supportmany tons of load. The use of Micro piles has grown significantly and has been used mainly as elements for foundation support to resist static and seismic loading conditions, and as in-situ reinforcements for slope and excavation stability. Micro piles can be designed as soil frictional piles and rock rocketed piles either under tension or compression. Rock suckered micro piles usually experience very small residual settlement as compared to other piling systems. Micro piles have been used effectively in many applications of ground improvement to increase the bearing capacity and reduce the settlement particularly in strengthening the existing foundations. Advantages of micro piles are high carrying capacity, less site constraint problem and self sustained operation.

Introduction
People started to design and build structures for different usages and environments, foundation systems to support such structures has to be developed in order to match the architectural and structural needs. It is not always possible to find good supporting ground instead of large, mass concrete foundations, which require large areas and mass excavations, smaller and deeper drilled shaft or pile foundations became a more economical, In which steel reinforcing system embedded in concrete and cement grout are the majorcomponent. They are very simple but unique in design and construction are becoming more and more popular.

Drilling
Micro pile excavations are done using rotary drilling machines. These machines come in many different sizes and designs. The capacity of a drill rig is expressed in terms of the maximum torque that can be applied to the drilling tool, as well as downward force torque and crowd are transmitted from the rig tothe drilling tool by the drill casing. drill rings can be mounted on trucks, cranes.

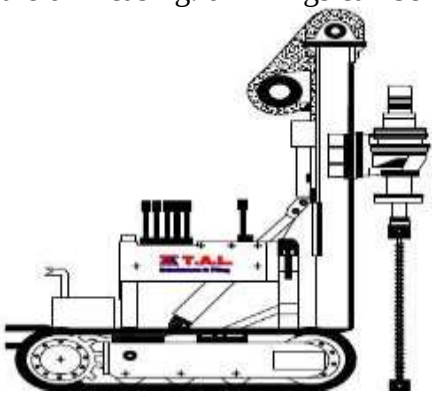


Figure1 Rotary drilling machines

The drilling approach is chosen on the premise of inflicting minimal disturbance to the floor and close by touchy systems and capable of gain the specified drilling performance.

Drilling techniques

One tube development:- One tube development is the toe of the drill casing is fitted with an open crown, and the casing is superior into the floor through by rotation of the drill headwater flush is pumped continuously via casing, which washes particles out and far from the crown.

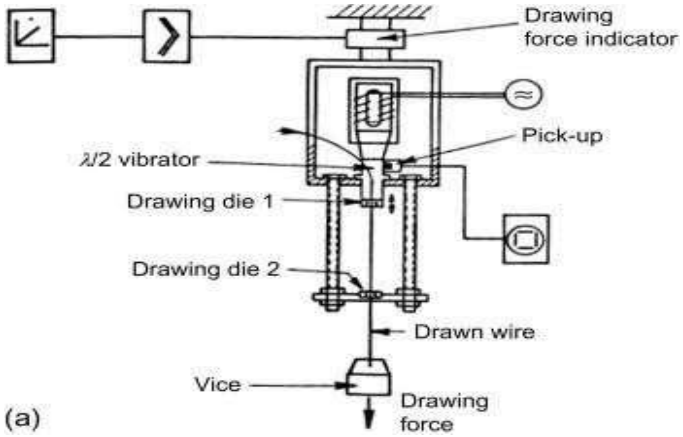


Figure2(a) Drill casing Machine

rotary duplex With the rotary duplex technique, drill rod with a appropriate drill bit is positioned with inside the drill casing. it's miles connected to the identical rotary head because the casing, permitting blended drill and casing string.

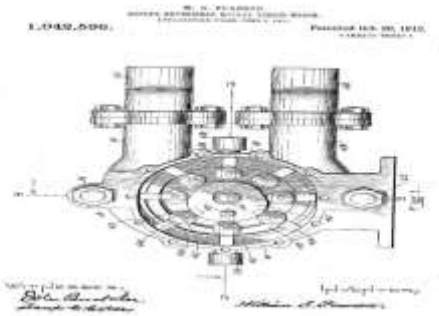


Figure2(b) Rotary duplex Techniques

Rotary percussive duplex

Rotary percussive duplex device are improvement of rotary duplex methods, the drill rods and casings areconcurrently per-cussed, turned around and advanced. The percussion is supplied through a pinnacle power rotary percussive drill head. This approach calls for a drill head of large rotary and percussive energy.

