A

Major Project Report

on

ANALYSIS OF POLYPROPYLENE AUGMENTED SOIL AS AN ALTERNATIVE LANDFILL LINING MATERIAL

submitted in partial fulfillment of requirements for the award of the degree of

MASTER OF TECHNOLOGY

(*Environmental Engineering*)

by

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under the supervision of

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CANDIDATE'S DECLARATION

I, Shashank, Roll No. 2K20/ENE/10 student of MTech (Environmental Engineering), hereby declare that the project dissertation entitled "*ANALYSIS OF POLYPROPYLENE AUGMENTED SOIL AS AN ALTERNATIVE LANDFILL LINING MATERIAL*" is submitted by me to the Department of Environmental Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology in Environmental Engineering. This is my original work done and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place: Delhi SHASHANK

Date

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CERTIFICATE

I hereby certify that the Project Dissertation titled "*ANALYSIS OF POLYPROPYLENE AUGMENTED SOIL AS AN ALTERNATIVE LANDFILL LINING MATERIAL*" which is submitted by **Shashank, Roll No. 2K20/ENE/10**, Department of Environmental Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work caried out by the student under my supervision.

Place: Delhi

Date

MR. ANUNAY A. GOUR

SUPERVISOR

ACKNOWLEDGEMENT

I want to express my deepest gratitude to my supervisor Mr. Anunay A. Gour, Assistant Professor, Department of Environmental Engineering, Delhi Technological University, New Delhi for his unconditional support, guidance, and supervision without which this report could not have been possible in showing a proper direction while carrying out the project. I also acknowledge the unconditional freedom to think, plan, execute and express, that I was given in every step of my project work; while keeping faith and confidence in my capabilities. I would also like to thank my dear friend, Mr. Asif Iqbal for his constant help during tough times and all along, HOD CE, HOD ENV, Aman.

- *Shashank*

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ABSTRACT

The COVID-19 pandemic has created an international health crisis. It has also threatened the environment by creating new kinds of waste. Increased quantity of surgical facemask, personal protective equipment (PPE), and other medical supplies are evident. These wastes are found to be non-biodegradable. Hence their disposal is a tedious task. If not disposed properly, they may enter the food chain and cause the threat to life on earth. Multidisciplinary collaborative techniques are essential and necessary to reduce the environmental hazard associated with the disposal of used PPE and one-time use masks.

This research work explores an innovative way to reduce pandemic-generated. Thesis proposes an alternative use of shredded surgical facemasks in construction of landfill liner. Here, soil samples with and without polypropylene augmentation were tested for moisture content, Atterberg's limits, specific gravity, maximum dry density, Proctor compaction, and direct shear. The proportion of mask chips for soil augmentation was 0.5%, 1% and, 1. 5% by weight of soi. To test the effect of the length of mask chips, various strip length i.e., 5 mm, 10 mm, 15 mm were cut and mixed. The experimental results show that silty soil mixed with three different percentages of surgical facemask satisfied the stiffness, Permeability, and strength requirements for landfill liner. This study explains the effects of variation in width and percentage by weight of shredded facemasks on engineering properties such as shear strength, brittleness, permeability, and bearing capacity. Cost-effectiveness of using facemask as a reinforcing material instead of polypropylene fiber should be studied.The hydraulic conductivity of the heavily compacted ground is measured after the soil attains a saturation state. It is observed that with increasing shredded facemask content in the mixture, the hydraulic conductivity of the soil decreases.

This study gives a new innovative information in the use of one-time facemasks use in the civil engineering field. And also, help to make better quality of landfill liners and landfill covers.

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CHAPTER 1.

INTRODUCTION

CHAPTER -1
Introduction

In India, Solid waste disposal poses a significant challenge. Solid waste was disposed of in landfills. But in landfills, leachate passes through the base of landfill and mix with underground water is a considerable problem in landfills, for example, in South Africa of city Bloemfontein was investigated that leachate passes through the bottom liner and contaminates groundwater and soil below the landfill (Olusola O. Ololade, Sabelo Mavimbela, Saheed A. Oke: 2019). Today, landfill is used as public parks and residential colonies. In India, landfill covers are not too strong, so that they cannot bear a load of buildings and animal's feet does rip off the top surface of landfill. So, a body of landfill have to construct that have sufficiently enough shear strength, bearing capacity and low permeability for fullfill the purpose of landfill uses as residential and public parks. So, a model with deplorable hydraulic conductivity act as a leachate barrier and requires bearing capacity and shear strength.

The sand was procured from river use as landfill liner material (Subir Kumar Sharma et al.; Sandeep Gupta, Vaneeta Devi. 2022). Similarly, this thesis used different materials with low conductivity to act as a barrier to leachate. Polypropylene fiber is mainly used as landfill liner material (M Amini, HS Isfahani, A. Azhari, 2021). So, any waste from which extract polypropene fibers use a raw material for landfill liner. So, marginal cost and the quantity of garbage reduce.

In the COVID-19 pandemic, the use of PPE (personal protective equipment) such as facemasks, etc. is pandemic waste that is produced in huge quantity every day; approximately 3.4 billion single-use facemasks and face shields were being generated as waste per day globally (Nsikak U. Benson et al.; David E. Bassey; Thavamani Palanisami, 2021). In India, in April 2020, 139 tonnes of biomedical waste related to COVID-19, and this data increased in May 2021, 203 tonnes per day (Parul Saxena, Indira P. Pradhan, DeepakKumarc;2022). Predicted in June 2020 that a monthly, 129 billion facemasks had been discharged into the environment. Unfortunately, used facemasks may be noticed anywhere from streets to automobile parks to nearby parks, even if masks are disposed of in trash cans or in landfills, but due to their lightweight nature, wind and rainwater can freely flow into streets, rivers, and oceans, wherein a mask primarily composed of plastic may be fragmented into microplastics. Therefore, throwing away the mask and PPE creates inflicting issues for flora and fauna or kills animals and marine life. Thus, it is mandatory to manage such waste. This waste stays for a long time in various countries and regions, and the use of face masks will be a common practice in the upcoming years. So, as a result, disposing of this waste is a big undertaking.

Hence, a multidisciplinary collaborative technique is needed to combat in opposition to the environmental dangers associated with the disposal of used personal protective equipment (PPE) and used one-time use masks. Thesis says that use such waste material in the construction field, for example, construction of landfill liner, because fibre material used in one-time use masks and landfill liner both are made up of same material, are polypropylene and polyester. When One-time use facemask waste material can be used in the construction of landfill liner then it is double beneficial first one reduces waste material, and second, this waste is used as valuable raw material for landfill liner.

The world faces various challenges when one-time facemask comes to the recycling and reuse of disposed face masks. Incineration and landfilling are two standard treatment techniques for discarded face masks, although both have drawbacks. Energy uses and carbon emissions in this process have always been a source of worry, which goes beyond many countries' carbon neutralization policies. At the same time, the primary plastic component of masks, polypropylene (PP) takes many years to break down (Nzediegwu and Chang (2020)). As a result, it is crucial to put forward a "GREEN" and effective solution for discarded face masks. Without causing any damage being in the influence of sunlight's illumination, facemasks can achieve self-sterilization, creating the chances of recycling masks in any field (Prata et al.,2020). Several studies carried out to find out the impact of randomly orientated fiber on the engineering behaviors of soils. The motive of this study is to figure out the effect of fiber (when mix in 0.5%, 1% and 1.5% by weight having length of shredded facemask are 5mm, 10mm, 15mm) on the overall performance of fiber-augmented soils. A number of laboratory experiments have been carried out with polypropylenes with exclusive length and different-different percentage by weight.

Kaniraj and Havangi (2001) conducted an experimental software to examine the character and blended impact of randomly orientated fibers inclusions and cement stabilization at the geotechnical traits of fly ash-soil mixtures. Over the years, experiments and studies facts were accumulated and studied the behaviors of soil-cement mixtures, and some studies were carried out for fiber reinforcement in soil-cement combinations. Lawton EC, Khire MV, Fox NS (2003) told the prototypical geosynthetic multi oriented inclusions carried out to Ottowa sand and silts sands. Gray DH and Ohasahi H. (2013) discover the enhancement in shear strength with growing fiber length. Mahar MH, Gray DH (2004) told static reaction of sand bolstered with randomly disbursed fibers. Ranjan G, Vasam RM, and Charan HD (2016) tested was given wonderful contributions to the grain length of given soils and fiber bond strength. Leung C, KY (2012) supplied a derivation of fiber bond power.

