Semester-IV

17BECEE0078 Ground Improvement Techniques 2H-2C

Instruction Hours/week: L: 2 T: 0 P: 0 Marks: Internal:40 External:60 Total:100

End Semester Exam:3 Hours

Course Objective

- Analyze the expansive soil properties and apply the same for the design of structures on expansive soils.
- Apply mechanical modification, using deep compaction Techniques, Blasting, Vibro compaction, Dynamic and Compaction Piles.
- Design dewatering system, and using dewatering methods for ground improvement
- Adapt physical and chemical ground improvement techniques using thermal modification, like grouting, shotcreting and guniting technology.
- Analyze the Stability analysis and Design of Reinforced earth retaining wall.

Course Outcome

CO1: Analyze the field problems related to problematic soils and solve the problems using the ground Improvement techniques.

CO2: Summarize and practice ground improvement using Mechanical modification techniques.

CO3: Design drainage for seepage control, Assess dewatering field problems.

CO4:.Application of physical and chemical ground improvement techniques using thermal modification, like grouting, shotcreting and guniting technology.

CO5: Demonstrate the ground improvement techniques such as ground anchors, rock bolting and soil nailing, Design of reinforced earth retaining structures.

UNIT-I: Introduction on ground improvementtechniques–Basic soil properties and phase systems-Role of ground improvement in foundation engineering-Methods of ground improvement-Geotechnical problems in alluvial soil-Geotechnical problems in laterite soil-Geotechnical problems in black cotton soil-Ground improvement techniques – its application and effects-Selection of suitable ground improvement techniques on soil condition.

UNIT-II: Introduction to drainage and dewatering System-Drainage techniques-Vacuum method-Electro osmotic method-Introduction to seepage-Seepage analysis – principles-Seepage analysis for two-dimensional Flow-Fully penetrating slots in homogenous Deposits-Partially penetrating slots in homogenous deposits.

UNIT-III: In-situ densification of cohesion less and cohesive soil -Consolidation of cohesive soil-Dynamic compaction-Consolidation – Principles and basic Concepts-Vibroflotation-Sand pile compaction and stone columns-Preloading with sand and fabric drains-Lime piles – Installation techniques-Relative merits of various methods and their limitations.

UNIT-IV: Concept of reinforcement-Types of reinforcement materials-Properties of reinforcement material-Application of reinforced earth-Introduction to geotextiles-Uses of geotextiles as earth Reinforcement-Geotextiles for filtration and drainage Works-Geotextiles for separation in road works and other works-Design concept of geotextile.

UNIT-V: Introduction to grouting system -Types of grouts-Grouting equipment and machineries-Injection method-Grout monitoring-Stabilization techniques – concepts-Stabilization with cement and limeStabilization with chemicals-Stabilization of expansive soils.

SUPPORTING MATERIALS

TEXT BOOKS:

Sl.No	Title of Book	Author of	Publisher	Year of
		Book		Publishing
1	Ground	Purushothama	Tata Mc-Graw-Hill	2012
	Improvement	Raj, P	Publishing company,	
	Techniques (T1)		New Delhi	
2	Ground	Moseley, M.P	USA and Canada – CRC	2004
	Improvement (T2)		Press Inc. Florida	

REFERENCE BOOKS:

Sl.No	Title of Book	Author of	Publisher	Year of
		Book		Publishing
1	Design with	Koemer, R.M	Prentice Hall, New	2002
	Geosynthetics (R1)		Jersey	
2	Soil Reinforcement	Khedkar, M.S	CIRIA- Special	2009
	with	and Mandal, J	Publication, London	
	Geotextiles (R2)			

STAFF INCHARGE

(M. Sumesh)

HOD (Department of Civil Engineering)

DEAN (FOE)



KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University Under section 3 of UGC act 1956) COIMBATORE-641021 FACULTY OF ENGINEERING DEPARMENT OF CIVIL ENGINEERING

17BECEE0078/ GROUND IMPROVEMENT TECHNIQUES LECTURE PLAN

Number of credits	: 3
Contact hours	: 3 hours per week
Lecturer	: M. Sumesh
Semester	: VI- (2019-2020)
Course Type	: Core/ Elective

Lecture	Hours	Topics to be Covered	Text / Reference	Page No
1	1	Introduction on ground improvement techniques	T1,T2,R1	24, 98, 195
2	1	Basic soil properties and phase systems	T1,R1	30, 189
3	1	Role of ground improvement in foundation engineering	T1,R1	35, 191
4	1	Methods of ground improvement	T1,T2,R1	37, 112, 202
5	1	Geotechnical problems in alluvial soil	T1, R1	45, 210
6	1	Geotechnical problems in laterite soil	T1,R1	47, 212
7	1	Geotechnical problems in black cotton soil	T1,R1	51, 230
8	1	Ground improvement techniques – its application and effects	T2,R1	124, 238
9	1	Selection of suitable ground improvement techniques on soil condition	T1,R1	61, 245
Total	9 Hrs			
10	1	Introduction to drainage and dewatering system	T1,R2	48, 196
11	1	Drainage techniques	T1,R1	49, 198
12	1	Vacuum method	T1,R1	51, 201
13	1	Electro osmotic method	T1,R1	64, 212
14	1	Introduction to seepage	T2,R2	135, 198
15	1	Seepage analysis – principles	T1,R2	79, 215
16	1	Seepage analysis for two-dimensional flow	T1,R1	83, 219
17	1	Fully penetrating slots in homogenous depositsT1,T2,R1		85, 140, 222
18	1	Partially penetrating slots in homogenous deposits	T1.R1	103, 231
Total	9 Hrs			
19	1	In-situ densification of cohesion less and	T1,R1	88, 235

		cohesive soil		
20	1	Consolidation of cohesive soil	T1,R1	91, 240
21	1	Dynamic compaction	T1,R2	118, 218
22	1	Consolidation – Principles and basic concepts	T1,R1	113, 242
23	1	Vibroflotation	T1,R1	130, 245
24	1	Sand pile compaction and stone columns	T1,R2	138, 249
25	1	Preloading with sand and fabric drains	T1,T2, R1	145, 154, 249
26	1	Lime piles – Installation techniques	T1,R1	149, 251
27	1	Relative merits of various methods and their limitations	T1,R1	1150, 257
Total	9 Hrs			
28	1	Concept of reinforcement	T1,R1	198, 271
29	1	Types of reinforcement materials	T1,R1	199, 273
30	1	Properties of reinforcement material	T1,R1	201, 280
31	1	Application of reinforced earth	T1,R2	204, 287
32	1	Introduction to geotextiles	T1,R1	207, 283
33	1	Uses of geotextiles as earth reinforcement	T1,R1	212, 290
34	1	Geotextiles for filtration and drainage works	T2,R2	217, 289
35	1	Geotextiles for separation in road works and other works	T1,R1	219, 294
36	1	Design concept of geotextile	T1,T2,R1	224, 167, 298
Total	9 Hrs			
37	1	Introduction to grouting system	T1,R1	146, 270
38	1	Types of grouts	T1,R1	149, 271
39	1	Grouting equipment and machineries	T1,R1	152, 273
40	1	Injection method	T1,R1	165, 281
41	1	Grout monitoring	T1,R1	174, 283
42	1	Stabilization techniques – concepts	T1,R2	177, 270
43	1	Stabilization with cement and lime	T1,R1	189, 289
44	1	Stabilization with chemicals	T1,R2	191, 291
45	1	Stabilization of expansive soils	T1,R1	195, 294
Total	9 Hrs			

SUPPORTING MATERIALS

TEXT BOOKS:

Sl.No	Title of Book	Author of Book	Publisher	Year of Publishing
1	Ground Improvement Techniques (T1)	Purushothama Raj, P	Tata Mc-Graw-Hill Publishing company, New Delhi	2012
2	Ground Improvement (T2)	Moseley, M.P	USA and Canada – CRC Press Inc. Florida	2004

REFERENCE BOOKS:

Sl.No	Title of Book	Author of Book	Publisher	Year of Publishing
1	Design with Geosynthetics (R1)	Koemer, R.M	Prentice Hall, New Jersey	2002
2	Soil Reinforcement with Geotextiles (R2)	Khedkar, M.S and Mandal, J	CIRIA- Special Publication, London	2009

STAFF INCHARGE

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HOD (Department of Civil Engineering)

DEAN (FOE)

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charge there will be vise a fall in ground surface (\bigcirc in required cycle true to such secondal volume JUIL YE \cap allernately we and dry season, susceptible soil swell ? \bigcirc to region which have well defined Ċ leading to volume increase $(\tilde{})$ reputering force which soperates the clay perticle, (\mathbb{C}) Swalling coursed many due to (``) 90 tration sinterion \bigcirc drying but also shows walling with increase q \bigcirc Some sail not only shrinks due Ô high plasticky shrink growing coursing settlement $\langle \rangle$ presence of sand & sill size particle soil which \bigcirc Shrinkage is reduced due to the \bigcirc \bigcirc נוסקד ג הטגונגועבטבסך סף לכסןבלירסן קדטליביקיבט 7 $(\)$ initial maisture context, type & amount of day contact (;)The offect of shinkage depends on \bigcirc structure cotrict is termed as shinkede nos ul () tension in the water leading to a compression · U] \bigcirc in each voids at the soil surface and brings mp Ŷ \bigcirc When a saturated soil is allowed $\langle \rangle$ moisture content voriation hq Eassonal Ò Soil may undergo volume changes caused \bigcirc af seawing Maisture variation EHOGS \bigcirc \bigcirc ground alteration are discussed below \bigcirc A few faction cabido contribute for Ù the design- Life of shucknee 0 Ô possible ontherpoted change which could occur during Ö taken while designing a Anuchune Keeping in view the 0 Maccessony precontion have to be Ö Saladion of Convert Inprovede 0

