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Influence Of Stress-Strain Behavavior Of Soil Mixtures

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Abstract

Soils are often mixture composed of coarse and fine particles which are intricate inhomogeneous material and occur with widely varying characteristicsin nature The main objective of this study is to investigate the effect of fine content on unconfined compression strength of clayey soils and shear resistance offered throught angle of internal frication, in case of sands. Tests were conducted with varying percentage of fines(10,20.40,60%) in soil samples. The individual constituents in soil composition have different mechanical and physical properties and interact differently under the influence of external and internal loads,and the relation between coarse and fine particles is difficult to differentiate.once more the high-quality content material in coarse soil are cautiously taken into consideration because they decide the composition and kind of soil and affect sure soil residences together with permeability, particle friction and brotherly love.In this study, laboratory tests were conducted to investigate the deformation of soil. A series of direct shear tests were carried out under same weight of sample and density with fine, reducing percentage of fine in sand with different gradation properties. A series of unconfined compressive strength tests were carried out under same weight, optimum moisture content and dry density in order to assess the effect of increasing percentage of fine in clayey soil. The angle of internal friction is found to decrease with increasing percentage of fine in sands and the unconfined compressive strength is found to increase with increasing percentage of fine particles in clayey soil.

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I. INTRODUCTION

The individual components have different mechanical and physical properties and react differently under external and internal loads, and the relation between coarse and fine particles is difficult to discern. Angle of internal friction, ø is one of the vital parameter taken into consideration for reconnaissance of granular soils. soil friction perspective, not like pore pressure and obvious concord, is not temporally variable and is a derivative of the dimension of soil shear power .again the fine content in coarse soil are cautiously considered due to the fact they decide the composition and kind of soil and affect certain soil homes together with permeability, particle friction and cohesion. best have also been located to affect the liquefaction capacity, compression characteristics and strain- pressure behavior of soil.the excellent content in soil additionally performs an important function in section issues inclusive of minimum and maximum void ratios and porosity. Internal erosion is a escaping of fine particles from soil structures. A complex phenomenon with reasons essential problems to levees, dikes and embankment dam balance. about one-0.33 of the failure of modern earth dams had been attributed to inner erosion, which may be

January - February 2020
ISSN: 0193 - 4120 Page No. 11550 - 11557

initiated by focused leak erosion, back ward erosion, soil content erosion or suffusion(ICOLD 2012). the lack of great particles in an earth shape throughout the internal system will induce gain rearrangements and affect the content material between soil debris, main to a rough and extra permeability or maybe failure of the shape. (Wan and fell 2008 Chan and Zhang 2013). This research studies the strength changes due to internal erosion.It is a well-established fact that the resistance due to interlocking, friction and cohesion among the soil particles is the principal cause in deriving the shear strength of soil of soil. Many natural soil deposits and artificial fills contain matrices of coarse and fine soil fractions thus imparting frictional and cohesion properties. Thus, the interplay of these contributors, like interlocking, friction is expected to affect the soil shear strength parameters C and Ø. At smaller fine contents, the dry coarse grained soil may exhibit its usual dense or loose skeletal structure significantly. However, in case of higher amounts of fines having larger surface area, the content of the coarse soil particles may diminish thus changing the whole matrix of the soil mass thus affecting the strength parameters.

II. LITERATURE REVIEW

Donghwi Kim,Boo Hyun Nam and Heejung Youn(2018)studies the"Effect of Clay Content on the shear strength of clay-sand mixture.To measure the shear strength of clay sand mixtures. direct shear and angle of repose test were carried out.They concluded that for pure sand the angle of friction was 35.7^0 and by the addition of 10% of clay content,it increased to peak value 38.7^0.and for clay content of 30%,it decreased to 34.0^0. for pure sand the angle of repose was 34.5^0 and.by the addition of 25% of clay content,it increased to peak value 40.8^0 and for clay content of 30%,it decreased to (40.3^0)

Orabi Al Rawi.et al(2018) studied the"effect of sand additives on the engineering properties of fine grained soils"Atterberglimits,coefficientpermeability,unconfinedcompressive and direct sheat tests were performed for this study they concluded that by abbition of 20% of sand material with cohesive soil decreases the value of liquid limit(47-33%),increasesthe value of plastic limit(20-24%) andincreasees the value of plasticity index(20-24%) they also concluded that by addition of 20% of sand with soil increases the value of co-efficient of permeability(1-12.5%)and in direct shear test, by considering the shear strength parameters,cohesion value decreased(1.50-0.15%) and angle of internal friction value increased(13-30%).