OBJECTIVE

1. To Study the generation of facemasks in biomedical waste.

2. To determine the physical and chemical properties of the surgical facemask.

3. To find an alternative solution for the disposal of a facemask in the field of civil engineering.

4. To Assess usage facemask for strengthening soil used for landfill liner.

SIGNIFICANCE OF RESEARCH

This research proposes an innovative solution to reduce COVID-19 pandemic waste such as surgical facemasks by recycling and reusing the surgical facemasks mixed with soil for the construction of landfill liners and landfill covers. This is one of the first experiments done on biomedical waste, including the California bearing ratio test, Proctor compaction test, and Direct shear test to find out the feasibility of using surgical facemasks with soil in the construction of landfill liners and covers. The outcomes of this study can provide practical guidance on the application of surgical facemask (SFM) and soil.

CHAPTER 2.

LITERATURE REVIEW

CHAPTER-2

Literature Review

Numerous research studies have been conducted on the construction of landfill liners by using various materials at the Indian and world levels. Some of them are given below related to this study.

Chao-Sheng Tang, Bin Shi, Yu-Jun Cui, Chun Liu, and Kai Gu; (2012) result shows that the cracking behavior of soil reduces significantly after using the addition of polypropylene fiber. The crack opposition behavior was significantly enhanced, and the number of dry cracks was significantly lessened by fiber addition. The surface cracking ratio (surface of crack to total surface area), length breadth of cracks, and break connectivity reduces with increased fibers amount, while the average size of lumps, number of nodes per unit area, number of crack segments per unit area, crack density, and specimen cohesion increased. During crack propagation, the surface crack ratio increased with decreasing water content and finally reached stabilization.

According to Kumar & Mohan (2019), polyester fibers have been combined with clay soil to determine the relative strength and benefits in terms of unconfined compression. The specimen has been examined in unconfined compression with different percentages (0%, 0.5%, 1.0%, 1.5%, and 2%); simple and pleat polyester fibers reveal the percentage enhancement in UCS of highly compressible clay blended with polyester fibers. The improvement in shear strength is 50% to 68%, with the addition of 0.5% to 2% of three mm length fibers. An increase of more than 100% with 6 mm (undeniable and crimped) and 12 mm fibers suggests the proportion increasement in UCS of fairly compressible clay blended with polyester fibers and with the addition of 0.5% to 2% of 3 mm length fibers to 10% sand, the strength increases by 79% to 96%. The improvement is 150% to185% with 6 mm (undeniable and crimped) and 12 mm fibers.

Heineck et al. (2017) found that polypropylene (PP) fiber with a length of 24 mm, a diameter of 0.023 mm with a content of 0.5% by weight mixed with soil. The advantage of polypropylene fiber augmentation is more successful in a specific amount of shear strain and strength depend on augmented soil. For augmented (Botucatu residual soil) BRS and Osorio sand, there was an enhancement in shear stress among shear strains, even at the maximum strains achieved in Ring shear apparatus. In contrast, for the augmented bottom ash at lower confining stress, the shear stress reached an almost fixed value of shear stress rather than strain-softening as was obtained for augmented soil. The stress dilatancy relationship shows that all the cases with augmented soil had a simple frictional type of behavior, with the highest strengths directly correlated to volumetric dilation. The mixing of fiber caused soil behavior change from the frictional trend determined from the nonaugmented soil so that the strength was no more related to volume change. The effect of fiber addition on swelling and volume change is big at higher load and strain levels because of fiber.

Casagrande et al. (2006) study on polypropylene fiber with a length of 12 to 24 mm, a diameter of 0.023 mm, with 1.5 to 3.0%, and stated that the post-peak, the rise in strength from the fiber until constant, about 50 mm displacement for 1.5% fiber amount. For large horizontal displacements, there is a downturn of the augmented impact of the fiber, obtained strength alike to reinforced sample at a shear displacement of near 180mm. The reinforced fiber of bentonite is only effective for a shear displacement of up to 50mm, decreasing its impactiveness for large distortion. Fiber exit in the fiber augmented bentonite samples after the trial was converted to have been both extended and broken, showing that fiber suffers non-elastic tensile deformation prior to breaking. The behavior of fiber is approximately strain-rate dependent, so the conclusions may be only valid for the low strain rates used in the tests.

This is a significant effect of fiber augmentation on the topmost strength. There is no tendency to lose strength, and these outputs indicate the highest potential of these types of fiber when used as soil augmentation.

Consoli et al. (2013) study on pp fiber with a length of 24 mm, and a diameter of 0.023 mm, and found that the polypropylene fiber inclusion sample indicated a noticeable hardening character up to at last of the tests at axial strains greater than 20%, whereas the nonreinforced samples exhibit an approximately ideal non-elastic character at large strain. The triaxial trial results show that the friction angle is negligibly influenced by PP fiber inclusions, improving from 300 to 310. On the other hand, the cohesion parameter increased from 23 to 122 KN/m2. The plate load test outputs indicate that the inclusion of pp fibers sufficiently increased the behavior of soils.

Kaniraj and Havangi (2011) conducted an experimental program to study the individual and combined effect of randomly oriented fiber inclusions and cement stabilization and geotechnical behaviors of fly ash soil mixture. Non-confined compression test was conducted on fly ash soil specimen with 3% cement by weight only and also with 3% cement and 1% fiber inclusion after various periods of curing. The study indicates that fiber inclusion increases the strength of the fly ash soil specimen along with that of the cement equilibrated specimen. Hongtao et al. (2009) find maximize design parameters for reinforcement of soil-cement mixture with glass fibers. Soroshain (2007), Buch and Rehman (2008), and Soroshian and Ravan Bakhsh (2009) found the result from the soil-cement mixture was modified by 0.15, 0.3, and 05 % by weight of dry soil. Khatak and al Rashidi (2005), Sobhan et al. (2009), Maher and Ho (2013), and Gaspard and Mohammed (2002) reported that the assessment of durability for glass fiber modified mixture is an issue and needs further investigations.

Khatak and Arashidi (2005), Mo et al. 2009) was conducted test on addition of glass fiber in soil-cement mixtures. Khatak and al Rashidi (2005) perform for Unconfined Compression Strength (UCS) on the soil-cement mixture with and without fibers. Two types of fibers were used Photonic Crystal Fiber (PCF) other is PP, and cement used. Gaspard et al. (2003) reported the inclusion of fabricated polypropylene fibers in soil-cement mixtures significantly increased the indirect tensile strength (ITS), the indirect tensile strain, and toughness index (TI). Moreover, enlarged curing duration and the inclusion of fibers significantly increase the resilience modulus of mixtures. The inclusion of fiber in the soil mixture did not increase the unconfined compressive strength when compared to a similar mixture with no additional fibers.

Gosavi et al. (2014) said that Black cotton soil is expansive soil, which swells or shrinks excessively due to changes in moisture content. When black cotton soil is used in engineering construction, it feels either settlement or heaves, depending on the stress level and the swelling soil pressure. Shetty and Shetty conducted a triaxial test, California bearing ratio (CBR) tests, and compaction test on silty sand (SM) and black cotton soil, individually, augmented with anyhow addition polypropylene fibers. The sample was augmented with discrete fibers of (1 to 3) % by the dry weight of soils. The test results show that on increasing fibers, there is an improvement in cohesion and a slight reduction in the angle of internal friction. However, on average, improve in shear strength of soil on increasing the fiber.

Various study related to the strengthening of soil was conducted by (Ismail et al., 2002; Aiban, 2014; Huang and Airey, 1998; Basha et al., 2005; Kolias et al., 2005; Sherwood, 2003; Al-Rawas, 2002; Tremblay et al., 2002; Lima et al., 2006; Thome, 1999). There are a few advantages to using randomly dispensed fiber as reinforcement. First, the discrete fibers are added and combined randomly with soil, in plenty as same manner as cement, lime, or different components. Second, randomly dispensed fibers have restriction ability to planes of weak point which could increase parallel to orientated reinforcement. Therefore, it has become a focal point of the hobby in current years. A wide variety of triaxial checks, unconfined compression checks, CBR checks, and direct shear checks at difficulty were carried out by numerous investigators withinside the previous few decades (Yetimoglu and Salbas, 2003; Yetimoglu et al., 2005; Gray and Al-Refeai, 2016; Ranjan et al., 2016; Prabakar and Sridhar, 2002; Kaniraj and Gayathri, 2003; Li et al., 2005; Al-Refeai, 2011; Krishnaswamy and Isaac, 2004; Ranjan et al., 2014; Wasti and Bu¨ tu¨ n, 2006). Over the year, research facts have studied the behavior of UCS of soil-cement aggregate, and few studies have been conducted for fiber reinforcement (r/f) in soil cement aggregate. Including fibers in soil, cement may also enhance soil-cement characteristics.

Pradip et al. (2007) observed that, have the effect of polypropylene fibers on the engineering characteristics of soil fly ash combinations for road making. The reason for this research was to identify & qualify the effects of fiber variables on the average performance of fiber-strengthened soil fly ash samples.

CHAPTER 3.