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matery the port -- Electro Esmosis method - Nallum Station - Wall point system os forgoms on Ć * Variares methode of suchage drainage dry so that connection can be done ecconation Ç * purpose of downoresting to the keep the affor your (below the ground water hered when it is swowded i water from a foundation pit when it is situated ()4 I.T. M. the presence of removed of ()desolering (* Sub-suffare drawage is also known as ()and disposal of ground water lollection of * 3mp - Sunface drawage convint ab a (: Entre Subar drawage ्रि Ö \bigcirc of the subace mode lo llection * Supare drainage is the \bigcirc nathod ob \bigcirc Subare drainage \bigcirc \bigcirc ii, Sub- Surface drainage \bigcirc ו׳ שווילטרה קגמוטטאר \bigcirc Drainage may be classified into two colegarias continuos Ó the soil mass in order to keep in as stable \bigcirc word is the removal of gravity from Ο Drawoode ()()Drainige + Devatering \bigcirc 2- InU

()O $\overline{\cdot}$ \bigcirc between 48-1 SO1-100 The hyper of soil & depth of water generally \bigcirc when The spacing of well points \bigcirc dependes * \bigcirc fin buildund parbiap \bigcirc a specially The header is connected 94 木 \bigcirc 15-30 cm tha known as header \bigcirc are conreded to a horizontal pipe 20 how how \bigcirc Fise pipe of some direction, since of diffuent 04 Ju Owhere we is included to M4 oyl wallog \circ × duection during installation. 0 spracecoup which parmile flow of water only in the bro rocial Э A value is also provided near the \bigcirc 术 of the well point installation pus \bigcirc rong aff. ¢γ C porory diver point is רשטי רסך ports Ы 术 9 rocor pur Э it to beliver is provided at its 4H * 2 ecrean to previoil degging diw 0 portonon Э Braj t saw in dia. The performance шъ are of. ωĮ Э roall point is parforated pipe gran # #) spots matches trigo the opbuis (o \mathbf{c} motelle th well point

 \bigcirc BUHOF \bigcirc pumping & lowered when Rubber ball raised when T poid sours un troot follo Filter ן ק ĺ 11 l'ength $\left(\cdot \right)$ \bigcirc ()enpole Britzalla -やし (\cdot) 4117 SCLOON (\cdot) <u>ر</u> . Rise pipe to header noin <u>(</u>) \bigcirc \bigcirc $\langle \cdot \rangle$ Jetting them bound atra Ó hold hours are installed by oy1* \bigcirc Ъ 3mforto this pipe and then neaches off \bigcirc outer pipe to hole duilled in the bottom Po Ó puo epare between the gauge the outside off \bigcirc * Water drawn Arwayn Screen resport Ó sall Jething Lupe лQ \bigcirc spou with either M צרגדי סטק closed ends OO * I'I is withor with brass or Stain-laws Ο yprov all at Ea of \$ 4. un mars at as Po azis . O * Well point are רססון - צרגשטי nous \odot WOJSKS prod mm

ت ال \bigcirc \bigcirc ropyrod pros an 9H!I 20 \bigcirc there is ANDY drawnages water fullered & corrises \bigcirc \bigcirc סט מקופטנסטאב געסר it is there is UT ()2 voudmbo ()your repid & request reasonable & check way \bigcirc & The wetallation of well point system is \bigcirc Erigand gund-coods on while property 0075 \bigcirc Stabilization the side and thereby permitting is duaren away from the excenduon, thus О * turther in wellpoint system the water \bigcirc in sand a sandy graved of modarate permanent \bigcirc * Well point gystom acts more officiantly \bigcirc to be drained is not too deep \bigcirc re accentité and where water bearing straturn \bigcirc ofil * A wall point is suitable when the \odot method for lonstruction purpose \bigcirc prog Montes pleases as materes have been to \bigcirc mound confutured pump \bigcirc separator and a vacum pump as well as the 5 felling pump. The well point pump has an air wala С O.3m contars. In general with a separate 0 90 In high crows groved they may need to be as class $^{\circ}$ Spacing of 15m for sully sond of fain low posinede presentes about of orts to mind a solution 9 * In fire to wave said or sond for Э 5 the drawbarn Dormeal itil of soil & avail ability of time to affect С * spacing of work point depends on the D a sommeria some so about 10 hilors Im. * The capacity of a surgle well point with .

()() \bigcirc Fig. 3.5. Single-stage wellproint installation. ()(-WELL POINT < $\left(\right)$ TOMERED WATER LEVEL Ć - 3919 A3218 Ċ 5-51 COARSE SAND FILTER \bigcirc DEJOINT MULEY LEVEL () \odot BOWE 200.104 FEAR COMMECTION NIAM REDER MAIN **BARVI** ()* INEOSI, LNEWSAONGAU ONBORO ()()() ${}$ ()trogless is in not possible to instal wellpoor 10 $\langle \rangle$ gravel, Still clay or sail containing cobble obrog ()40 minou butterion is consisting mount of I * \bigcirc Exposito bridand \bigcirc founds in pipe. Volue ate resulting in hors 90 \bigcirc Approvalt materies ant shall be drawn into LNO \bigcirc generally pessible beyond which accessive ponor R Ó Aund more up opany Pu popan bound \bigcirc suction lift Ô Ś notege tring the bar of national Ô * The serious Ο Burund dung О -rego alive rout broug ground then with open-Po 2 Majana \bigcirc * Becourse of this fors gauger of mout. 81



Disody - les officeray adv - Not limited depth by suction high pump at Gr.2 and swrrended with a filler sand in recessary эcy & jet-eductor pipe pump are installed in a cased * There twee pipe abong with the wellpoint refut unter punp, with one pressure pipe and slightly longer attached to the bottom of jet-aductor tring then * A jet-eductor wellpoint system consist of a jet-eductor collocit system collipoint system with subace pumps, one can use a * As a alternate to the convertional bracking to be used of sheet pilos coffer dan thus allowing higher pock it. to swimply hydrostatic pressure on the Shoet piles are ab limited peretration voyon 1, to prevent quice condition of the bottom Ghost pile under the fallowing condition ypin oyf * Wallpoint are provided in Conjunction excondion they are placed class to the Sheet pile rous * When coellipoint are used in braced installing the pump & header Stage by excending down to water level before the other hand it is possible to avoid multi-wellpoin excendion at ground lovel became very harge on Ouronation in this way, but the overall width of in fig. Those is no limit to the depth of navalle spote snam 10 out ni belletani 20 ' pmul * Tax devoloring despor excendion noglaw att

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N ()С Fig. 3.10. Deep-well dewatering. <u>Benerikaset in de harry men andere de herrie das proprieten andere de server</u> ()TNIO9 JUB -----DEEP WELL-- \bigcirc -DEEP WELL PUMP \bigcirc VIAM ABDABH . \bigcirc LOWERED WATER LEVEL \bigcirc \bigcirc D OBIGINAL WATER LEVEL () \cap DISCHARGE PIPE \bigcirc О quind adiensinale pump \bigcirc casing which depend on the size of the \bigcirc Were so to soom longer than the well 90 \bigcirc o buyus by Cased borehole hoving a diamedar \bigcirc installation ob snots is the coop 241 × Ø \mathbf{O} ground water table off. $^{\circ}$ all point system on cortain field condition for lowering * Deep with may be combined with the О Ĵ great depth of water howening is required ()* This method is also guildele when 0 105 О soctand through or is underlin by coarse grained \bigcirc formation is pervious with depth, the excordion Э Los and the growed water table where the soil С * Dag wall system is suitable for Э prov Э applier operation & water table however to desire .) which can be installed outside the zone of construction of good wall & submarsible or turbine pump) * D. eep-Wall drainage system consist Э, Deop-Woll Drainage (0770)



oft majod . belle purched in installed. parjor which fall into yed and beredenced and by w!Y ybronyf and at the same time any unisarted the filler to promote blan back and buyoq yraf 1024 O water in well is than sugged by <u>541</u> * backfilled with any available mallerial Opara alove ab the screen is m1 * spots The filler motorial is placed 90 υγ outer cosing is withdrawn off voy1 * benetocueb ed at Aprol syl cosing over well casing and the order bolehide DY1 * Enraded piller malerial is placed between ·you material solids might be drawn through the filler and ing the collect any fire po ¥ 910 υ 3 to sin langth of Unperforded v vr por unidad your which required devotedring and nos .go * A partorolad ecrean installed 101Q off of the completion porsion sit. GURING poposui AOUUI . moon. . 741 *