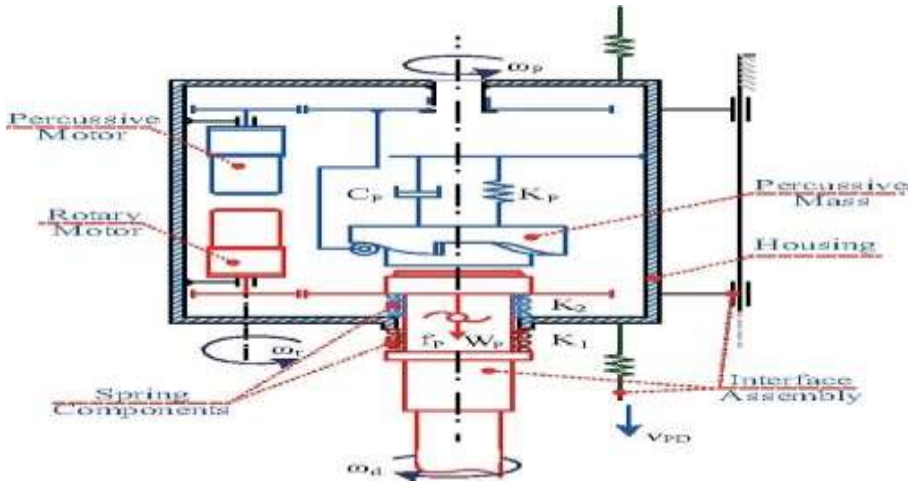


Figure 3 Rotary percussive duplex

Types of Micro piles

A) without delay loaded micro piles elements, which might be loaded without delay andwherein the pile reinforcement resists the bulk of the carried out load.

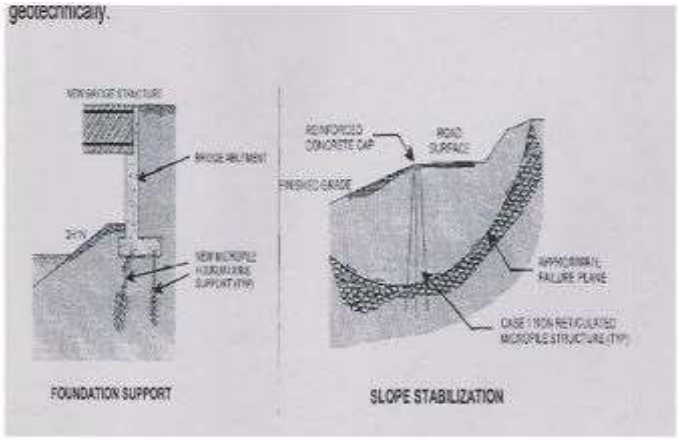


Figure 4 Slope Stabilization

Reticulated pile network those are of 4 types

kind a-gravity grout kind

b-strain thru casing

kind c-unmarried international publish grout kind d-more than one repeatable publish grout

kind a:-right here the grout is positioned beneath gravity head most effective the use of sand-cement cars or neat cement.

kind-b:-on this kind neat cement grout is positioned with inside the hollow because the brief metallic casing is withdrawn. injection pressures varies from 0.5 to 1.0 Mpa.the strain is confined to keep away from fracturing of the encompassing ground.

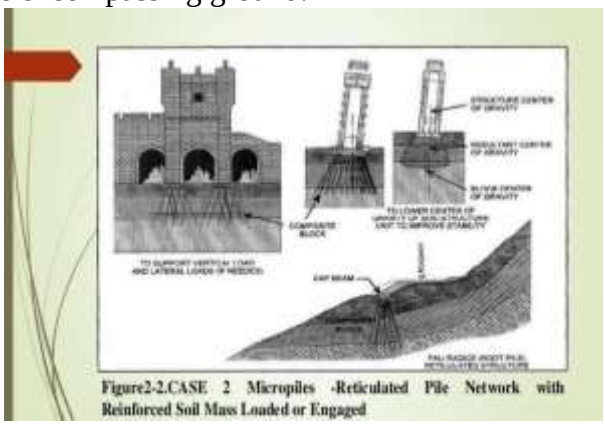


Figure 5 Micro piles

kind c:-that is executed in step procedure.

1) As kind a (the grout is positioned beneath the gravity head most effective the use of sand-cement or neat cement.)