METHODOLOGY

CHAPTER-3
Methodology

3.1 STUDY AREA- The study area for this research work is Delhi Technological University (Formerly Delhi College of Engineering) Bawana Road, Delhi. Delhi is the capital of India.

To complete these objectives following methodology was undertaken.

3.2 MATERIALS-

(A) Soil- Samples of soil were collected from excavation work being undertaken at Technological University. Sieve analysis, plastic limit, liquid limit test, optimum moisture content, maximum dry density test (OMC & MDD), California bearing test (CBR), Direct shear test have been conducted.

(B) One-time use facemask-There are three reasons why surgical facemask or one-time use mask was selected as one of the raw materials for the construction of landfill liner.

- One of them is, the main constituents of fiber of surgical facemask fiber and those of geotextile/geomembrane that are used in construction of landfill liner, both are polypropylene, polyethylene, and polyester (Thomas,2012; T. M. Aminabhavi a1 H.G.Naik a1,1999), are same.
- As a result of the Corona pandemic, billions of waste facemasks generate as waste fabric in our vicinity, causing a harmful impact on our environment and threatening because widespread fibers of facemasks are fabricated from plastic that is not degradable. Due to its lighter weight, it spreads everywhere with the use of air, water, or may be comes from landfills with the use of wind, so they are safely disposed of can be a very difficult task. But if we use facemask as uncooked cloth for creation of landfill liner to control dispose of such kind of waste.
- The requirement of polypropylene fibers for landfill liners is lessened with the aid of using the used waste facemask in the vicinity of the fibers liner. So that it serves two purposes: one is to control waste, and one is to use it as raw material for the creation of landfill liners.

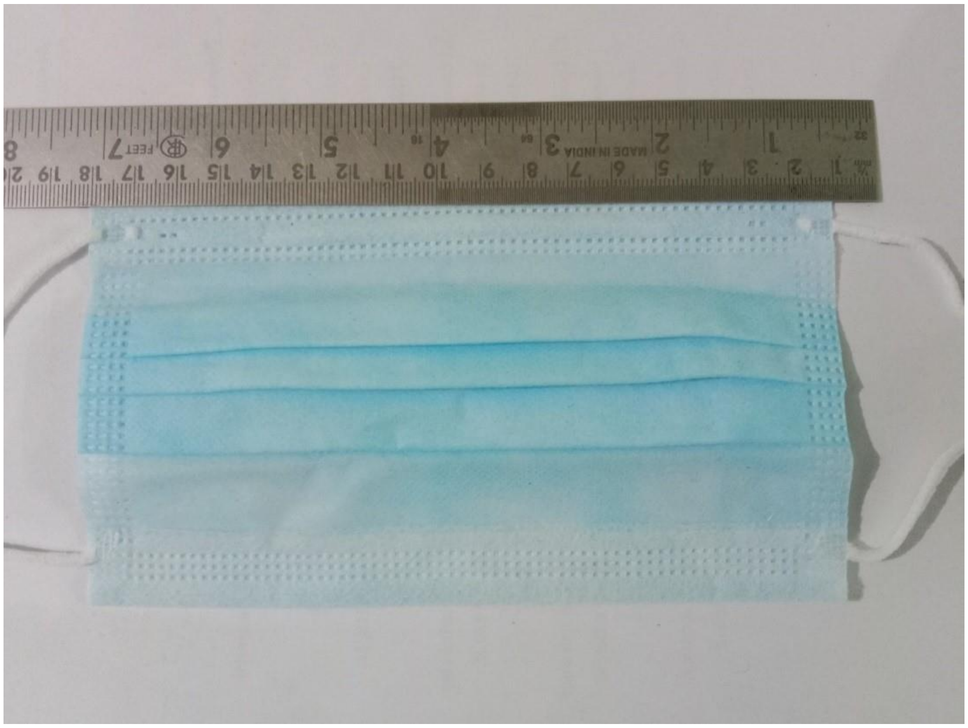


Fig 3(.1)   Length of facemask = 17 cm.

3.3 TOOLS AND TECHNIQUE-

Sieve analysis was conducted as per IS 2720-4(1985): Part 4 (Grain size analysis). The result of the sieve analysis is as follow.

Table. 3.1: Observations for Sieve analysis

S.no	Sieve size (in mm)	Soil weight retain on sieve (in gm)	Retain % on each sieve
1.	4.75	0	0
2.	0.075	16	8
3.	0.002	62	31
4.	Pan	120	60

Inference:

From the observation table, soil sample is clay and silty soil.

Fig. 3.2: Apparatus used in sieve analysis

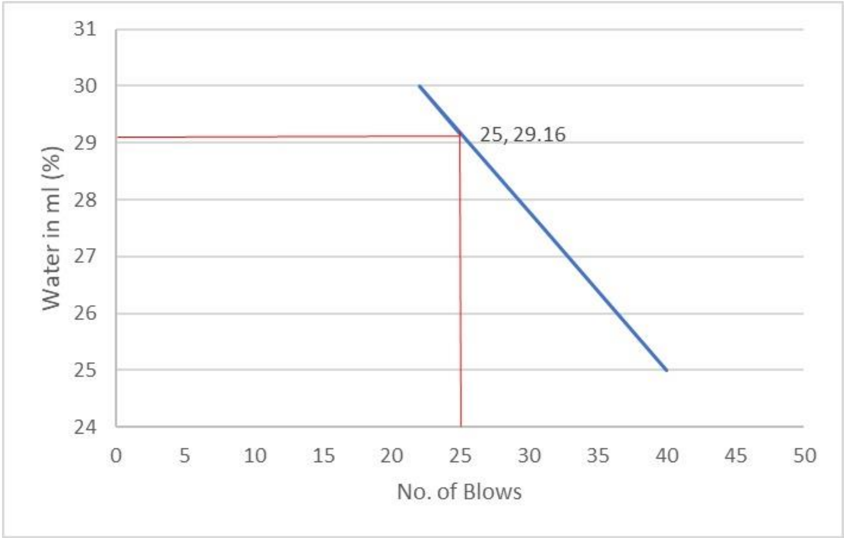
Liquid limit

Liquid limit test was conducted as per IS 2720-5 (1985): Part 5 (Determination of liquid and plastic limit). The result of Liquid limit test as follow.

Fig. 3.3: Apparatus used in liquid limit

Table. 3.2: Atterberg limit test data table

S.no	Water in (%)	No. of blows
1.	25	40
2.	27.5	31
3.	30	22



From graph, Liquid limit is 29.30%.

Plastic limit

Plastic limit test was conducted as per IS 2720-5 (1985): Part 5 (Determination of liquid and plastic limit). The result of Liquid limit test as follow.

Fig. 3.4: Apparatus used in plastic limit

OBSERVATION

Fig. 3.5: Moisture content determining apparatus

Table (3.3): Properties of sample soil

Sl.no.	Name of test	Results
1.	O.M.C.	18.50%
2.	M.D.D.	1.70 gm/cc
3.	C.B.R.	3.12
4.	Plastic limit (PL)	11.88%
5.	Liquid limit (LL)	29.30%
6.	Plasticity index (PI)	41
7.	Clay content	60%
8.	Silt content	31%
9.	Sand content	09%
10.	Gravel	0%
11.	Angle of internal friction(ø)	14.98˚
12.	Cohesion (c)	3.10kN/m²
13.	Permeability (k)	1 x 10^{-4} cm/sec

As per the above data, the thesis concludes that the soil sample is not suitable for the construction of landfill liner material. For example, the permeability of liner material should be less than or equal to $1x10^{-7}$ cm/sec to $1x10^{-12}$ cm/sec (Kendall et al., 2014; Petrov et al., 1997; Weerasinghe et al., 2020) But. The soil sample has very high permeability (1×10^{-4}cm/sec) As compared to what is required. So that soil sample has permeability as per required permeability so adding some fibers which are economically good and having low permeability.

Proctor Compaction Test

Proctor Compaction Test was conducted as per IS 2720-7 (1983): Part 7 (Determination water content- Dry density using light compaction). The result of Liquid limit test as follow.

California Bearing Ratio Test

California bearing ratio test was conducted as per IS 2720-16 (1987): Part 16 (Laboratory determination of CBR). The result of California bearing ratio value of the given soil is as follows:

Fig. 3.6: California bearing ratio apparatus

Direct Shear Test

Direct shear test was conducted as per IS 2720-13 (1986): Part 13 (Direct shear test). The result of Direct shear test as follow.