Boufer et.al(2018) conducted research on"influence of fines on the resistance to liquefaction of aclayey sand" trial apparatus on sand-clay mixtures and on soil sample undrained compression tests together with cycle liquefaction test were carried out in this study they found that the resistance to liquefaction of sand-clay mixtures reduced (R_c) (0.2-0.16) with the increase in fines content (f_c) (0-15%).

H.B.Nagaraj(2016)studied the "Influence of gradation on proportions of sand on stress-strain behaviour of clay-sand mixtures". In thisstudy.undrained test were were carried out for this study.(kaolinite, bentonite)claymixed with three grades of sand varying from 10to80%.red earth and Bc soil are later mixed with different grades of sand . the results showed that,in kaolinite mediumsand series , there isincreasesin in unconfinedcompreession strength(160-400kpa) with increase in sand content upto (50%).in Bebtonite medium sand series at 50% unconfined compression strength(480-1100kpa) in red sand medium sand series, unconfined compression strength (410-780. kpa) in BC –medium sandseries, unconfinedcompression strength(900-1500).kpa.

Meraj Ahmad khanet.al (2016) studied the effects of fines on liquefaction resistance on fine sand and silty sand. In soils containing less than 10% fines are most susceptible to liquefaction. The fines with plasticity index greater than 10% and clay content above 10%. Possessive the relatine density beyond

January - February 2020
ISSN: 0193 - 4120 Page No. 11550 - 11557

75% shows the liquefaction of soils.The results shows that increasing the percentage of fines increase the resistance to liquefaction also increases.

G.O.Adunoye(2014) studied the"An Experimental Study on Fines content and angle of internal friction of a lateritic soil. Tri axial tests were carried out for this study to determine the shear strength paarametersi.e..,cohesion and angle of internal friction.Three samples of red soils(S1,S2,S3) were taken.The results showed that for sample S1,for 10% fines angle of friction (Φ)value is 42^0,Cohesion value(C) is 8 KN/m^2 and for 100% fines Φ value is 0^0,C value is 63KN/m2.This represents that for 100% fines,there was a decrease in Φ value(42^0) and for 687.5% fines,there was increase inC value 55KN/m^2 .for sample S2,for 10% fines angle of friction (Φ)value is 41^0,Cohesion value(C) is 5 KN/m2 and for 100% fines Φ value is 0^0,,C value is 67KN/m2..This represents that for 100% fines,there was a decrease in Φ value(41^0) and for 1240% fines,there was increase in C value 62KN/m^2.For sample S3,for 10% fines angle of friction (Φ)value is 36^0,Cohesion value(C) is 10KN/m^2 and for 100% fines Φ value is 0^0,C value is 66KN/m^2.This represents that for 100% fines,there was increase in C value 56KN/m^2.Hence it was concluded that,with increase in fines content,angle of friction(Φ) decresed and Cohesion(C) decreased.

Muawia A.Daflla(2013) studied the "Effects of clay and moisture content on Direct Shear Tests for Clay-Sand Mixtures.Cohesion and angle of internal friction were obtained by using direct shear test.The results showed that there was increase in shear strength(2.4-3.6Kg/Cm^2) for the increase of clay content for all normal stresses tested (0.5,1.0 nd 1.5g/cc) and there was increase in moisture content of cly caused the cohesion drop for 5%(0.15-0.08KN/m^2) nd 10%(0.5-0.05 KN/m^2) of clay sand mixtures and at 20% showed a very steep drop(0.05-0.03 KN/m^2) and increase in clay increses cohesion for 5%(0.08-0.14 KN/m^2) and 10%(0.3-0.28 KN/m^2) of clay.for 10% clay content,the angle of friction(40.3-39.7^0) and for cly-sand mixture of 20% moisture content ang1e of friction is less than 38^0.Hence it was concluded that with the increase of clay content,the cohesion increased and there was a drop in cohesion and angle of internl friction with the increase in water content.

Benjamin et.al(2010) conducted research on "Index and strength properties of clay-gravel mixtures" and studied plasticity of mixture of fine sand coarse grained soil.They use fall-cone,Quasi-static cone penetration om mixture of gravel and high plastic clay.The plastic limit used in this study is corresponding to hundred fold increase in the liquid limit undrained strength and is denoted by PL100.Tht Quasi-static penetration test is used to determine PL of coarse and fine grained soil mixtures.The plasticity of mixtureses of highly plastics clays and fine gravel appears to be linearly dependent on gravel fraction content of 50%.