2) Previous of hardening of number one grout, comparable grout is injected one time through a sleeve grout pipe at strain of as a minimum 1.0 Mpa. kind d:-that is executed in step procedure of grouting much like kind c with changes to step 2 wherein the strain is injected at a strain of 2.0 to 8.0 Mpa.

Grouting

Grout for micro piles should be designed and located in a way this is precise to micro piles. The fundamental traits of grout for micro piles are: excessive energy, true durability, low shrinkage. Micro pile grouting system is composed not less than a colloidal excessive speed, excessive shear mixer, conserving tank with agitation, grout pump of able to accomplishing pressures of three hundred psi, strain gauges, recirculation traces. the colloidal mixer is a excessive shear grout

plantthis is able to swiftly blending neat cement primarily based totally grout in some minutes, with a thru wetting of the person cement grains. a thru wetting lets in a low water-cement ratio grout to be pumped without difficulty thru the grout traces that run from the plant to the pile. without a colloidal plant, clumps of cement will grasp together, clogging injection traces, ultimately yielding a decrease energy grout, due to the fact sizeable quantities of the cement grains aren't hydrated. the grout should be saved in an agitation tank with agitation blades that continuously stir the combined grout, prolonging separation of the cement from the combination nature water. With right admixtures, grout existence can be prolonged without difficulty to a running time of 6 hours. it transfers the imposed hundreds among the reinforcement and the encircling ground. It is able to shape a part of the load – bearing pass phase of the pile. It serves to shield the metallic reinforcement from corrosion. its consequences might also additionally increase past the confines of the drill hollow via way of means of permeation, fissuring. the grout, therefore, wishes to have ok homes of fluidity, energy, stability, durability.

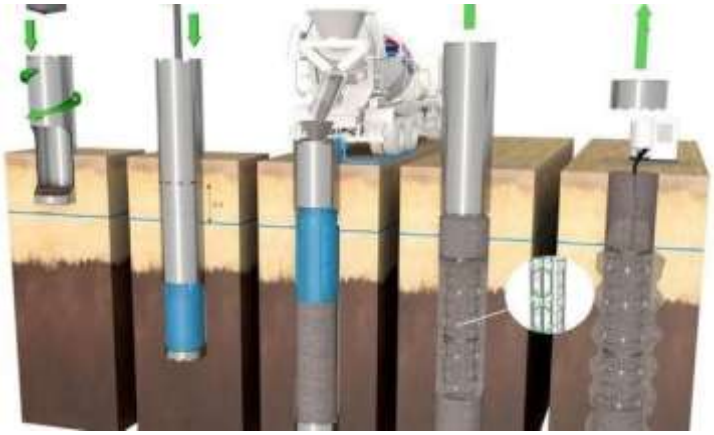


Figure 5 Grouting techniques

Grout placement techniques

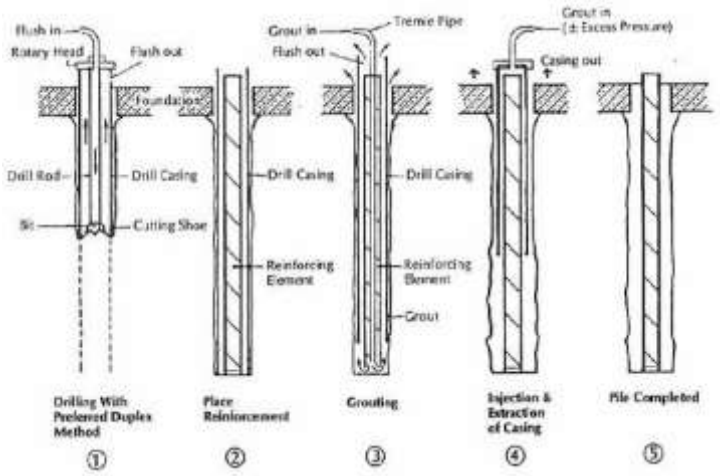
- Gravity fill strategies (kind a micro piles) as soon as the hollow has been drilled to depth, it's miles packed with grout and the reinforcement is located. Grout must continually, added into the drill hollow via a tremie pipe exiting at the lowest of the hollow. Grout is pumped into the bottom of the hollow till grout of comparable exceptional to that being injected is freely flowing from the mouth of the borehole. no extra that the exceptional of the grout is maintained for the whole period of the borehole. this kind and section of grouting is known as the number one treatment. Gravity fill strategies have a tendency now for use most effective while the pile is based in rock, or while low-ability piles are being established in stiff or tough cohesive soils, and strain grouting is unnecessary.
- strain grouting via the casing (kind b Micro piles) extra grout is injected below strain after the number one grout has been termed, and because the transient casing is being withdrawn. The intention is beautify the grout bond characteristics. This operation may be restrained to the weight switch period with inside the layout bearing stratum, or can be prolonged to the whole period of the pile in which appropriate. Strain grouting is commonly performed via way of means of attaching a strain cap to the pinnacle of the drill casing and injecting extra grout into the casing below managed strain. grout pressures are measured as near the factor of injection as viable , to account for line losses among pump and hollow. Commonly, a strain gauge is set up at the drill rig and monitored via way of means of the driller as a manual to price of casing withdrawal at some point of the pressurization section. Alternatively, if a grouting cap is used and the casing is being extracted via way of means of manner apart from the drill rig, it's miles not un usual place to discover a strain gauge set up at the cap itself. line losses are inevitable with inside the system, however contractors generally report the strain indicated at the strain gauge without the correction, reasoning that such losses are compensated via way of means of the more strain exerted via way of means of the grout column because of its weight with inside the borehole. the powerful injection pressures are dictated via way of means of following factors:- the want to keep away from floor heave or out of control lack of grout. the character of
drilling system. General pile depth. the “grout ability” of the floor. the desired grout bond ability. the