Fig. 3.7: Direct shear test apparatus

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CHAPTER –4

RESULTS AND DISCUSSION

CHAPTER -4
Results and Discussion

4.1 Result of test conducted on soil (without augmentation)

4.1.1 Proctor compaction test-

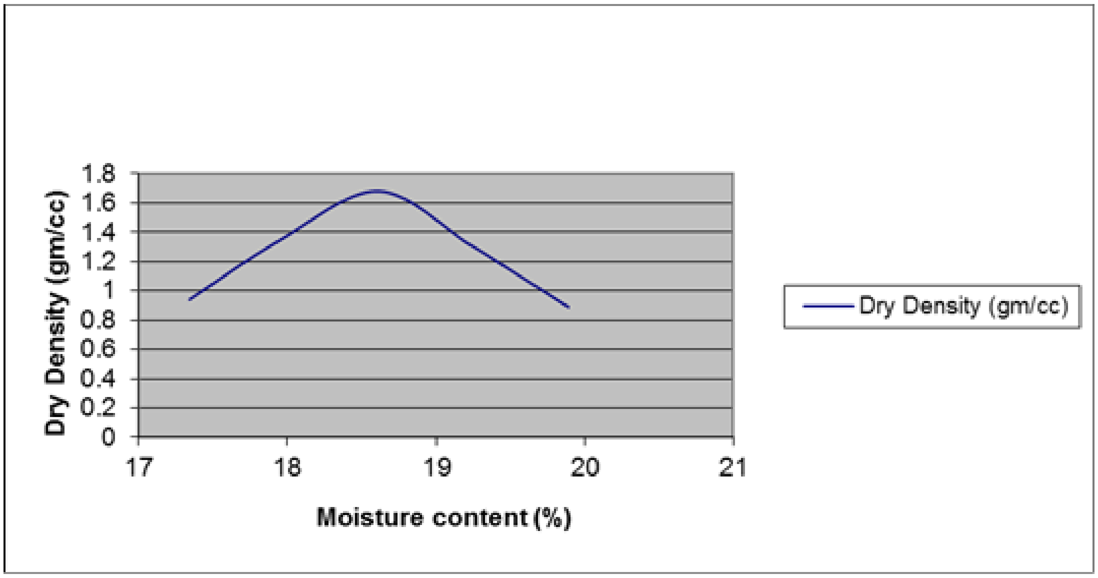

Fig.4.1- **Proctor compaction test for soil only**

From the graph, on the horizontal axis is moisture content in percentage and on the vertical axis is Ÿd dry density in kg/cc. Dry density increases as water content increases and reaches a maximum water content of 18.50%, corresponding this dry density is the maximum dry density of sample soil is 1.70gm/cc. Maximum dry density should be increased by adding a shredded facemask so that it acts as a good hydraulic barrier for leachate of the landfill, because as maximum dry density increases permeability decreases (Sindhu A.R. et al.; Tiju Susan Thomas, 2017). So, notice changes in MDD in the next soil sample testing by mixing shredded facemask.

Result:	1) Optimum Moisture Content	=	18.50%
	2) Max. Dry Density	=	1.70 gm/cc

4.1.2 California bearing ratio (CBR) Test-

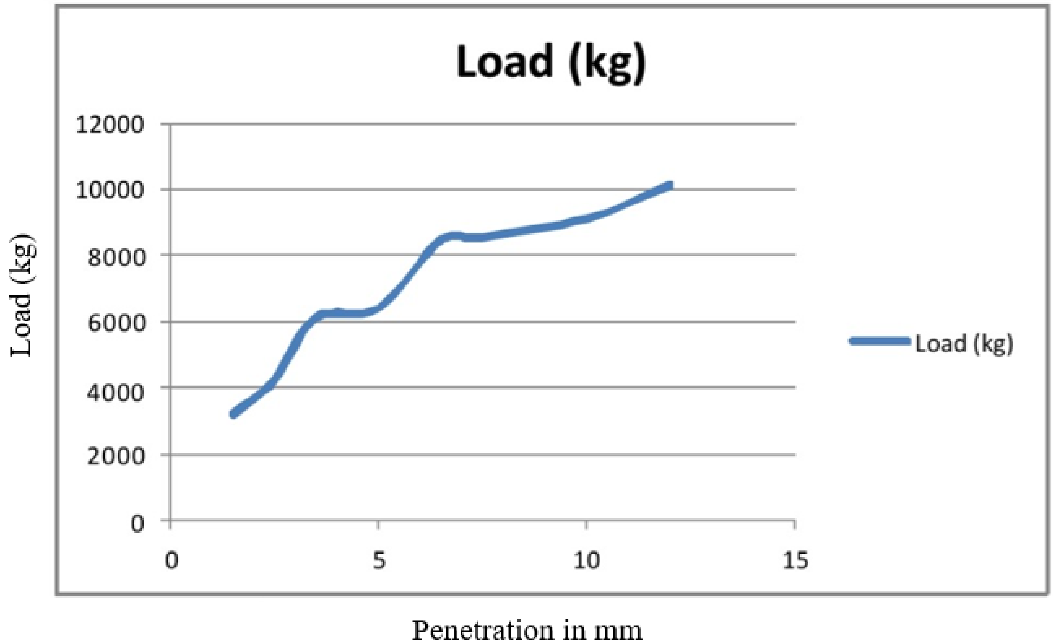

Fig.4.1.2- **California bearing ratio test for soil only**

From the above graph horizontal axis represent penetration in mm, and the vertical axis represents load in kg. Here load bear by a sample at 2.5 mm penetration of plunger is 4274 kg, and at 5mm penetration, load bear by a sample is 6412 kg. If, on adding shredded facemask, CBR value increase of sample then bearing capacity of the augmented soil sample is increase. (SS Razouki. 2005).

Results:

CBR)$_{2.5}$ $=P_{2.5}/1370$ $=4274/1370$ $= 3.1$

(CBR)$_5$ $= P_5/2055$ $= 6412/2055$ $= 3.13$

4.1.3 Direct Shear Test

Here normal force on the horizontal axis and on a vertical axis, shear force. This direct shear test was conducted on soil samples, not mixing shredded facemask.

From Formula

s = c + σ. tan ϕ, where tan ϕ is the coefficient of plane sliding friction

The value of c and ø increase, so the value of shear strength increases.

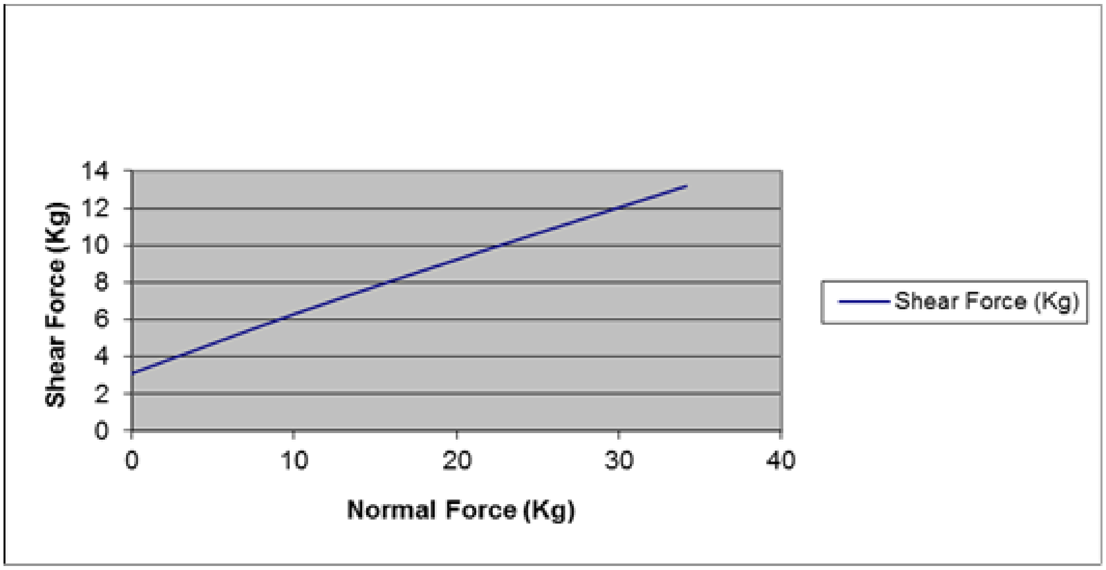

Fig- 4.1.3 -Direct Shear Test

Result: C = 3.10 KN/m^2

Φ = 14.98º

4.2 - Result of test conducted on soil augmented with polypropylene by mixing 0.5% shredded facemask and shredded mask of length 5mm

4.2.1- Proctor compaction test-

This Proctor compaction test was conducted on a soil sample having 5mm size of fiber with 0.5% by weight of shredded facemask. In comparison to fig 1 value of dry density decrease. In the previous sample of only soil, MDD is 1.70gm/cc, but after adding a shredded facemask, the MDD value decreased up to 1.68gm/cc.