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1 \bigcirc C \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc $^{\circ}$ \bigcirc \bigcirc Ò \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc bond sub-aqueous trond \bigcirc pariod such as dry dock or access shaft for \bigcirc method to job which have a long construction $\langle \rangle$ * Thus it is advised to restrict this О $(\cdot,$ high deep-well gystern is relatively high out Ô roctor or under other difficult field environment. Ő well in very adviense formation hike bouldars, ort. the heavy boring plant is used to sink Ô nont to thout excessive nead hors sufficient langth of submanged screen to admit the the bottom of well should be set to provide ' dand your doop by podand one your off I # non below the computed water surface in the proys wed in a deepwall system, the top of screen M and when white commission I canterfugal pump off 0: *This is the last operation before putting <u>)</u>:

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permaderiting of rorge 0.1 to loxis contsec Stratified soil with wallicent of paratro l0 trom & borthom my1 * suitable V1 -97 well point is increased off. pressure, the hydroulic gradient for flow UMION mon prigrand att privad vous soff 0 suitable matarial בכסצובק or copped could an impervious 91 POF -<0 top few postion of the hole oyL ¥ within a few meter of ground surface N entradad voith filler sand actanding pipe be tott mp. or well point screen, and river poco H * vacuum dewo deving system requires ma application of vacuum to water Build at * Such soil can be devotered satisfactory spunte-alkal at 1.0 go obvor ui Permeability affective in the bine-grained Sail with 7 ml ynu 220 Hear-geord & Inid have a very print & deep-week

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Fig. 3.12. Vacuum dewatering system.



Water

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 \bigcirc \bigcirc () \bigcirc \bigcirc \bigcirc О \bigcirc \bigcirc \bigcirc δ 0 \bigcirc \bigcirc О О Ó \bigcirc 0 Э (0 Э ਼ or the С mode troub 3 watshs UĮ suff and practical maximum height 0 Jo UT * and say on Budion procession С charger thick) the conversional system Ð Tranks tried bound maters with it *) placed Pr Strattical S υĮ ΰ Э gif is reache et lice Э * A typical vaceur devolering system).

(_____ \bigcirc (execonation \bigcirc molecults bocated rear the top of Slope of \bigcirc # Anode are in form of 5ted O soil partile gets shear eggs abitrog live \bigcirc part of double loyer which absorbed to the \bigcirc #In but the conter entrie out ()മുന്നു സാന്ദരനും \bigcirc cathede they take with them the attached Ô shit at enorm \bigcirc The Cation voya * \odot olipole \bigcirc dipole the action also attract the -ve end ab ()A H3 the water malacule or po \bigcirc service charge \bigcirc charged surface of clay minerals to satisfy the (:Edition more towards - Vely my 1 * \bigcirc are formed in pore water Cation \bigcirc exclined with help of electriced double loyer 81 \bigcirc *The phenomena of electro osmosis \bigcirc nates fring the \bigcirc water collected is discharge as in a convertional \bigcirc collect the water drained from the soil. The \bigcirc AA cathede is a well point which \bigcirc Le the regative charged electride (cathode) \bigcirc and negative declude to pour water migrate \odot Ö through a gaturated goil between positive electrod ()terrer direct work is passed Ο worrent is wea ()trained di consissiones de aparticités de O *Electro ponton υ 87 wound ·0 (991 bailter Merrie E / ectra · O
C Cohassime po 'M.08 \bigcirc about the relation increasing the short strand ()of how parmeabaility 1x100 to 1x108 1.05 ()mestre is romally wed to drain water in where 0 bertien retto reales eeros 0 Crift col UĮ sonnot be Ο ad bluente bantam witt * The mog О toy10 poypu О is experison companied with erectus esmos ye \bigcirc electricity consumption drainage abolo ybry puo \bigcirc * Become of specialized equipment Ò 10 km of S.Q Ο Ο consumption of areger is between oy1 * electricity per well at a voltage of 40-180 \bigcirc b \odot ano oc - os tradues along requires that 20 - 30 and O water contact of soil ul \bigcirc Stope aver il there is no significant Þ O 0700000 V duiting flow Jo alt prisosing in the 2 tability Õ hydrop priserona som arros prom ni dolo la \bigcirc * This arrangement is required to prever Э 9 C chatteredo Э (\neg) Non go only Jocoon Marco 9 Э orlyinde water to 1910 Э Э 0 Э 45-4 papo 990 W Э prind marais well point installed in the nos.): for man in fame of porpragad Cathode . Lues • ۋ

 $\langle \rangle$ mpervise loyer ()() $\langle \rangle$ ()- Equipotantial in \bigcirc \bigcirc pus () H115 (`) avil colt ()()()()Ī ()Wood Dig tools -> () Ī (_____ (, Flow line + Equipotential line = Flow net (`` pressure vormal to duction of flow (:of right angle since they represent onil with \bigcirc (\cdot) Equipotential lines must cross (:buipments the path of moving when ()Flow not are pictorial method ab ()malt - The ist tou with Ô О to eariest between two point if there is apply differed in mydraulic head at thus point \bigcirc \bigcirc Õ A hydroulic gradient is supposed \bigcirc 20000016 Ó of fluid, through soil under hydroutic Ο О seepage is defined as the flow ٠Ô Another abodoos \bigcirc

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 \mathbf{O} \bigcirc 90. <u>Gp</u>: y = b ()qu=y' mp=! $\left(\right)$ О 6= KiA \bigcirc in, whited there \bigcirc [284-24] - 12 = B \bigcirc \bigcirc $\begin{bmatrix} \sqrt{2} - \sqrt{4} \\ \sqrt{2} + \sqrt{2} \\ \sqrt{2} \end{bmatrix} = \frac{\sqrt{2}}{78}$ O. () $\frac{4}{H}\left[\frac{7}{2}h\right]^{2} = \frac{71}{76}$ \mathbf{O} \bigcirc mping = pps = 7 \bigcirc \bigcirc P: the = bb . 12 \bigcirc О $f_1 \cdot \frac{pp}{pp} = \frac{v}{b}$ \bigcirc \bigcirc H 0 h. mp.7 = 6 \bigcirc \bigcirc $bh = H \quad \frac{pp}{hp} = 1$ $(\cdot$ \bigcirc all is given by gall 0 the vertical place through p per will length a ab Õ For any point p(x,y) the discharge crowing O interest the drawdown curve \bigcirc slope of drawdown aume @ point where the vertical line \bigcirc the hydrountic gradiant is constant to is equal to the Э that on any vertical line below the drowdown sume. Э The discharge is given on the assumption Э one side of the slot consider a length a of slot 0 I't is assumed that the flow originates on Э incontined there ្ល 13.6) Fully peretuding 310t .

 $\left[q - H \right] \frac{67-7}{qbX} =$ [=4-H] -1 =16 and roiset-ro rol no sprondia => 3 mp ratues 21 = 15 (12 - 12) | H 9 × h (1°4-2H) 12 = 18 (GIC)O Discharge equation for gravity flow in place of he d bro 2 do 2019 in place is harded in place of 2 and b The discharge equation for antesion flow for dus charge equation in place of 2 and 6 in place of H in growing flow equation for gravity there for langth (29) that is using 29. The analysis can be done by using the discharge 195 the drowdown curve goes below the imperviews layer at the In this case the rate of withdraw is such that (intermend flow (artesion & gravity flow) [°4-H] 7 = B $\circ 4 - H = \frac{4 \nabla y}{7 B}$ $\frac{e^{2}}{2} \begin{bmatrix} e^{2} \end{bmatrix} = \frac{e^{2}}{2} \begin{bmatrix} e^{2} \end{bmatrix} \frac{e^{2}}{2} \begin{bmatrix} e^{2} \end{bmatrix}$ $\frac{4}{5} = \frac{1}{5} e^{\frac{2}{5}} \frac{4}{5} \frac{4}{5$ The gas of the second · · · · · ·

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$$(4 - H) \frac{d}{dx} = h^{-1} - h^{-1} = h^{-1} - h^{-1} + h^{-1} = h^{-1} + h^{-1} +$$

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En = Externo legth factor aray (?) 43+7 (94-H) 09H = 0B hy nome of 4 For the core of a Glot partially poretating artesion flore the dischange ?p, per with langth Ù щ

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tox dive - Vibratin prating primary primarie principrativ - 21070701/ 4 > Rollers - Smooth wheeled rollers, preumatic byred rollers, shupploot rollers Dimunut compaction equipments and · Soil compaction or densitication can be achived by using self propelled records, sull dozers, gradurs and truchs. Soil is excavated elson suitable borrow pits and transputed · Structural dill consists of placing, spreading & compaction. > bending ar distortion of possible be and their absorbed layers. > sue orientation al possibicies, achieved by the tollawing ways such as · Dansification - readuction in void volumn calier can be : Jus sintuoisnes la voitoritisme . + collective soil - soil clay, lange void matter silvigh water carlon & - Convionues soil - Sandy soil, loss condition . settlement on huare, per meabile, durable and sofe against deterioration certain property to coillistand the force coursed by the 41 is resurted that in-place sail should pourses soil is used as a basic contruction material. Foudmint of conceptures & collectre sould MISUT 3. INSITU TREATHEAT \mathcal{O} IJŊ