want to keep away from "seizing" the casing via way of means of flash setting of grout because of immoderate strain, stopping right final touch of the pile. the injection of grout below strain is aimed toward enhancing floor pores and skin friction, consequently improving the weight sporting ability of micro pile. strain grouting additionally appears to purpose a re-compaction of soil across the borehole and increases the powerful diameter of the pile within side the bond zone. Those mechanisms efficaciously beautify soil contact, main to better pores and skin friction values and advanced load performance.

Post-grouting (kind c and sort d micro piles) it isn't always viable to exert sufficiently excessive grout pressures at some point of the casing elimination stage. for example, there can be floor leakage across the casing. Alternatively, a few micro pile creation techniques might not use or want a transient drill casing, and so strain grouting of the sort b technique isn't always feasible. those occasions have cause the improvement of post-grouting strategies, in which via way of means of extra grout may be injected through unique grout tube a while after the putting of number one grout. Such grouts are continually neat cement-water mixes and can consequently have better water contents than thenumber one grout. it's miles reasoned that extra water from those mixes is expelled via way of means of strain filtration at some point of passage into the soil, and so the real located grout has a decrease water content.

Reinforcement

Generally, there are three styles of reinforcement for micro piles and is composed of single reinforcing bar, reinforcement bars are metal pipe. Reinforcement bars is broadly speaking deformed excessive-tensile electricity metal bar and is generally located in businesses to will increase the structural ability. They are to be had to forty mm in diameter with yield electricity of as much as the 460 Mpa, metal pipe is specially used ex-oil API(American petroleum institution) pipe that are excessive tensile electricity metal pipe to be had length stages from 60 mm to three hundred mm



diameter with usual yield electricity of 552 Mpa.

Figure 5 Reinforcing of Piles

API pipe device is commonly endorsed for compression piles because it affords appropriate lateral balance of the pile beneath axial compression load. Reinforcement bars are not un usual place foranxiety piles due to its resemblance with anchorage. Some designers additionally use reinforcement bars for compression piles with provision of enough helical hyperlinks to keep away from bucklingof reinforcement bars and for piles in grout with appropriate lateral support.

Design

Micro piles may be designed as rock docketed piles in rock formation and friction piles in weathered rocks or soils to hold both compression load and anxiety load. All micro piles are designed to switchload via shaft to friction to over a period of a pile shaft to the founding medium. Stop bearing on the pile tip is commonly negligible for the motives of small base bearing areas, wherein the axial load can't be effectively switch to the base. This layout philosophy additionally

intermittently needs afounding medium with enough thickness to hold the imposed load from the micro pile. If there's ahollow space beneath the pile toe or the pile is pocketed right into a boulder, there can be a fewswitch of the burden to the encircling the soil cloth via way of means of arching impact or to unfold the load to the below soils. If huge pile institution is concerned on this founding conditions, caredesires to be taken to keep away from punching shear failure of the rock slab or bearing failure of the soils below the boulder inflicting immoderate agreement beneath the complete pile institution. There isn't any particular layout popular for micro pile layout, however, relevant layout requirements for every layout additives may be mentioned with inside the pile layout. Those requirements are BS449, BS8081, BS8110, BS8004. However, operating pressure method continues tobe broadly followed for the pile designs in view of the compact ability among the structural and thegeotechnical designs.