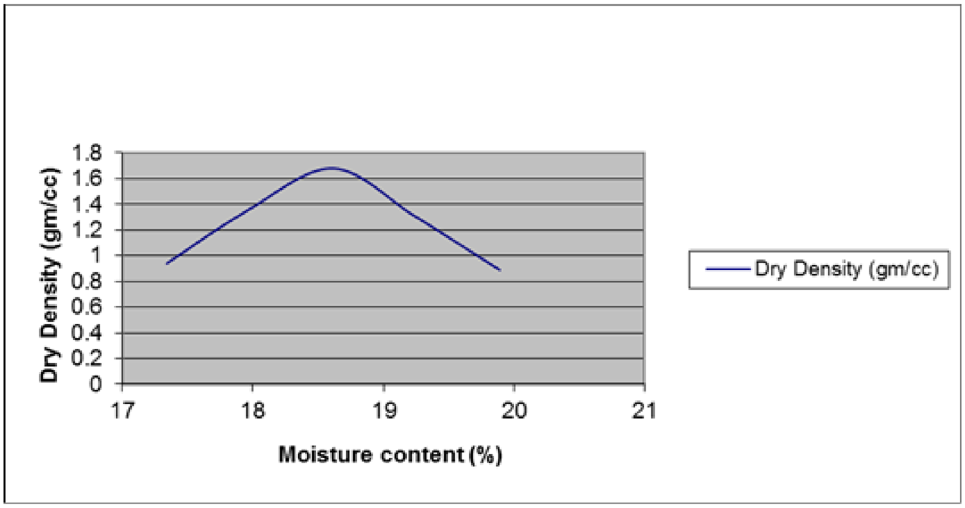

Fig.4.2.1-**Proctor compaction test for fiber length 5mm with fiber content 0.5%**

Result: 1) Optimum Moisture Content = 18.60%

2) Dry Density = 1.68gm/cc

4.2.2 California bearing ratio (CBR) Test-

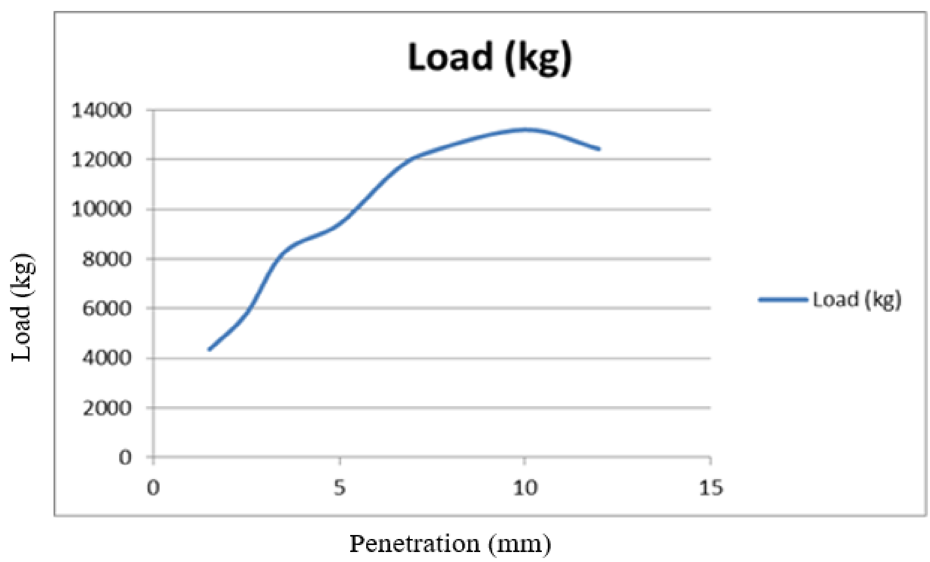

Fig.4.2.2- California bearing ratio test for fiber length 5mm with fiber content 0.5%

This test was conducted soil sample having 5mm size with 0.5% by weight of shredded facemask.

In comparison to fig.2, the CBR value increases, so a positive impact also on the bearing capacity of the soil. The previous value of $CBR)_{2.5}$ and $(CBR)_5$ are 3.12 and 3.13, respectively; now, values have increased to 4.24 and 4.58

Results:

$CBR)_{2.5} = P_{2.5}/1370$ $\qquad$ $(CBR)_5 = P_5/2055$

$=5808/1370$ $\qquad$ $= 9413/2055$

$= 4.24$ $\qquad$ $= 4.58$

4.2.3-Direct shear test-

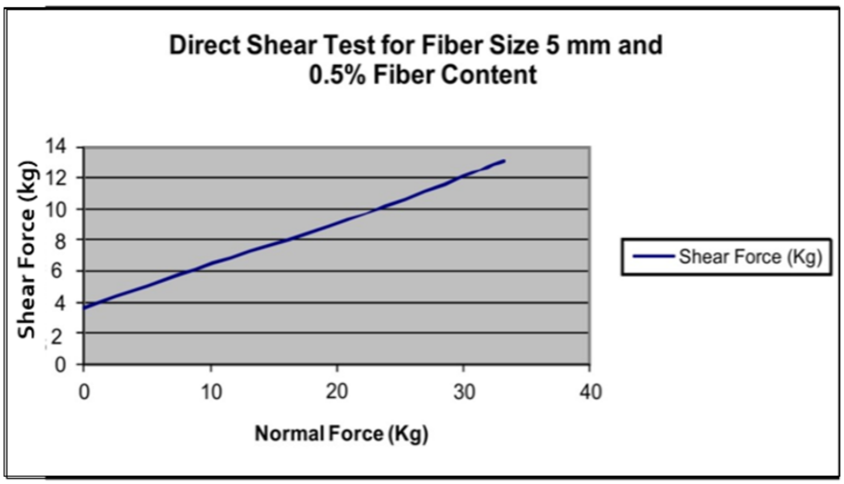

Fig-4.2.3-Direct Shear Test for fiber length 5mm with fiber content 0.5%

This direct shear test was conducted on a soil sample having 5mm size of fiber with 0.5% by weight of shredded facemask. In comparison to the previous direct shear test (without shredded facemask), the value of C increased from 3.10 to 3.70 KN/m2, and the ϕ value decreased from14.98° to 13.10°; hence the value of C increased, and the value of ϕ is positive than the overall value of shear strength increase.

Result: $C = 3.70$ KN/m_2

$\Phi = 13.10°$

4.3 Result of test conduct on soil augmented with polypropylene by mixing 1% shredded facemask by wight and shredded masks length 5mm

4.3.1. Proctor compaction test-

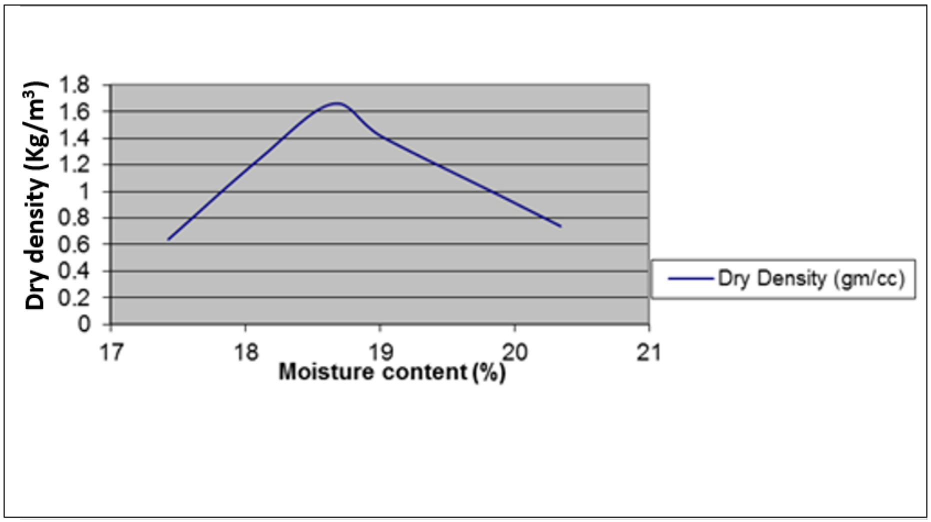

Fig.4.3.1-Proctor compaction test for strip length 5mm with 1% content of shredded facemask

This Proctor compaction test was conducted on a soil sample having 5mm size of fiber with 1% by weight of shredded facemask. In comparison to the last previous Proctor compaction test value of dry density decreased. In the previous sample, augmented soil MDD is 1.68gm/cc, but after 1% adding a facemask, the MDD value decreased up to 1.652gm/cc. So, here further decrease dry density.

Result: 1) Optimum Moisture Content = 18.65%

2) Dry Density = 1.652 gm/cc

4.3.2- California bearing ratio (CBR) Test-

This test was conducted soil sample having 5mm size with 1% by weight of shredded facemask. In comparison to the previous CBR test, the CBR value increases so that positive impact also on the bearing capacity of the soil. The previous value of $(CBR)_{2.5}$ and $(CBR)_{5}$ are 4.24 and 4.58; respectively, now values have increased to 5.645 and 5.235. Overall CBR value increased till now on increasing percentage of a shredded facemask by weight. Hence bearing capacity of augmented soil increases.