In concerention soil it courses liquefaction dollowed 12 po pour fail donne france curatara. to jubring is mouse producing by 000'ST - Jubrin o haven . Judnie Compaction: · rummos zuars < > but compausion & wide drains The consolution technique involves Ø is ineccesed and compressiblily is descended. increase the strength so that the bearing copacily ф is sugained to sudduce void statio and water content (nurvoire du d'adres content content d'around impression) · Combive Soils such as balt clay thave large. · senored juppuration suit to se 7I . . In clays the consolidation proceeds long after construction Consolidation. of pore water under steady poursence is outerred as . The process of gordmal compression due to exputsion consolidation of consizers substances

spacing - 6 to 10 m for istabilization. No of blows - 5-10

- your du to rapid decinage.

generated in ground , case should be taleen to ensure In dynamic compaction methica loage what wares are . (m) notionitiente densitiention (m). (w) down of quot (w) Η = Mass of the black (Kg) H ' any co $\eta_1(HW) = C$ tion effective compaction the depth is determined by densification is du cucused. everage during the duption depth - 6 to 10m within depth interesting - ellip brout your sanitary land fills. abruz philis confaction attactive in loose sands, simply. · the upper lugar upper lugar upper lugar. · me of 1 to yod op of . punosh af I to sur 1/2019 · A pit is formed at the point where the weight · hirozo rubon planet and then it is allowed to dall down under A Grann is used to lift the averaght to required . The heavy weight is made at confert or alled black. compacted at alpha . . All but sugarined number al dereps the rg lloys onco

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Merils: > Simplest & built holh abour & bulow water table > suppliedde to all types of soills. > produces equal sufferents > reduct to all types of soills. > rouger table.

Major variables in this process : Adjor variables à ils distribution a) angle of free dall. 3) do at derops & ils distribution a) don-thomogenity of soil. 3) do at derops & ils distribution a) angle of free dall.

Ebut the hoormfal vibrations are not transfared to adjount of the reaction of influence (R) beyond which no hoormfal vibrations are benefited is given by R = 130/14H

Grane and frank and loader. Equipment - Vibroflood probe, power supply, which pump. · notionales but rollion div wor not units a notion or formit · noitable 10Hd 1 of above accused and the nothogiation Symmobility is increased during comping because of > saft clays liquidy under impact. auditéring void volume in vader is dissolved in pore water ander hammer impach > soft cluys when not tully solurated contains gos, · Dynamic consolidation effective in soft clays. - impact points and by pointural & horizontal drains. Drainage is enhaved by madial dissures around - 10/100069 put quientents at take mager. · In each sepretition immediate settlement accord · beboschne il sword un chu prouse is superdad. · Serveral blows at each location dollowed by 1-4 wulks tor dynamic compaction but more time is required. e The application of this method is some as that readed Dynamic Consolidation:

Apail me 2 & mmoor rotonting losubatily - 200mm & 2m lught



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- Front end loader supply beeckfill as in-situ soil is densified
- water jets the vibragloat into the ground with the rone. MIL

- Alow rate 225 to 300 there / min at a presence 400-600 th · Maler

 - where the length can be ravied depending on compaction depth.
 - · song to wolf a time grade vibrating with a flow up pros.

 - contactudad force at 100KN @ 1800 Mar. with recentric wight inside the equador developing
 - \mathcal{D}

> auicher in operation. pairies dion pil doiting · primored er phisodos burnosq ybiH < . Longit uniformity in density and control on settlement. - No material cost except backfill. Merits 4) backfill moderial al vibrofloat withdrawl · guillemonishion (3 1) Equipment capacity nuture & privace adorry (c lios lo squa (e Factors involved: et proposed up of UB yzono about " US - burrods · primpord In thus word a thirde toyer of comparated soil is and the operation of compaction and backfilling is reprede The vibration is then raised about socn at a time continuously direpped into the conter. As the compartion of soil accurs, additional soil is (7 the compaction is started to compact suprocunding soil Atter the vibrotloat it Aunk to desired depth (? loce as strength and stability) by the jetting action. and condition is developed ; biguitied soil which (7 Vibration is possibioned and house det is fully opened. (t)

othere, control void action othere bion lonit & 3 $p \times \int_{0}^{\infty} \frac{1}{\sqrt{1+1}} \int_{0}^{\infty} \frac{1}{\sqrt$ $p \times \left\{ \frac{3+9}{1+1} \right\} = g$ utilité provide provides morets builde set prom 2 pressing du vot Factors: All rangement by diameter of compaction pile and spacing. The compacted poile prevents collopoing at the compacted concurrently while with drawl at pipe pik a hooper in let te with each let the sand is cutrile the pripe is being device down. deuver, the in-situ coil is densified simulitancousty The pipe is deviver using an impacet hammer or vibradery a desired depth. à hollow steel pipe is deviven into the soil to Proceeding :

Equipment: Hollow Ebut gipe coith dutachable bockfill sand. Equipment: Hollow Ebut gipe coith dutachable bockfill sand.

of Layer is loss and more construction time is allowed. prelociting is sufficient only when the thickness abrus in soil equal 6 that anticipated from the final structure to be improved in amounts sufficient to produce a The precloading material placed are the ground in the soil accompained by surface settlement. Direjosquid riverson en the pore water principard : salquinieg principles : durgation to cause devirable changes in the boil. is merely applying an external heading for a long principality And is simpled method which : pribool ve? aging grites indoper VIDIO

· COBHILT INCOM of deeper depth.

Demerits:

- · Jouded grand has uniform properties.
- · E conomical for madurate depthis upto 13m

: Stint

Thus the soil is densified by hydrocompaction. particles increating switcher tension forces and the water weigh The effect of pougoonding is breaking losse bonds belower opposite action i.e. by inmading or pose pording the sudde a load can be applied to some soils by Lowering at work table is applicable when the work table is low Amother apparach à invadating or pourloading. devolering system is the weight by about lot which is indeve the bowering of water table is done by switchble ranozing the water table provided the soil conditions pumi Another . pàr quibre method at poulociding is by . In another method al preloading, the final structure, • The required weight for prelocing can also be and filling the enclosed areast with wider. the same project. mp To buiddory. materiale subich may le scentilized for : sported pribades:

 $\left(\begin{array}{c} \\ \end{array} \right)$

when used Vertical Drawing: etractures and low cost for utilities. In general mixed methods provide increased safety for · mi 07 8.6 29 Illion aprove Junua Hars and the maximum hught upto 18m. m8-2 i quir l'or broined le faiter un sitenam 8-2 prelocating is embankment leading. This por ourse tales e In normal pracher the mast prequent method of painnique un valique and spilles in underprised au la be added. Jacking is standard method of portings at either new buildings to which extra stories Jacking is an method mostly applied to individual which acts as an equivalent overload. covered with an impartieur numbrane, in application ٩ľ is placed on the surface of soft clay, the layer · In Vaccum Prudocaling method a 150mm layer of cond

Verticali I matter is in institution when used when used it is premised in the production build along the contract when used in promodential in the provident in the provident in the provident in the consolidation time the consolidation time the consolidation time the consolidation time.

A layer of sand or sand shonled is priorision water than the permission water bound of the permission water bound the priorision water bound the priori sin the priori sin

Dirinciple: • Vertical drains and continuous vertical columns of parvious material (sand or filo rous) installed in claupy soil. • The drains provide pathway for pore water to escape from the soil by travelling shorter path • They allow frow inside soil along horizontal direction ond serves the propose of collecting and ducharging expelled industrial containing consolidation process.





atomieux sound à moter is introduced and pipe is without its introduced and pipe is without . The mandred is deriven by precubicion or vibration or judi the lower and by a losse cap is used closed mandrel made of steel tube closed at ¥ ii) Displacement method: by its own weight as the hole prograss downward. proved arround jetting rod. The steel proved suble The wooder felting looses up the soil and the loosened soil Abrough the bottom of steel jetting rod at a rate of 50 these High pressure water jetting privides forcing water. : poyrou builtof impos provence infilt (1 us - s. c - hun nod Diameter - 180 - 450mm pround and withdrawin as sand is powered I room the hale by In all thuse methods a steal pipe is inserted in the prind hash (iii) ii) dupplacement of natural graund : pright - preuseure worker jetting : The holes sugained for saind down consists of three methods · pubs utim