Ali Firat Cabalar(2000),studied the "Effect of fines content on the behaviour of mixed samples of sand" In this study,the uses of SEM to demonstrate linkage between particle size and particle shape.They found that coarse particles are round nd fine particles are platy and angular.They investigate the fines content with its effect on tri axial behaviour of corsesand.They carried out tri axial test on two types of fine grined sands and corsesand.The results shown that high compressibility and mixed with clay particles because of particle characteristic i.e..,size and shpe.

Kajun and E.Rugenga(1986)studied the "Relationship between the angle of repose and angle of internal friction for angricultural granular materials".The parmeters angle of repose and internal friction determine the flow characteristics of agricultural granular materials such as rice,mize and wheat. Trixial compression mchinews used for this study.At four moisture content levels 10,15,20 and 25% angle of internal friction,angle of repose

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 11550 - 11557

were determined.The results showed tht angle of friction,angle of repose increased with increase in moisture content.Above 15% ngle of friction(23-30^0)sensitive to water content,below 15% angle of friction (20-23^0) increasedAt 10 to 25% of moisture content,angle of repose(30-45^0) sensitive to water content.At 50% water contentit increased to 70^0. The angle of friction ws large for maize(25-32^0),followed by rice (17-26^0) and wheat(23-31^0).Hence ,it was concluded that angle of repose greater than angle of friction and angle of internal friction highest for maize followed by rice,wheat.

III. MATERIAL INVESTIGATION &IT'S PROPERTIES

The soil and sand samples are used in this study and collectedfromThadakanapalli(Kurnool)and chandragiri(Thirupathi). For these samples the engineering and index properties are determined and are tabulated in table1 and table 2.The soil sample collecting as representive soil sample were collected from trial Pits at a depth of about 3.0m from ground level.The soil collected from the site was pulverized with wooden mallet to break lumps and then air-dried. Subsequently it was sieved throught 4.75mm sieve and then dried in an oven at 105^{0}c for 24 hours. The soil are classified as I.S Classification system (IS 1498-1970).

Table1:Properties of sandy soil

Description	Sand A	Sand B
D_{60}	0.93	0.96
D_{30}	0.59	0.43
D_{10}	0.39	0.2
Specific gravity	2.56	2.42
Density index	52.57	46
Coefficient of uniform(c_u)	2.389	4.739
Coefficientofcurvature(c_c)	0.960	0.98
Classification of sand	Poorlygradd	Poorlygraded

Note: sand A colletedfrom Thadakanapalli(Kurnool)
sand B colleted from Chandragiri(Thirupathi).

Table 2: Properties of clayey soils

Description	SOIL A	SOIL B
%Gravel	5.56	------
%sand	46.12	7.8
%Silt + clay	48.32	92.2
Liquid limit	56	57
Plastic limit	22	22
Plasticity index	34	35
Free swell index	90	140
Specific gravity	2.64	5.54
Maximum dry density(g/cc)	18.4	17.3
Optimummoi stueContent (%)	14.53	18.64
Classificatio nofsoil	(SC)	(CH)

Note: Soil A colletedfrom Thadakanapalli(Kurnool)
Soil B colletedfrom Chandragiri(Thirupathi).

Fig 1: Mixture of soil with sand

From Table2 the soilsample classified as SC(clayey sand) and soil sample B can be classified as CH(clay with high compressibility). From these soil smaples the sand is mixed in different proportions like 100% soil(S1), 90% soil + 10 % sand(S2),, 80% soil + 20 % sand(S3), 60% soil + 40 % sand(S4), 40% soil + 60 % sand(S5), and the strength were detrmined and are discussed.

January - February 2020
ISSN: 0193 - 4120 Page No. 11550 - 11557

IV. EXPERIMENTAL PROGRAMME & DISCUSSION

The unconfined compression and direct shear tests are conducted on samples and the test results as follows.