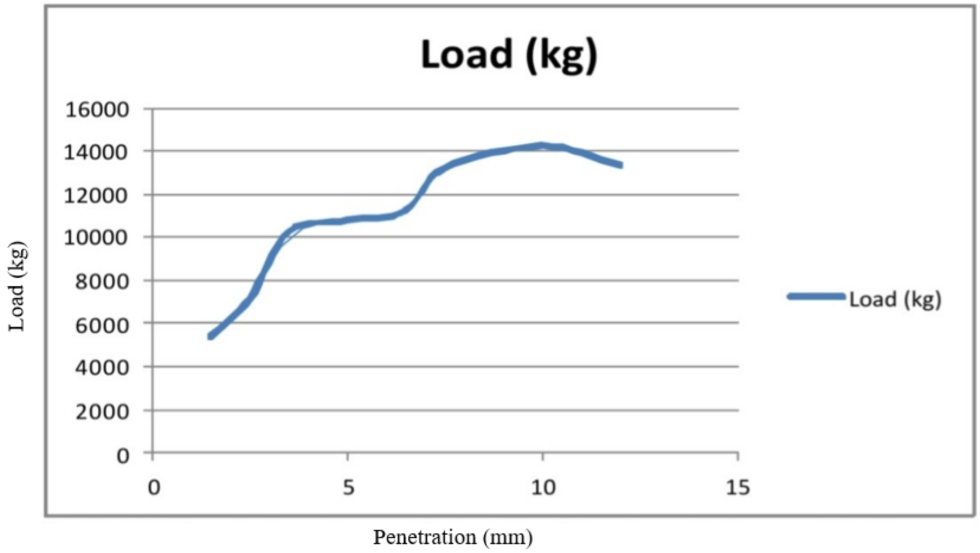

Fig.4.3.2- California bearing ratio test for masks strip width 5mm with fiber content 1.0 %

Results:

CBR)$_{2.5}$	= PP$_{2.5}$/1370	(CBR)$_5$	= PP$_5$/2055
	=7132/1370		= 10757/2055
	= 5.645		= 5.235

4.3.3- Direct shear Test-

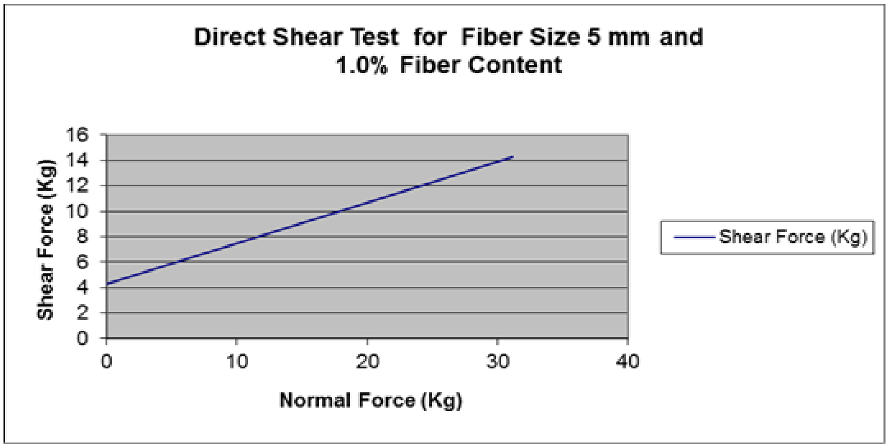

Fig-4.3.3-Direct Shear Test for masks strip width 5mm with fiber content 1.0 %

This direct shear test was conducted on a soil sample having 5mm size of fiber with 1% by weight of shredded facemask. In comparison to the previous direct shear test value of C increased from

3.70 to 4.28 KN/m2, and the ϕ value decreased from 13.10° to 12.10°, hence the value of C increased, and the value of ϕ was positive then, the overall value of shear strength increase.

Result: C = 4.28 KN/m2 ; Φ = 12.10°

4.4 - Result of test conducted on soil augmented with polypropylene by mixing 1.5% shredded facemask by weight and shredded masks length 5mm-

4.4.1- Proctor compaction test-

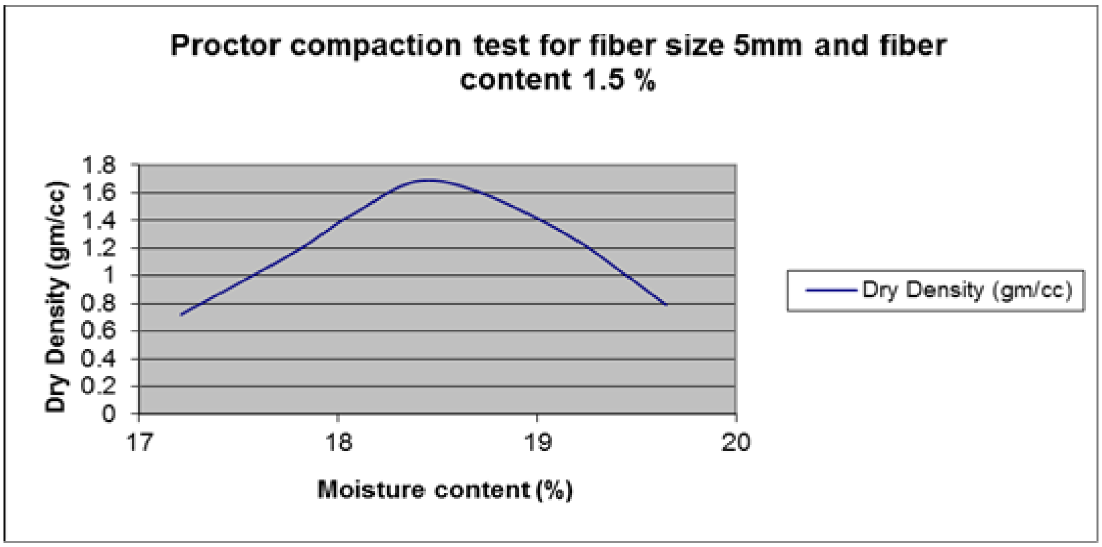

Fig.4.4.1-Proctor compaction test for strip width 5mm with content 1.5%

This Proctor compaction test was conducted on a soil sample having 5mm size of fiber with 1.5% by weight of shredded facemask. In comparison to the last previous Proctor compaction test value of dry density increased, but in the previous Proctor compaction test, dry density decreased continuously on the increased percentage of a shredded facemask by weight, so it indicates adding 1.5% of shredded facemask is a good for required soil sample. In the previous sample, augmented soil MDD was 1.652gm/cc, but after1.5% adding a facemask, the MDD value increased up to 1.69gm/cc. Here dry density is comparatively high in both cases, 0.5% and 1% shredded mask.

Result: 1) Optimum Moisture Content = 18.48%

2) Dry Density = 1.69gm/cc

4.4.2-California bearing ratio (CBR) Test-

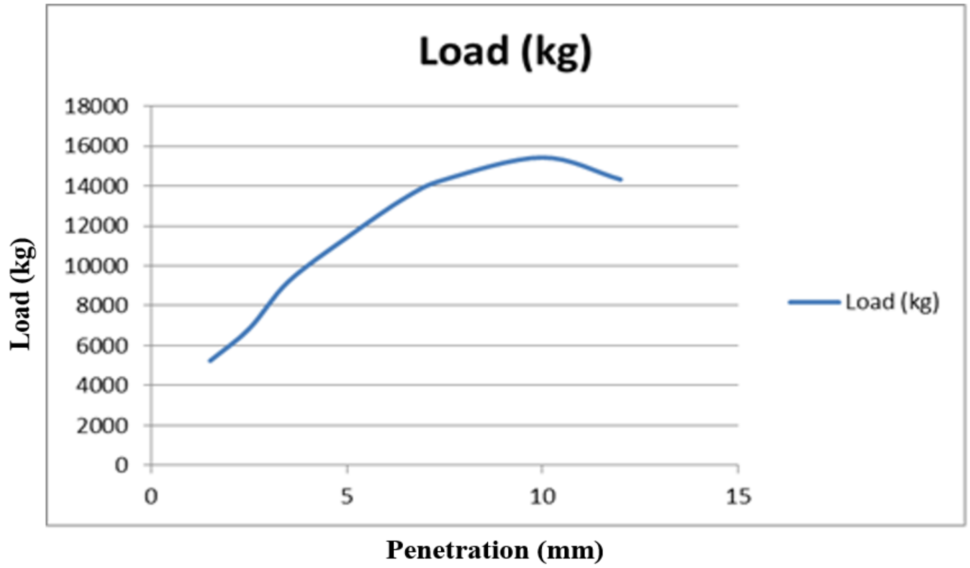

Fig. 4.4.2- California bearing ratio test for strip width 5mm with fiber content 1.5%