Sand drains au mode by filling a glindrical hale : vitrono pitros

. An abritated drains. niondo bradi (1 suger roomman columnant types 1) cand drain Vir bial

they derive up to four wicks @ a time downword for a rook N is exembed by the sigs and open or doied mandrel ave fitted to the suge . A . himuquoz Lorge settlement takes place without bouch of chroin give long inte The exterior filler paper is chemically imprugnated to · mois mon proto paper : covered pady theme strip which contains channels Geodrain consists appe-100mm wide and some thick 2) Fabruic dirain: Alow of water of som coll into drain Should le sufficienting pervious to allow unobstructed The voids in cand audred by filling the slod · bieu sà ton bluds maria. sand should not be coarise and poundiclus out fines and uniformely graded the sond used for filling the holes niotnos ton bluode : inorge jotros (1 and from which chan water is drawn back into incuit slort sits mosely proceed lies ut au allowed to settle of a state of 1-21/600 advanced by availating coater into the hole is short sitt : pour Bound Hutted :

aviens des la method is clower & expensive. mitial pore pressure , low permeability Gevere soil disturbance talus place which causes high a displacement method due to the forcing of pipe and cuates problem in disposing soil showy. Attanta retting mathing sugarines longe water quantify. : Prottotimil mil Ensured drain continuity liezduz aldi Bilpan (inv philidormarg April (iv notholloopene. Loot (" nompiones rotallation themes - their (v 7907 mo7 (! 14) chian site vii) positive deainage · 196 DTUDAPY · buipuimm y bowered into the ground the band is released by plantic diquits and wound wound signify and as the manded Doming depth - 45m, 5poung - 11/2 - 2 wick deale per sand drain Indullation speed - 0.3 - 0.6 m/sec

· Vertical drains are bus effective in organic soils,



invagin is setted au poir and and the pipe is without the and the gravelt is filled after opening a trip valve Acted and pipe manderel is deviven to desired depth : moved the entrop dorme a cybindouical granulax pile. tr pub compacted till the hole is completed tilled ମ୍ Bore hole in paceptilled with gravel of 12 to 750 m 5120 Compressed air is used for positially educated es prime plinte vole breau ar retter la med dor duilly eathered jetting praceds and brove hole of lorger digneter is formed. Le parteure magaziel con le sumored by re britagen die vibration is dieburbed or Tios ML ausisted by route or our as alluching medium. ŶĮ Sill zi à mb brizzip d'ai étriz d'a bourda au fochordiv Nibrollodi Lechnique is quite suitable for colheive soils : pour commin mind Nipsion jungs compacted spons commu of certain depth and diameter displaces the material readially. This subult in a densely compacted by a suitable duvice which simultaneously and gravel backill is glaced into the hole in incoments and abon is short tout of cylindoucal vertical short is made Stone columns also called as granular putes are installed · Louringoz tugs

noimon mind & wish egos d = hurage dia of " " 3PIL (70- ye (dcb)) אי א כן צ סענט טן צרטער נטאוווו unios orbits us proof 10797 & d not done column den chard be guader than > spaining - 1.2 - 311 on white over site - mmoog - 0.57 : 520 - 600mm mmost-007 : dia : 400-450mm mmoos-008 - Dib dia - toolloxdiv & Specifications : by this process compaction is achived. minner al weight 1250 LN. with a face fall & #somme The two layered with is compacted with cast iron fright voundoi-03 pub unions - 000 p ssou gring builder upin The aggregation and sand layers are placed addred of aug 70-76-1. of Early . and drawn or bills and care care wind 2010 somm 6126 Efor In this method the sore hole is made by spiral ages Augus bored clone column · solar A hommer weighing 15-20KN falling trom hught of. Formendi Stone column: thick deposite of peak or high organic cilit or clops. > etone columns connot be used effectively in Dir aquanta de: > Decreases Lateral randh pressure. radojs hojo là hilidades alay slapes . donne que de contra c dig brusho l'ise la rottogizzub londal transeg e entréprise régative de la faitetion on pilles Application Advantagues: and sudduce void scattor It is capable of dissipating excess pore water pressure - phisile deposite derived the derivedue Elone columns are very much suitable for safe, et = solety factor. of = effective radial she c = drained collection (10+24) - 49 = W/b internal friction of stor o = quained angle of of spone columns is quen by $(= F_{0} + g_{+}) + (F_{0} + g_{+}) = K_{0} + (F_{0} + g_{+}) +$ appraximate dormula dor W allowable becoming capacity



Figure 1: Dry - top - feed method process schematic(Taube, 2001).



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Figure 2: Dry - Bottom - feed method process schematic (Taube, 2001).



Figure 3: Wet - top - feed method process schematic (Taube, 2001).

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9789231492 890363192 944358368 F) - Amo 9 Saraswath colony Govinthapenor Tindugal -Vekantopanesh E as -Cank wmai gued results, the is densified Sto 4 time be gleder than Greetee and the the pile. 4 More over, 20 Series aboil-G tot influence compaction puls in Much the diametee 4 hot influence is -Soul . burner centert should pule duarietze . radius of upon the is present in the Justice realine of 2 J. depends Clark -Mis them 44 なり

	ching if necessary.	section of another system	or fill matrix		in the divection parallel to the applied.	use of tensile nearly comput in Planus direction of applied stress of Compression	The Supporting capacity of Soft, compressible e increased and the Sattlemant may be	thin horizonted membranes.	of a weak soil such forced by	all sation of the problem of soil rangercement	The Concept of Soil guinterconnect lies	Earth Rentbreement: -	Earth Reinforcement.		Ground Improvement Techniques
(₁	in) Acts as a support membrane.	and lateral movement between the Boil	ill) Rustrain the Subgrade Soil from upward	laboral movement in the soil,	1) provides local trainbroement 11) Restrains the aggregate from downward and	to oftentilize an unperiod read to a no of ways.	Providing a geosynthetics sheet batevoeen	Alteration remain exantial.	The secondary functions ef subspreaments and	In unpaved road Construction & separation,	Although the prime function of a Geosynthetics	are a well-established and a most common one.	Use of Goosynthetics by unpaved mads	Seperation : - Clinpaved Roads) :-	Application de la Geosynthetics :-

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Railivaeys -	Ballost reiting on a clay subgrad	courses proston pumping failures due 10 the dynamic. 1000	Another type de pumping failure may be caused by the contamination of the ballast by the distry ballast pumping	failure.	Thus two pumping failure could be prevented by	Províding a Sand brankat.	A third mode of track Support Pailure 2, a	bearing capacity failure et the subgrade.	Garardly this occurs in consiste soils because of	Increase of pore water Pressure.	A bearing coopacity failure could be avoided by	of the Sond Aller larger.
In the second application, a high geosynthetics	ellastic stifthass is required to bring in some realbycing	eblect. For the application the most ablactive location for	the acceptitication is within the base course on bolicoeen the base course and the wearing counse, at a depth of	hot less than known.	The prosence of the geoscipationtes. Improves the	tonsile strangth and gives the read a greater revestance	to cracking and halps to provide a longer lite.	In the third application, the geosynthetics is placed	on the surface of an existing parament prior to laying	an overlag.	prosence of the geosynthetics restricts propagation of reflection crocks and thereby increasing the life of	the overlad.

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			Puneture and wear from object.	Gaomembranes have to result tensile forces,	to be used.	. In this case heavier grade grosynthetics has	Surface Water drafinge System.	Gossynthetics one also used in railway track	thickness of filter laws.	Conjuction with fine granular materiates could	In other Situation use of a geosymmetric.	failure,	excess development of pose water may cause liquefaction	of dissipating the excess ponewater pressure. Otherwise the	higher servitance and strength and also Should be capable.	For such we the goosynthatics should have
be easily smed, handled and placed during construction.	are easily anailable in various sizes and shapes. They can	6. The reinforcing doments used for such structures	n Stages.	5. Raw hred garth Structures Can also be Constructed	easily, Honce there can be constructed speedily.	H. Reinforced Structural alemants Can be transported	de masany or Concrete.	Conventional is Comparison to the Conventional Structures	3. Reinforced earth Structures are much more	rigid structures	withstand earth-quake forces more allicently than Conventional	9. Reinforced earth structure, being frexible, Can	and sottlements.	flexible, Hence those can withstand foundation dubrimations	1. The pumbried carth Structures are quite	Advantages of Reinforced Earth Structures !

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Austrying are available. In thickness varying	front to the Socientis C.1/100 meth = 1 mil) and in width	upto lom and go not length upto boom.	Geotextiles can be made of a variaty of natural	Such as Jule paper or wooden material atc	Common Form de Geosgynhietics:-	Gaotextiles and Gaostrips	Greagriphs	bementoranes	Georets	Ouocalls of Unouna manhors action	Gaosynthatric cloy liner	Geo com posítes.			
Other applications et 2011 publicement:-	Reinforce d'arth wealls	Bridge works	Dems Embankmants	Foundations	highways Root pile system	Anaher would Structure	Under ground ctructure.	Guotextiles :-	Gactertites are permeable or porous fabrics made	from synthetic materials that are used with geotechnical	moherial as an inhegral part eff a man made product,	Arrechare or System	Geobartiles are permable gheets of synthetic	fibres like polyester, polyprogylene, polyalitelene, polamide,	visase etc