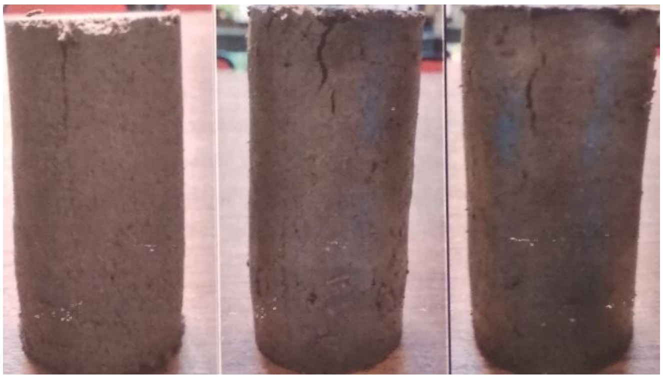


Fig 2:Unconfined compression test samples

Fines content added at10, 20, 40 and 60% by weight of soil. The quantity of fines computed corresponding to the above percentage is directly mixed to thesoil before water adding to it, in order to obtain even distribution of the fines.

4.1 TEST REGARDING ON SANDY SAMPLE:

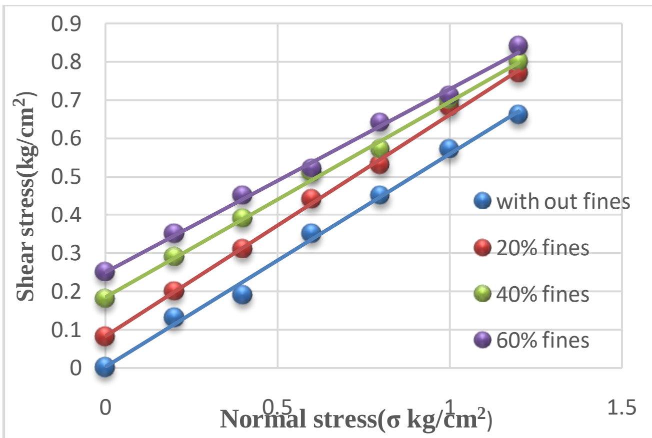
In sands with increasing percentage of loss of fine particles the angle of internal friction should be increased, because generally shear resistance is a result of angle of internal friction, content between particles and interlocking between particles. The fines increasing in sands the surface gets smooth and coarse particles have highly interlocking compare to fines, so increasing fine particles decrease the angle of internal friction .in sandy soil content of fines affect initiation and rate of suffusion. The soil A and B are well graded soil this are resist more shear strength compare topoorly graded soil. The coarse sand (4.75mm to 2mm) show higher value of angle of internal friction compare to other ones. In Table 3 shows the relationship between shear stress and normal stress obtained by direct shear test for different sand proportion. The graph shows linearly variation between normal stress to shear stress

The phenomena may be because of the fact that, at smaller fine contents, fines could hardly occupy the full volume of void in between the coarse particles. Thus it had a very little effect on the strength contributors like interlocking, friction or cohesion. At higher percentage of fines the voids would have been filled with finer particles. If the fine were sample, they might have surround the coarser particles.

Fig3: Direct shear test apparatus

Table3:Varion of angle of internal friction with increasing of %fines

DESCRIPTION	Angle of internal friction(deg)	
	Sand A	Sand B
Without fines	32.12	34.59
20% fines	28.48	32.00
40% fines	26.33	27.42
60% fines	24.13	24.12
Fine sand	26.33	27.48
Medium sand	36.52	34.59
Coarse sand	42.59	41.59



January - February 2020
ISSN: 0193 - 4120 Page No. 11550 - 11557

Fig 4: Normal stress- shear stress curve for sample A withincreasing %of fines

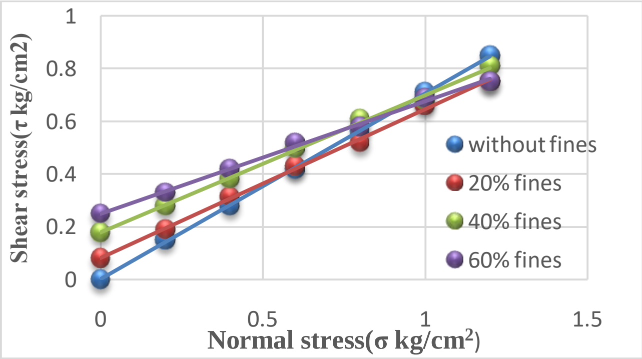


Fig5: Normal stress- shear stress curve for sample B withincreasing %of fines

From the analysis above fig.3 show the graph coming from direct shear test of sample A. The coarse sand of sample A having higher angle of internal friction is42.59^0 compare to same soil with 20%(28.48^0), 40%(26.33^0), and 60 %(24.13^0) fines. When increasing fines in sand also increases the angle of internal friction and decreases the cohesion sand.From the analysis above fig.4 show the sample B of coarse sand having a high angle of internal friction (41.59^0) Compare to medium sand (34.59^0) and fine sand (27.48^0). The sand without fines having higher angle of internal friction compare to increasing percentage of fines in sand.