Minimum component of protection for each structural and geotechnical capacities are 20 as endorsed in BS 449,BS 8004 and Bs 8081 as properly customary in nearby exercise. Structural layoutIn exercise the layout compressive pressure with inside the metallic reinforcement is restricted to 50%of the yield strength. The pile ability is usually derived from the allowable structural ability of the reinforcements with inside the initial layout. Different additives along with the grout and addition reinforcement bars may be protected to decorate the allowable structural ability. However, greater care had to make certain its effectiveness for the duration of construction. The minimal required bond period must be three metres. If empty hollow space or very tender lime region is encountered, the bulking load must be taken into consideration for important downgrading of pile ability in compression. The well-known Euler‟s formulation proven beneath may be used to calculate the buckling load relying at the stop constraints.

Pcr= (Π2 EI)/Kl2

Where ,

Pcr = buckling load in kN,

Ep = Young's modulus in kN/m^2,

IP=moment of inertia of the equivalent pile section (kN/m2)

L=length of pile column without lateral support (M) K=1.0 for pinned ends,0.25 for fixed ends.Construction control

8) grease or coating on reinforcement must be eliminated to make sure proper bonding.

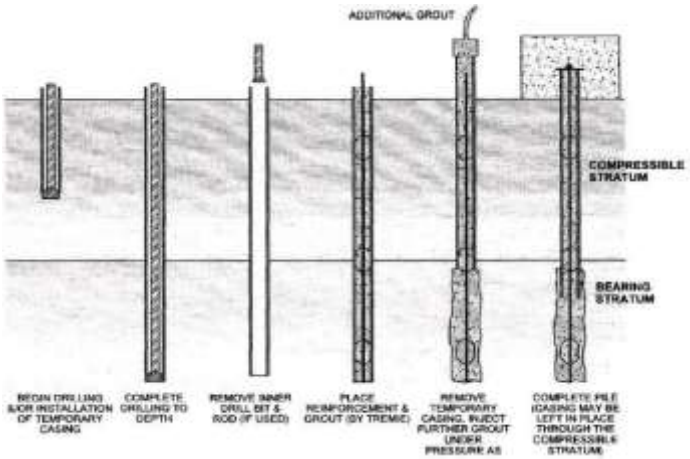


Figure 6 Placing of Piles

Installation

The micro piles had been forged in sand of 50% relative density thru an aluminium casing pipe of outside diameter 12 mm and inner diameter 10 mm. on the decrease give up of the pipe a 60 diploma conical wood shoe became connected. A 1.five mm diameter slight metallic rod became positioned with inside the pipe as reinforcing element. The aluminium casing pipe together with the metallic rod and the wood shoe had been driven with inside the sand manually, preserving the pipe precisely vertical. The pipe became then grouted with cement slurry having a water cement ratio of 0.five.

Since strain grouting with inside the version tank became now no longer possible, the piles had been grouted below a consistent slurry head of one hundred cm.The pipe became

tobegin with crammed up upto one hundred cm by means of cement slurry, the regularly lifted up by means of 2 cms and the extra cement slurry equivalent to 2cms top became poured from the pinnacle. This became performed if you want to hold a consistent slurry head of one hundred cms. This manner became repeated until the complete pile became grouted to make the piles unfastened standing a 50 mm lengthy aluminum pipe became connected to the pinnacle of the grouted pile preserving the slight metallic rod on the middle and once more forged with cement slurry. The piles had been examined after an c program language period of four to five days of grouting.

Advantages of micro piles

Micro piles are regularly used to underpin the prevailing shape wherein want of minimum vibration or noise is of high importance. Micro piles may be effortlessly established at any attitude beneathneath the horizontal the usage of the equal device used for floor anchors and grouting projects. Micro piles may be effortlessly laid wherein low head room is a constraint. Micro piles provide a realistic and cost –powerful solution. It do now no longer require big drilling platforms.
Micro piles subjected to lateral loading situations:-Measurement of load and deflection:-
Load deflection take a look at became performed in line with code of exercise for load take a look at on pile besides the slow software of load became as much as failure. Load carried out to the pile cap by means of a mechanical jack, became measured by a proving ring and displacement measured by means of a dial gauge connected to the pile cap.