This test was conducted soil sample having 5mm size with 1.5% by weight of shredded facemask. In comparison to the CBR test, the $CBR_{2.5}$ value decreases, so that trend is reversed on the bearing capacity of the soil. The previous value of $(CBR)_{2.5}$ and $(CBR)_5$ were 5.645 and 5.235; respectively, now values of $(CBR)_{2.5}$ and $(CBR)_5$ are 5 and 5.554. Overall, the CBR value has decreased. Hence bearing capacity of augmented soil decrease. So, obtained data, conclude that if the varying percentage of shredded facemasks, maximum bearing capacity of augmented soil is obtained at 1% of facemasks

Results:

$CBR)_{2.5}$ = $PP_{2.5}$/1370 $\quad$ $(CBR)_5$ = PP_5/2055

=6850/1370 $\quad$ = 11413/2055

=5.000 $\quad$ = 5.554

4.4.3- Direct shear Test-

This direct shear test was conducted on a soil sample having a 5mm size of fiber with 1.5% by weight of shredded facemask. In comparison to the previous direct shear test value of C decreased from 4.28 to 4.01 KN/m2, and the ϕ value decreased from 12.10° to 11.50°; hence the value of C decreased, and the value of ϕ decreased then the overall value of shear strength decrease. Hence at 1% shredded facemask, a maximum value of shear strength is obtained.

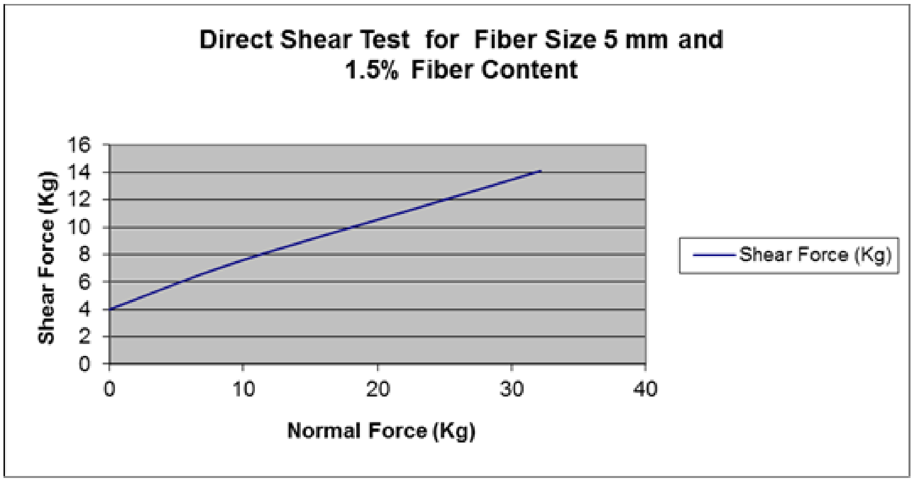

Fig. 4.4.3 -Direct Shear Test for Fiber Size 5 mm with fiber content 1.5%

Result: C = 4.01 KN/m_2 Φ = 11.50°

4.5 Result of test conducted on soil augmented with polypropylene by mixing with 0.5 % of 10 mm length shredded facemasks by weight.

4.5.1- Proctor Compaction Test

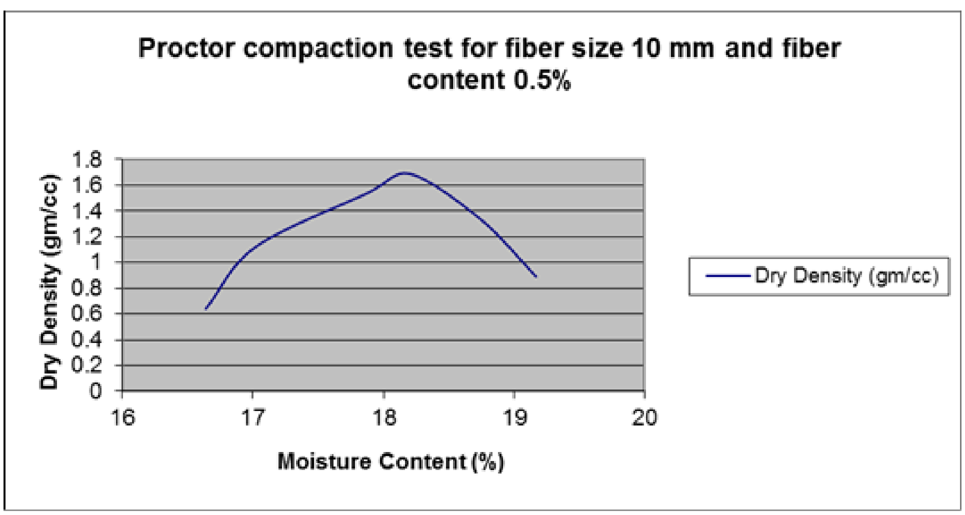

Fig.4.5.1-Proctor compaction test for strip width 10 mm with content 0.5%

This Proctor compaction test was conducted on a soil sample having 10mm size of fiber with 0.5% by weight of shredded facemask. In comparison to the previous Proctor compaction test (facemask strip size 5mm and 0.5%), value of dry density increases. The value of dry density in this test is 1.69gm/cc. So, considering the size of the strip and comparing data of previous direct shear test with 5mm strip size and with 0.5% of facemasks content, dry density is 1.68 gm/cc, and current (strip size 10mm & 0.5% facemasks content) dry density is 1.69. Hence on increasing strip size, dry density increases.

Result: 1) Optimum Moisture Content = 18.20%

2) Dry Density = 1.69gm/cc

4.5.2- California bearing ratio test

This test was conducted soil sample having 10mm size with 0.5% by weight of shredded facemask. In comparison to the previous CBR test (strip size 5mm with 0.5%), the CBR value decreased so that on increasing the size of the strip, soil bearing capacity decreased. The previous value of $(CBR)_{2.5}$ and $(CBR)_5$ were 4.24 and 4.58; respectively, now values decreased to 4.2 and 4.56.

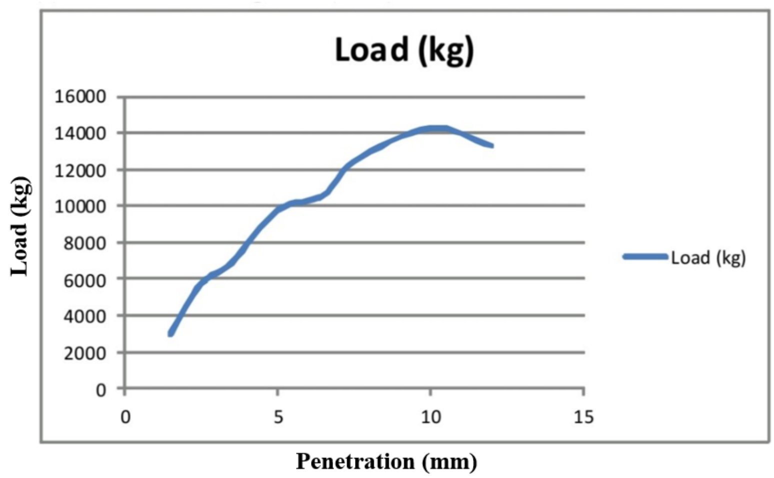

Fig.4.5.2- California bearing ratio test for fiber length 10 mm with fiber content 0.5%

Results:

$CBR)_{2.5} = PP_{2.5}/1370$ $(CBR)_5 = PP_5/2055$

$= 5754/1370$ $= 9765/2055$

= 4.200 = 4.751

4.5.3- Direct shear test

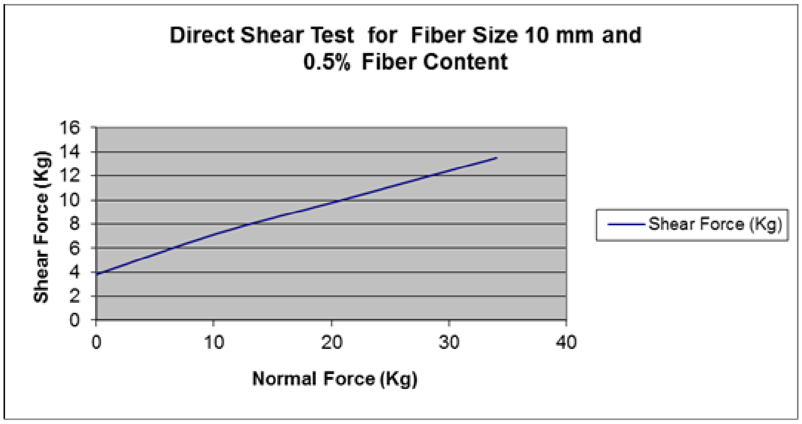

Fig-4.5.3-Direct Shear Test for strip width 10 mm with content 0.5%

This direct shear test was conducted on a soil sample having 10mm size of fiber with 0.5% by weight of shredded facemask. In comparison to the previous direct shear test (strip size 5mm with 0.5%), the value of C increased from 3.70 to 3.80 KN/m2, and the ϕ value increased from 13.10° to 13.22°. So, increase the size of strip, C and ϕ increase.