The maximum and minimum of angle of internal friction is more than compared with sand sample B due to the fines .

Table 4: Variation of cohesion with increasing percentage of fines in sandy soils

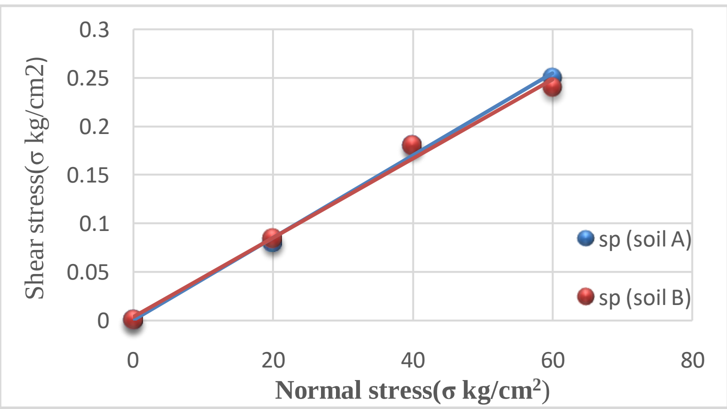


Fig 6:Variation of cohesion with increasing % fines insands

When increasing percentage of fines in sands the cohesion will be increases because the fines are attached each other and also amount of cohesion less particles (sand) will be decreased. So find out the angle of internal friction will be reduced when increasing percentage fines at same time cohesion will be increases. So the angle of internal friction will be inversely proportional to cohesion. In table 4.3 show the how to change cohesion with increasing percentage of fines in sands. The SP soil (A) with 60% fines having higher valve of cohesion is (0.25 kg/cm^2) compare to other B (0.25 kg/cm^2) and (0.3 kg/cm^2). Figure 4.63 shows how to vary cohesion with increasing fine content in soil in sand. Finally cohesion is found to increase with increases fine content in sands.From the analysis above fig.5 incresing fines cohesion will be increased

4.2 TEST REGARDING ON CLAY SOILS

The fines and coarse particles taking from oven after 24 hours, the coarse and fine particles are mixed with requirepropeortion. In UCC test amount of coarse particlesshould be decreased with increasing fine particles at 20%addition.

Disruption	Cohesion (kg/cm^2)	
	SP (Sand A)	SP (Sand B)
Without fines	……	……
20% fines	0.08	0.084
40% fines	0.18	0.18
60% fines	0.25	0.25

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 11550 - 11557

Fig 7:Mechanical operating of UCC testing machine

After a certain amount of fine particles was lost, a significant change in the soil microstructure occurred. In clay increasing percentage of fine particles the bonding between coarse particles should be increased then it resist the more compressive load compare to soil having a less fine particles. The percentage of fine particles increased from 10% to 60%. The graphs are show the increasing stress with increasing strain up to certain limit after reaching maximum stress its decreases with increasingstrain

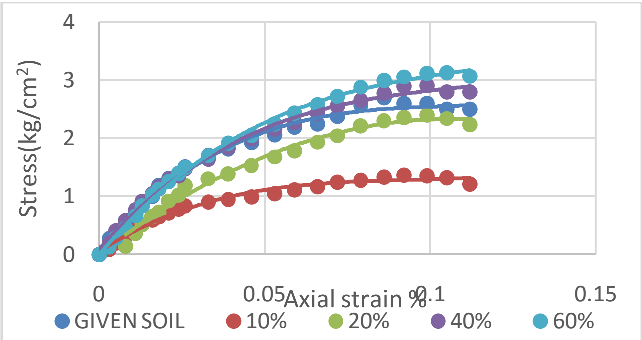


Fig8: Stress-Strain behavior in uni -axial compression for SC soil with increasing %of fines