Loading arrangements

Figure7 Mechanical jack

A mechanical jack changed into followed for making use of lateral load. The mechanical jack changed into installed to a horizontal pass beam with bolts and nuts alongside which it's miles loose to slip whilst required. One cease of an extension rod of period 17 cm changed into constant to the end of the lever arm of the mechanical jack and cease to a proving ring. The different cease of the proving ring changed into pivoted to the pile cap, constant on the pinnacle of the pile with the aid of using ball and socket arrangement. The pile cap changed into made from timber having size (6.4cm*6.2 cm*2.8 cm). The cap includes halves with semi round groove to house the pile head. The halves had been screwed tightly to the pile cap.

Test results

Single micro piles had been forged for period/diameter (l/d) ratios of 8, 21, 24, 27, 30, 35, 55. More over for every l/d ratio 3 micro piles had been forged at 3 special relative densities of 30%, 50% and 80%. In general 30 numbers of micro piles had been tested. in the end resistance of the pilebeneath lateral load has been taken remaining resistance of pile beneath lateral load has been taken because the factor at the lateral load as opposed to lateral displacement curve at which with the curve continues a non-stop displacement will increase without a in addition will increase in lateral load.

Mode of failure of the micro piles

There are sorts of disasters of the micro piles with the aid of using formation of plastic hinges or structural failure. The first kind is determined with the aid of using a quick pile. A quick pile on utility of lateral load rotates and passive resistance is advanced close to the floor at the alternative face. Failure takes place on the toe whilst passive resistance at the pinnacle and toe is exceeded. The 2d kind is determined in case of a protracted pile, in which cumulative passive resistance advanced on the decrease a part of the pile is pretty excessive because of which the pile can not rotate and failure takes place on the factor of most bending moment.

Micro piles subjected to oblique loading conditions

Loading preparations:- The loading preparations for indirect loading is proven from the schematic view of the experimental meeting is proven below. Loads are implemented on pile pinnacle via a double pulley arrangement. Non extensible bendy metallic cord changed into connected to the „s" hook on the pinnacle of the pile cap. Wire changed into taken via the adjustable pulley close to the pile head after which over a 2d pulley to the loading pan in which weights had been positioned for loading in stages. Loads had been implemented at 0,30,60,90 levels dispositions with the vertical. Vertical dial gauge readings and lateral dial gauge readings had been recorded similar to axial pulling masses, indirect pulling masses and lateral pulling masses respectively.

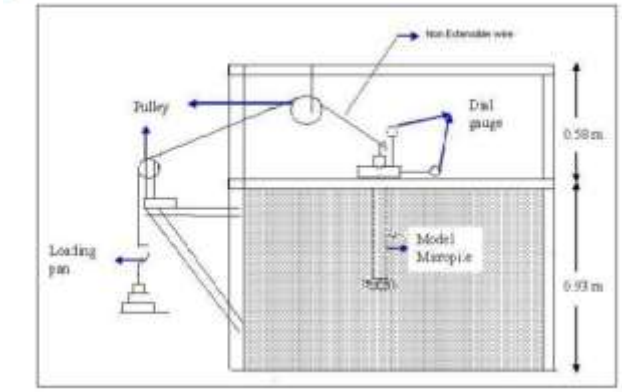


Figure 8 Micro piles subjected to oblique loading

Applications of Micro piles :-In-situ reinforcement;-
slope stabilization and earth retension.Ground strengthening and protection. Settlement reduction.
Structural stability. Structural support :-
Earth retension. Foundations for brand new structures. Underpinning of present foundations. Seismic retrofitting.
Under pinning of present foundations ;-
Scour protection. Repair/alternative of present foundations. Prevention of movement. Upgrading of foundations capability.

Conclusion

This describe the bearing capability of the inspiration of the soil is advanced the use of micro piles. Non linear finite detail evaluation is executed to observe the applicability and degree of development received within side the field. Densification of the soil surrounding the micro pile and the frictional resistance among the micro piles and the inspiration. Micro piles may be established in low overhead clearance much less than 3.5metres in all sorts of soils and floor conditions. Minimum disturbance is precipitated all through construction. Inclined micro piles may be without problems constructed. They are capable of face up to axial and lateral masses. Only small volumes of earth are to be excavating because of small diameter. They may be drilled with uninteresting machines that don't motive a lot noise. The excessive flexibility all through seismic conditions. How that the method used changed into powerful in acquiring the favored degree of development.

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