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 \cap €., rings - long ends. and functions. SHIP 8 Geogrids :geotextiles han breement. Gleotesctile_S demants (Atrips of grotantiles. Ang. ð types density polyethylanc. Guostrips au used Geostrips are generally produced These J. CE Spirals and æ Those ð Can be Ounchors include Guostrips :which geograds uned include drainage, stabilization and ₹° entruded, woven, fremible and n E pad Prom Connected ta ta monon form of p <u> </u> 92 92 and nonwoven uith, ኇ 青 cut fabric or pom polypropylane Shabili sali an anchors at the Cen Aning form of reinforcement رعوما 9 2 2 that Opening Process functions 9nd Strength as Prc [polyvinayor chioride], pp [polypropylana] linals etc... Positive Giacrats :achieved and HOPE [High Density polyethylane] nots Soil Geo membrane :one g 17 inter-locking while which alter molecular Charles of polymers, Geogrido are also ag 片 Obtaining Shmilar bosically impervious. The geogrid, the Compared 青 These in a geoloxitle, include LIPPE [Low Density PolyEthylane] đ the material of high tensite include Switace \$ ð geogrids. randorcing ħ đ produced by Special friction HOPE (High sonsily polyEthylene) おっ 哲 extrudiad polymeric mesh. malorial Antorcing function is achieved by populaan and ute function 28 febric and have ħ j. ာ

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They are made from flashelded Polymert. Privation de meriodo and the flashelded Polymert. Privation de meriodo and the meriodo	de vorying keights, wed for stabilization applications.	Georembranes and Geolexitia or any of these litre brok
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These synthesis are made from thick hape Brites Too to 2000 min cuite, generated or welland begeter at den to ser me inhereda. Generation. These Include programme dentes of verying These Include programme dentes of verying dimensions and the neight analyst and other applications. Geographics Cloy lines a promoted Anglebrack Geographic Cloy lines a pomoted Anglebrack Compassion. These Include geotechie I cloy J geotechie Compassion. These Include geotechie I cloy J geotechie Compassion. These Include geotechie J cloy J geotechie Compassion. These Include geotechies geotechie Compassion. These Include a provide a positive ponter the lights in Containent application.	Systems .	bank protection etc
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Thur Include polythypone dracts of varying dimensions und the hight weight fills and other applications. Geosgythetic any linears:- Thur throtade gradatile / any/geostatile / any/geostatie Thur throtade gradatile / any/geostatile Composition. Composition. Geosgythetic any liner a parented registered trade mark is a sandwitched composite gradatile trade mark is a sandwitched composite gradatile b liquids in contrament application.	Gree foram ,-	
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Geosgynthetic clay linese:- Thue thotade geoloratile / clay/goolaritie Compositie. Compositie. Compositie Geosgythethe Clay liner a parambed ragistered Frade mark is a sandwitched composite agebrities and banknike clay weld is provide a positive porties in liquids in contrainment applications.	dimensions und then light weight fills and other applications.	
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Compositue. Geospritethe Clary lither a portented regristered Frade mark is a sandwitched composite of geolertifice and tenthnike clary used to provide a positive burrier to inquide in contrainment applications.	These throude geological clay gookzitie	
Erade mark is a sandwitched angestered registered Erade mark is a sandwitched composite of generhies and tentonite any used to provide a positive tenties to inquide in containment applications	Compositure.	
trade mark he a sanduitched composite of gentrifies and bentonite clay used to provide a positive barrier to lightles in containant applications	Geospittette Clay there a potonied registered	
and benknike clay used to provide a positive bonnier. It inquids in containment applications.	trade mark in a sandwitched composite of gentrifes	
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	he linguids in Containment applications.	

pinone monnorad \bigcirc il Jealing the base of structure founded on \bigcirc Jonay ponof \bigcirc \bigcirc peoperation or allerratively growing a statum prom \bigcirc on unstable soil or rock prior to excendion of a tunnel \bigcirc О i, seating poded and heaves of permeable \bigcirc of relatively small volume and special problem \bigcirc Conscouting is usually limited to yones \bigcirc T72001 (\mathbf{k}) Eniminate new seconde, to apply in underpinning \bigcirc \odot Construction - [to reduce machine foundation vibration, stabilise loose sand against hiquebaction. Le () \bigcirc \bigcirc construction - [to control ground coator flows, to ୍ to increase soil bearing capacity], during \bigcirc water problem. to infill voids to control settlement \bigcirc four dettion work before construction - the control ()Essenting is positicular valuable in \bigcirc in civil Engineering $\langle \rangle$ \bigcirc printprate à spages priteases ret estron prinim ni ٩ The modern grouting was first started 63 Sub-Supare Boil 08 rock \bigcirc attained by injecting fluid hike material into 0 Introduction in lite material internant \odot \bigcirc Ô Criscout Techniques 2-mil
Controled displacement Permission /vnpodwoj Pendration / ූ) (\bigcirc $(\widehat{\cdot})$ \bigcirc adid. ξ, mail S) () \bigcirc pol6 Allont . ٢ trab 10 pros lo ybrasts rock being granted (the grouting preasure is greater the tarribe voyf ÷., brackweal zone which created when О dry solator <u>,</u> `` } this worderlien UT grout rapiddy :) par 10 pos Ug 4.70 08 0 or low instact sunssould prove and show alow Ó mit at - prituare northogram (11 mourant that give white るくしつ $\langle \hat{} \rangle$ Soil voids surors per лÒ ()smart freeze with minerale minimal affects with (1. Paration growing - In this situation (mark suf () and red grating are ros S ::-The three basic burchion involved in Tube into a required depth pumping soil fluid called grow down a small diameder () into rode fusimers cor into a soul by Bubstance Ø of granting is to intereduce The phone ut $\langle \cdot \rangle$ Buttong to strage A \bigcirc \bigcirc " prograid ware countre sound of amprif S 6 לטרם זיט אחטוסך הססגר prilling , Vi \bigcirc voids between the lining and rods woll , retaining wall , stabilishing rock cuttings , turnals III, Fixing ground anchor for shaet pile

1 mudiaderig , quite after weat for sawing parament voory denification & movement of adjacent area. This is ා frien excerted by great against soil mars coursing \bigcirc \bigcirc en amessary , and way tops is best very how, pressure is \bigcirc * No flow of soil-grad accurs when \bigcirc filler great, which produce low vis cosility \bigcirc * Kaplinite & illite are profilered as \bigcirc Shear Strangth & have wed to reduce permeaberlike 9 + This type of growt will each bit \bigcirc has ond other soil with permeability \bigcirc 20.000 mil is suitable for injection with Coarse sand 0 * Clay is a complear compand with postale \bigcirc out guiddy after injection \bigcirc may be used for this purpose which would gettle \odot Some voids in coase grained soil, Even sand & sul \bigcirc * Soil ibself can be used to fill up \bigcirc Himmig with soil $\langle \rangle$ \bigcirc Der > Partide Size at which 85% of Soil finge \bigcirc Dis > Particle suge at which is' of soil binor \bigcirc Groutability ratio = Dis > 20 () \bigcirc ponticle site and soil voids size should be considered ં formation the relationship between the grand 1.ºos \bigcirc * When there grow are injected who \odot one also referred to as particulate grout \bigcirc lime, soil atc, constitute suspension, suspension grad \bigcirc * When water is associated with coment, $\langle \cdot \rangle$ There average ?! $\langle \rangle$ il. Golution grant \bigcirc 1, Suspervior grant marb to radhi

approvine · sumoning administration additives Other materiale litre bine sord, they ash, (\cdot, \cdot) the conent in suspension 1 prubled red princesial jettics of beeu * ()grout loss the 31 by weight of coment \bigcirc ()W 7I * 5000 * consider as filler provos \odot Suppose and dilute acid ()un potto pritures rot & trans primile ApiH $\left(\hat{} \right)$ yboys (\mathcal{I}) worker R.H.c wed for its Repid settleing, conty Kopid hordoning compite * In & cose buicoopy ybing to presented soch, graval, course gard * Suite for rontition punaló + pombor ybionts us spuodop ()()022 - # water conert ratio from 05 to:1 to 5:1 ()Materials used: Growt an made of usually (yprosts ਼ੋ admissione gives good ultimote rodord yrin ्रे ator trans ration Alprantes were * 6.7 ٢ month fo in excers course high bleeding \bigcirc we ratio, rate of bleeding. The mobility UQ \bigcirc \bigcirc * The correct based growt is based \bigcirc Himiting Will Conort Misus \bigcirc soil by forming compaction pilos \bigcirc it is also wed to strangthen in-sil Morrogen underpin shallow building foundation ۵ * of. puo

13 0 \bigcirc ()prituare 2012 out \bigcirc FU. HAR 6 7045 000 \bigcirc chemical grout \bigcirc Many of them is termed as \bigcirc ٢ parmente finer soil than can suspension grout. \bigcirc Solution grout can generally ave available \bigcirc ()Thave are numerous solution grout marin vontrios (11 () \bigcirc hydrated oscide ()glaw, opal, pumicile, clay matarial, zealite, $\langle \rangle$ acture material, natural possiolars, volcanic $\langle \rangle$ ()bro alleviole - water insoluble and ()chanically \bigcirc marb \bigcirc tile 50il alone con some as displacament * Low water coment - Soil conant michtune \bigcirc \bigcirc porme othon grant \bigcirc * Bostonte cloy conert mous wed for \bigcirc trand (\mathbf{i}) So 20 the 2 three of volume of clay 160g of \bigcirc \bigcirc * volume of water mixing varies about ()times the Loose Volume ab consort, are common (\cdot) * Valume ab Boil between four and six ٢ ()coment meterial would be better then soil alone Water-Soil in combination with a suitable (