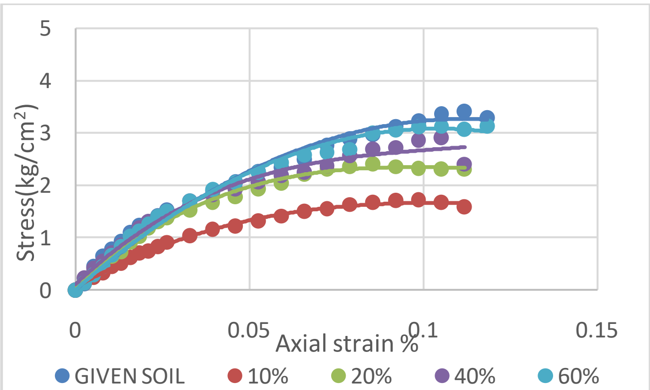


Fig9: Stress-Strain behavior in uni-axial compression for CH(soil)withincreasing%ofines

From the analysis of above graph sample Ahaveing amore stress than sample B. in sample a60% fines gives more stress due to increases of fine content.

Table 5:Unconfined Compressive strength of clay withIncreasing Fine Content

Description	Unconfinedcompressivestrength(km/cm²)	
	SC(Soil A)	CH (Soil B)
Given soil	2.6	3.2
10% fines	1.4	1.9
20% fines	2.4	2.6
40% fines	3.0	2.8
60% fines	3.4	3.3

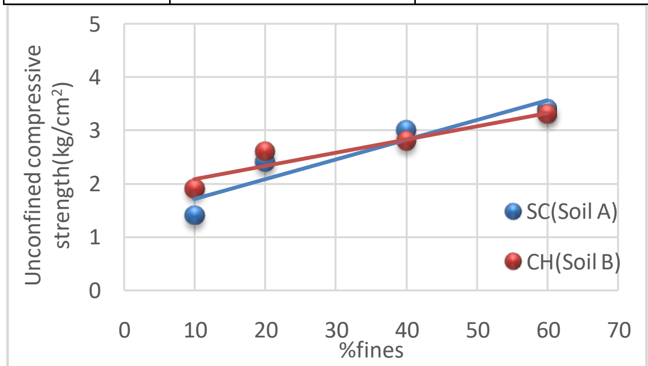


Fig 10: Variation of unconfined compressive strength with increasing % fine in sample A&B

Above fig.8 shows a variation of unconfined compressive strength with increasing percentage of fines in clayey sample and the un-confined compressive strength will be increasing when increasing fine content in clays. The unconfined compressive strength will be varing linearly with increasing fine content in clayey samples.

Fromtheanalysis of abovetable.5thesample(SC)havingmoreUn.confined compressive strength than (CH).at 60% fine gives more un,confined strength due to increases of fine content .

V. CONCLUSIONS

An attempt has been made to conduct series of experiments involving different composition in soil such as sand with varying fine content of 0-60%, gradation of sands and in clays with fine content varying from 10-60%. A detailed analysis of test results leads to the following concluding remarks.

- With the increasing percentage of fine particles in sand, the angle of internal friction will be decreased and cohesion increased.

- Thecoarse sand in sample A shows maximum angle of internal friction to a magnitude of 42.59^0 compared to other sandy soil, considered in the present study.
- Sand sample A, B show greater shear resistance with 20% of fine (28.48^0,32.00^0)as compared to 60%fines(24.13^0,24.13^0)
- Sand sample, A, B show greater cohesion with 60% of fines (0.25 kg/cm^2,0.24kg/cm^2,) as compared to20%fines (0.08kg/cm^2, 0.084kg/cm^2).
- Angle of internal friction is found to have inverse relation to cohesion.
- Sand sample A, B show maximum variation of angle of internal friction between coarse to medium sands (6.07^0,7.00^0) as compared to medium to fine sands (10.17^0,7.11^0)
- With increasing percentage of fine particles in clayey soil,the compressive strength is increased due to bonding between coarse particles increases, leading to grater resistance to compressive load.
- The clayey sand (A), clay with high compressibility (B) and clay with high compressibility with 60% of fines having more compressive strength of the order of 3.4kg/cm^2, 3.3kg/cm^2)to soil having20%(2.4kg/cm^2, 2.kg/cm^2) and 40%(3.0kg/cm^2,2.8kg/cm^2,) of fines.
- with increasing percentageof fines from (40%60%) for Soil sampleA,the unconfined compressive strength, increases by0.5 kg/cm^2.Soil sample B(0.5 kg/cm^2) show maximum variation of unconfined compressive strength compare to other sample A (0.4 kg/cm^2) and B (0.3 kg/cm^2).

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