÷., $\langle \rangle$ $\langle \cdot \rangle$ \bigcirc $\langle \hat{} \rangle$ $\langle \cdot \rangle$ \odot materes baniames id $\langle \hat{} \rangle$ ground or ground water sail \bigcirc production reads with ground - Reaction Ēλ gin 15 E mulion - Bituniaus ()'7 wofshe Bitumes material, solvest 3, Non aqueous solution - synthatic resin, vulcanizable oil 21 Colloidat 20/ution - Organic 20/ution imineral 30 hution) Arcylonides, pheroplast resin $\langle \rangle$ 1, Aqueous solution - Silicate deriver i Lignosulphile, .() Classif: collien \bigcirc with pritting over setting time ()ii, low visuscili i, absence of porticulate (\cdot) great holds with following advantages porods 9 higher injection preserve and more closely ombox () subsequently handern, it is shower and ypiyon (reacts with the fust to produce a get 42.40 (0) followed by injection of second chamical injected \bigcirc two-Shot system one chemical is (\cdot) UT to grout concentration, water composition and temporature ם רריטוקריא concentration syf Building earticolled by totolet (are injected together ofter mining satting time 87 (\cdot) avora motave trans and a nit Chamical alt the

broken the entire grout reaches an uniform consistency fill all the thicker fraction of conort lumps are into the partice vortex continues to apin iii, conculation of tracted braction back colloidal solution rather than a mechanical suspension and wat and produce a grant resembling hile a breater up thicker braction and lumps of consult a violant checoning action in a miace motor, which canent from the vortex. There are subjected to ii. Treatment of thicker freetien and unmored and passed to the mixing sotor concil are pushed to the phenipheny of vortex a certifiques equivaler - Huiden queur and unmused i, termotion of a vortea which acts 50 mixiture is done in three stages porone - more or tot a throw we the In Single - line type the gravit refussed is wasted returned to the agitator In concertating type, the waved grout is ii, circulating type squt wil abrie i There are two system estant holes ou agitator , a pump and piping connected to A growting plants include a maran, contern 6 fron que mainly differ in Storage & maing the same moving & delivery system and they Both susparsion and solution grout we mounto F Troughto Bunnary ٩

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אבטררוכד וטכרותקיעל גמיא קסיה שומש טייסקרימנה u pohonduo vide variety of grout consistencies actually at englace the type. The best all-purpose pump should be able 9Y appropriate many be of purition or dang. punoro 2800 killint or under and rate of displacement b provide pressure pump should be able to the quantity of grant in the agritutor measure A graduated dipetick is mag for dund syfe of dum delivery pipe, to prevent entering 90 syf. roor another sarren is froced to agitator ~]H of good , Shing and other boreign matter through a wire screen to remove place possed The grout nice from the 97 monu si upiyon udiool et of to porlevas which havigontal blades are connected 29048 oj agitating mechanism consisting of a vortical soy 00 agitator sump is gpiger UH ъ Jook dund month agitator sump between the fig marca and vo agitaled to prevent setting. This 81 Deherred grout mor grout post H momuyug

sabotes. throughly tightered before graching of house q caretine subore are executed. They should autemotically. During growing it any -90 any washings adiet , deals with Should pro strate and provide improvenent of upper zare is guite useful for helewgenerus poypou my This method gives have output betalquas is comparedo repeated growing are dance with the entire Washing bellewing by further doubling and and druilled continue to the next seam Subsequent carried out. Hales are deared by washing 91 to the surface and growing prop powoos 1-10 / 42 020 doubled dousn sht at -: dat work burnoug popodor is then deepered and the procedure goy precess chogging is almost aluminated. The grack returned up the doubt hale By thus pus and grout is pumped doesn the grout pipe A doub hole is based to depth of bottom zone principle of grouting from the top downward. L'ercuit (grouting method is bound the υa Electrokinetic Injection Emposed omstand Jet Gircuturg Point arouting Entrar P Tube.a. Manchette Circuit arouting I ajection Methods

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0 pipe is called tube a manchette, with a row of $^{\circ}$ dianster hole is drilled in stratum and 6 cm & 0 In the method a last to 15cm 0 to offect a good on hower parken \bigcirc unswitche in allunial Doil as difficulties faced \bigcirc penef soon many source pomsent ad pozdopo \bigcirc The double padron method $^{\circ}$ Intera mandrette \bigcirc (a) mouting from top diviting hole without pader \bigcirc ି(. unvivie 1. ofots pis boder. 0 smay 40 \bigcirc two is it out Fr mal6- \bigcirc spote ti darcu \bigcirc abotzby E Wint a \bigcirc abot sat \bigcirc \bigcirc \bigcirc \bigcirc mound sinony 70 $(\cdot \cdot$ 26015 put to the the out ં parton Ju naow \odot spots bas With ੇ 16 +5 Jal े 10) 201 d proprot5= ٢ \bigcirc minim 514 40 0 troji yron \bigcirc o foto Loj P. polo િ F. yoon 26015 ٣ day mil a stondord product of

supped6 ALCONED of now stage (b) eopod yfin .÷? 101 ſ. moni And it is not be bed unvivie mapo 80 again made sure 24 75 same preadure 2 Seet the peder have -⇒ 1. Tio des Ca source begin \bigcirc 7? proib $\langle \rangle$ 1) ale test il mon \bigcirc setpeder at top of it unujuju P. yesen 514 70 roband off tos asys pur (Privatul mo pigoon mound No. p. proub stroy 42 Walar Lat 'd <u>`</u> I Asoci nott abots got 11:160. then other method tong for puo pressure - intole difficult to assess oy.f 87 7_Z ' n conbos ()and desue Bronger B W σρομοτο m/ · 1.05 sit ()flow with and allowing grout 97 sojoy ()oy.t briconto supporting the holes pup b bropjaw $\langle \cdot \rangle$ in surrounding soil This st the both the (Spron Mr. or 2j4 crades and allow growt 40 mark may pressing Clay-Concort . Y pipe and 10001 mf yonory 0 on podand 87 morf sit. Uny ! • .• -nopod ban & pipe with the help of subler ٢ 97 poppy \bigcirc phyloph er the inner guest pupe · ochel dianeter Ö interior growt pripe howeved ind obu mous ь yonary spracy \bigcirc Producing. from bottom popollo 91 port provo - map e hag -oyl page Logno and ٢ sond pros my SOLOGNOS popoos 81 • putter rag ame \odot myyby wide mon. pororos a may mp \odot my1 oper Mind off howeved inside ٩ 97' may

 \bigcirc Buyyar mpard of uno 0 The upper romale deliner when is not to mpressed \odot nowske are provided at seemm apart or d oont \bigcirc 70 performed powerst porto matter add out apr 0 of howaring duil consult. payfour syl \bigcirc poort \bigcirc (तुन्मे and wood grades can be 10 11:5 word ٢ method, , soid regen rangen ĥġ suff 0 0 buynaling FOI Poretrability of fire 3 sporte has the limitation as regard to depth and ()0 off fo This is widdly wed and witter injection. $\langle \rangle$ geoching grow ingredient is to be placed independently $^{\circ}$ return in system where provos oy4 0970 ъ 00 \odot pre-determined pesition along the line of drive po () jotted lance. I used ton 10 vonnop ore delivered γD \bigcirc injected from the point of a er marg doop off \odot at of prosen al 10 th UT и СI \bigcirc Entrouting Joint, $(\cdot$ \bigcirc $\langle \rangle$ Cincular ground $\langle \rangle$ ()٩ scipl $\langle \rangle$ ()ale roaging ()sind of unfold a ()Jund Guset ()marin

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(formag south may be porojdari 90 unjoj ()seach alout 1.5m and by rataling the stam a ppnos (...) replaced by forwing growt. The jet worker 97 Ô where excorded malerial produce letting action ()Entrasting action require stan be istored rawed , ¥ The growt is delevared by 3 9 Quar vocion

) 0 - Trich growt mise maderials \bigcirc contribicate at compilared - Independent lab lest buiman 0 La coustic survey \bigcirc open 2 cross to hold \bigcirc dilling - conduct pregraut pund \bigcirc \odot \bigcirc Djou + procedure \bigcirc Establican destablish -) striod \bigcirc - Set devertion Survey buyra 6 \bigcirc - Inspect aquipment of somed ธิบฺหลุเบอน 2001W phivita montoring in addition \bigcirc during varians time of granting bucation $^{\circ}$ > Non destructive test \bigcirc -> Indirect on test - (beophysical method) (Better method adoptable re $\langle \rangle$ moury * ()pullquos de Alque * Salection af Lest is * boring hocation \bigcirc The constrains about this approach is े standard laborationy method $\langle \rangle$ Etrength , parmeability , Compressibility by adopting 1 of gravied material and then testing them for ુ by obtaining gample undusturbed goil f rock gample 0 This is accomplished by the convertional method \odot graut during injection chauld be continuedy monitored ୍ af flow malars are available. Hlow rate ab ો () flow rate, pressure, etc. for which difficut types (Ê) Greek montoting is measuranded of participant toma poort maria

the second second second . . . \bigcirc \bigcirc $\frac{1}{2}$ and $\frac{1}{2}$ and the states of 4 $\sum_{i=1}^{n}$ ÷ ; and a star of the second s -The second s <u>___</u> • • • • ; · '; (1,1)÷ \bigcirc \bigcirc and the second \bigcirc \bigcirc \bigcirc Houtes (\cdot) - Final newsers and + acoustic survey homal 6 soff of - Find heave survey - postgrad rador ()mond hommo ug (\cdot) ringous massaded moot -()mingro from in - plot grout-tode log Ç., 109 Bundicon Association and the .ow 4 . ٩ - Grout Danple for get - A tought within ()D'easure A blow rate - Insilu resistivity grant ... - Monitor injection prived - por pressure data

ා for drong , a conort loved of 5 to 10% by want \bigcirc of 5 to 10% for saturdation stabilization ٢ Addition ation wode with concret " \bigcirc Amount of concart \bigcirc 0 and having plasticky index law than 20%. ()then 501 of ile particula fuer then 0.074 mm \bigcirc obtomed with work-graded coil having law ()In general the best result are \bigcirc Chloride are sometimes added to conside P I Salt are presented Lime cons calcium \bigcirc \bigcirc antron propose in putrossing i maing and compading 0 \bigcirc \bigcirc can be pullionised by conent ()matter is consider to be gofe and inorganic soil \bigcirc for successful stabilization about 21. of organic \bigcirc Soil Should contain low again matter () Detune of soil ۰. ب (° \bigcirc sport to our fields \bigcirc condition adopted. It is specially utilised in \bigcirc anount of concart utilised, placencart + curing 3 depend on the nature of said treated , type & () The pyercal proportion of goid-conord () \bigcirc partied together \bigcirc concart react with silicorus goil to coment the \bigcirc I't is governorthy gararally accepted that ()conort à kuoron de 2011 conorté 2700 ilon hg () Bindung of soil particle Logather Stabilisation with consol

from its influence of composition quality of soil conent longle langoly arma :23 The offect of meining contant on ny dration \bigcirc ", I't furnish water for conert characteristic, as with nature of sail \sim 1, It inthuence the compaction rola in soil - Contant The movetune content play two Maisture contact bedorationy medune Bhown about so' to tot at shough af a by more in-place method and retrang Lillon have maining is upto optimal hand . Goil - consult made to regregation of longenard Thus lontrad a decrease in degree of moung and may bead of for inversing in continued mound courses proportionally to the mainy aready As a maler initimacy of machine is not directly provide strong and durable, soil-conent. The More uniform soil conent worker muchure. BURGIN and the state of the state of the state obtained with increasing concat contant a madeure, an increase in strangth is or When the consist is hydraling satisfactoridy /) . Service Providence tor clay, a concert have at 12 to 201 af wordhit For sitt, a canant land 12 to 151 of wordhil tor good, a concert loved 7 to 12%, af waght

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٢ \bigcirc ()FUIM 111 ٢ Enidenit i'v \bigcirc pinsoques in \bigcirc Buncihi ini \bigcirc iii, Adding water & conent \bigcirc 1100 out buizing the soil \bigcirc i, shaping the soil to be traded 0 $\mathcal{D}_{\mathbf{1}}$ Themas - 1200 to Construction \bigcirc \odot -anporature \bigcirc tanparature although it will harden at all ιυļ \odot * 30il-conent cures repidly with increase \bigcirc is cured influence the resulting product ()Cordition under which soil - consent 041 * \bigcirc offor compaction that prevent duying at subace \bigcirc * In practice, goil conort is cured \bigcirc of soil - coment increase with age yports (\cdot) * As with concete, the compressive \bigcirc burn pur aby and the second sec Ń () \bigcirc optimum mailune centert \bigcirc Content, the greatest strength is obtained for ٢ of lonpaction, but having difficul mousture \bigcirc Concert Contant and gues the same amount ()0 observed that for specimen having the game () \odot adequate compaction is ensential soil - Conert , Õ In order to obtain satisfactory amportion conducion

 \cdot · ` ; () $\langle \rangle$ $\langle \cdot \rangle$. 2507 handling & mouring, Reduce the Lotal stabilings \bigcirc additive readed to partorn, simplifying the e have Important adventages such as roduce .) Use of some chamical aborg with concat not responsive to concit Stabilization of Same at 30il which are required to freat a soil responsive to conent A roduction in anount of contact calium chiloride ... is added ()to improve properties at soil conject 1 line (ar) (In order to accelerate the puo pos \bigcirc Adminition for 2012 - Concat and accellent result are quaracted it was proparly (;) * concart is most successful goil stabilinger area should be done with witness care * Construction of soil-concert in frest ्रि \bigcirc by adding line (1:231) Ö * Hardling ab plastic soils can be reduced (\cdot) compared to plactic soil نې * bironulor soil are song to hardle $\{ \cdot, \cdot \}$ G Soil & site condition $\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i$ ()water and consist and musing depends on the \$ 1 he optimun sequence bei adding $\langle \hat{a} \rangle$

 \otimes ٩ Nos de setter of soil $^{\circ}$ In general, hine increase the strength ٢ JON HHNOLE ()SOILS DEASTERTY INDEX TO OPTIMUM ESSER LEVEL WHICH IS EASY \bigcirc مامعيد والمراجة مر المنها مراجعة ورفية عمل المعالم والمراجع المادة THE \bigcirc יוטקסד סך יצייה לושינוביצי כסיק נסה קדמהדיד אייד ۲ * Time garanding increases the plasticity 0 are charged by addition of lime to goil \bigcirc <u>}</u> Aposticity, danity & Strangth 0 cos) zilica from the goil ()calieren from line with prailable reactive alumina $\langle \rangle$ time in comenting action, it is reaction between \bigcirc Second reaction tales considerable \bigcirc man high PH at line ()ווי מי שמלטעיוטי של קומתקיד ומאדפי של הסידן הסוןסוק ()become ob increase in concentration of pore water ે because of double layer on soil which pppig p \bigcirc ii, a depression of double loyer on the Soil C correct by soil a ੇ is son soccharge of calcium for ion naturally ٩ reaction involving any of the fallowing 0 \bigcirc First -> It is almost a colloidal - type ab reaction takes place in addition to wat soil ٩ \bigcirc * Thore the two type of chamical 0 'yoo hif conert, bitunes ં rag pom 2011 Stabiligation with combination ab ٢ * Hydrahed inne is most commandy ()for shop upper and poor days Stabiligon \bigcirc * Time has been weed as a soil ()Stabilisation with lime - 💮

results in reduction of fresh heare trooping pound gots howard and (\cdot) sompai conjoiodano $\langle \cdot \rangle$ rapour reduces and rate of $\langle \rangle$ where water dinexphone and retain it alleration in pure water \bigcirc \bigcirc and subawing , sail abread marstune brom the 9 able to absorb moist enoid as a childred as a a Calcum charde -iozopog the second second second stabilization. Commandy wised chamical que cue discussed There are mony charical weater bor Stabilization with chanical provent corbenation of lime . * A dequate core should be taken to $\langle \rangle$ KIX' Had warning lower Vill, aure for alleast 5 days Will Shape the stabilized base Vir Lompart The muchune tration senteron annuldo ्) Ar Hadd water in nocosson to bring ()iv, this the stare 2 soil 1 \rightarrow \bigcirc iii, sproad the white \bigcirc ii putraise the soil $\langle \rangle$ Scouly the bores ()stabilization bases as fallous mij \bigcirc * The record construction sequence 90 •) 177 07 Sec. 9 (2)

muit - in place or plant mux method Soil, but it is mined with the soil by where the gast is not applied on of cracks in Shinkage cracks retard avaparation and reduce pornation ypiger in 30,21 paper pores near the such are 2005 Another phonomenon is cuestallisation of rate of evoporation Loduce It attracts and retain maisture and دمادنيس دلالمصبحلو , لمديد مت ماطولي ليعوم Sodium chloride The staticlization action similar to The rol ine adams sor for galt The relative hundily of atmosphene the climatic condition therefore increase the cost The frequest application depositing upon mus method poor

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Calcium chloride act as a soil to firm smalling. It facilitate compaction and usually causes a glight increase in compaction dansity The galt may be gproad on the surface The galt may be gproad on the surface

• : \odot \bigcirc \bigcirc \sim \bigcirc mix in place in plant prim manual (ind ood, but it is read when the set a strand the said to say applied for af arrela is contraction and ()enter a survey a survey of the second s in when filler part is been the subject AND AND AND A CONTRACT OF ੁ and the second Carlor Carlo \bigcirc 17 setting and intrine receivers deale \bigcirc cudetions when they build were southered asset \bigcirc The studenty day simpley to (. Section dellaride $(\hat{\cdot})$ ्रि about the alma are be almande $\dot{\mathbb{C}}$ the climate widden therefore manue to with <u>ن</u> The program application lopading your \mathbb{O} Mont mais restant ු or introgen held with will be note in plane well \odot The sould range the specified op the Coffeeter Ô Sight in all in longer his derigh ()LE Prestation Conference and a while Calmen Children Children Children A CONT