Result: C = 3.80 KN/m2;

Φ = 13.22°

4.6 - Result of test conducted on soil augmented with polypropylene by mixing 1% shredded facemask by weight and shredded masks length 10 mm

4.6.1. Proctor compaction test-

This Proctor compaction test was conducted on a soil sample having 10mm size of fiber with 1% by weight of shredded facemask. In comparison to the last previous Proctor compaction test value of dry density decreased. In the previous sample, augmented soil MDD is 1.69gm/cc, but after1% adding a facemask, the MDD value decreased up to 1.67gm/cc. So, here further decrease dry density. But based on strip size, dry density increases in comparison to Proctor test (strip size 5mm and 1%).

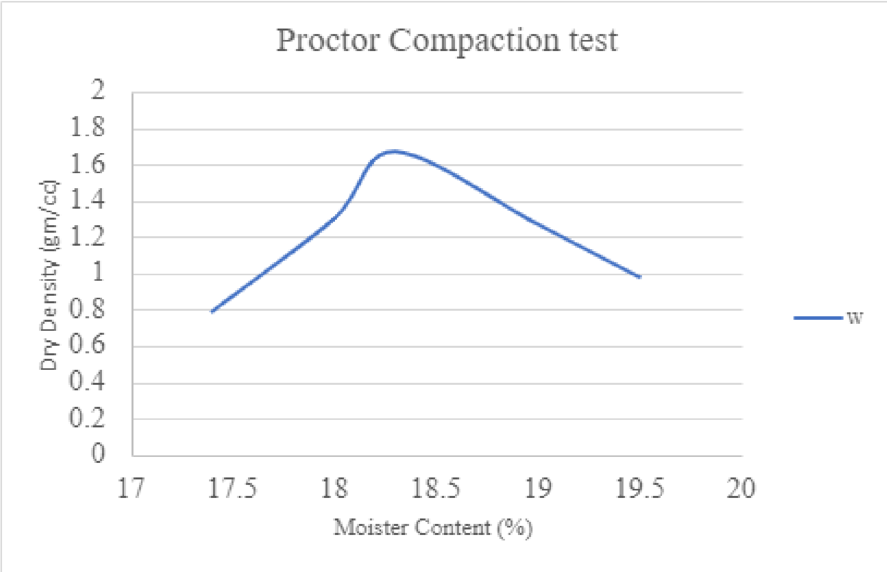

Fig.4.6.1-Proctor compaction test strip width 10mm with fiber content 1.0%

Result: 1) Optimum Moisture Content = 18.30%

2) Dry Density = 1.67gm/cc

4.6.2- California bearing ratio (CBR) Test-

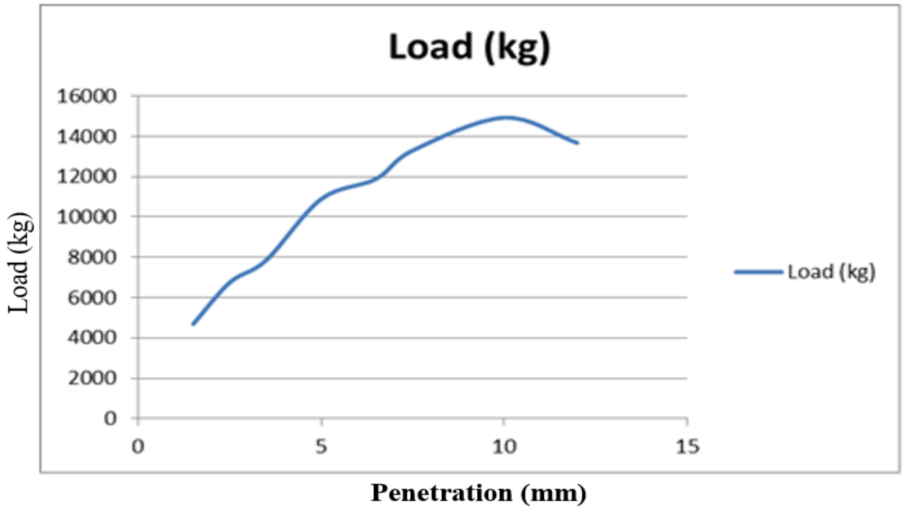

Fig.4.6.2- California bearing ratio test for strip width 10mm with fiber content 1.0%

This test was conducted soil sample having a 10mm strip size with 1% by weight of shredded facemask. In comparison to the previous CBR test, the CBR value increases so that positive impact again on the bearing capacity of the soil. The previous value of $(CBR)_{2.5}$ and $(CBR)_5$ are 4.2 and 4.75; respectively, now values have increased to 5.40 and 5.30. Overall CBR value increased till now on increasing percentage of a shredded facemask by weight. Hence bearing capacity of augmented soil increases.

Results:

$CBR)_{2.5} = PP_{2.5}/1370$ $\quad\quad (CBR)_5 = PP_5/2055$

$= 6754/1370$ $\quad\quad = 10892/2055$

$= 5.40$ $\quad\quad = 5.30$

4.6.3- Direct shear test-

This direct shear test was conducted on a soil sample having 10mm size of fiber with 1% by weight of shredded facemask. In comparison to the previous direct shear test value of C increased from 3.80 to 4.32 KN/m2, and the ϕ value decreased from 13.22° to 12.01°; hence the value of C increased, and the value of ϕ was positive than the overall value of shear strength increase. On considering the size of the strip, the value of the direct shear test (5mm strip and 1% content) C value increased from 4.28 to 4.32 KN/m2, and the ϕ value decreased from 12.10° to 12.01°. Overall, shear strength increases. Hence shredded facemask is helpful for increasing the shear strength of augmented soil till now

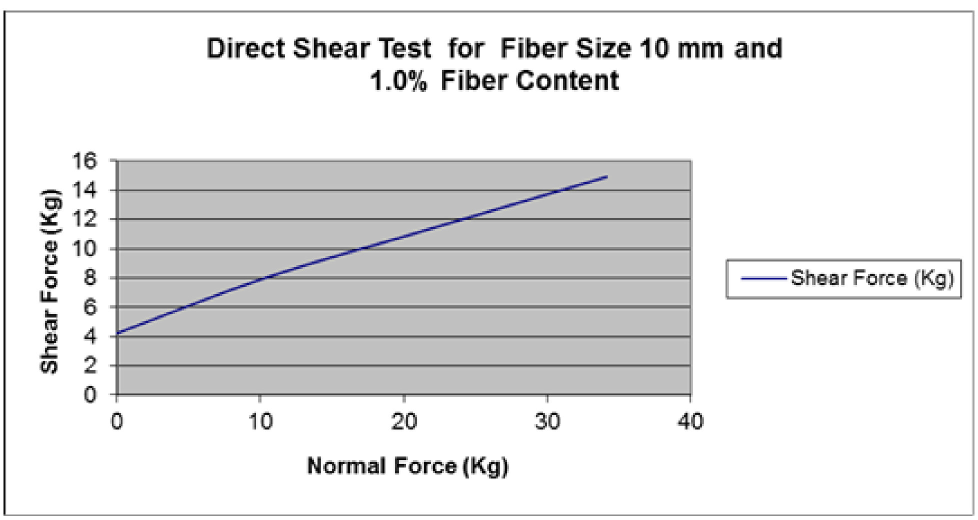

Fig-4.6.3-Direct Shear Test for Fiber Size 10 mm with fiber content 1.0%

Result: C = 4.32 KN/m^2

Φ = 12.01°

4.7 Result of test conducted on soil augmented with polypropylene by mixing 1.5 % shredded facemask by weight and shredded masks length of 10 mm

4.7.1-Proctor compaction test-

This Proctor compaction test was conducted on a soil sample having 10mm size of fiber with 1.5% by weight of shredded facemask. In comparison to the last previous Proctor compaction test, value of dry density increased, but in the previous Proctor compaction test, dry density decreased continuously on the increased percentage of a shredded facemask by weight, so it indicates adding 1.5% of shredded facemask is good for required soil sample. In the previous sample, augmented soil MDD was 1.67gm/cc, but after1.5% adding a facemask, the MDD value increased up to 1.70gm/cc. Here dry density is comparatively high for both cases, 0.5% and 1% shredded mask.

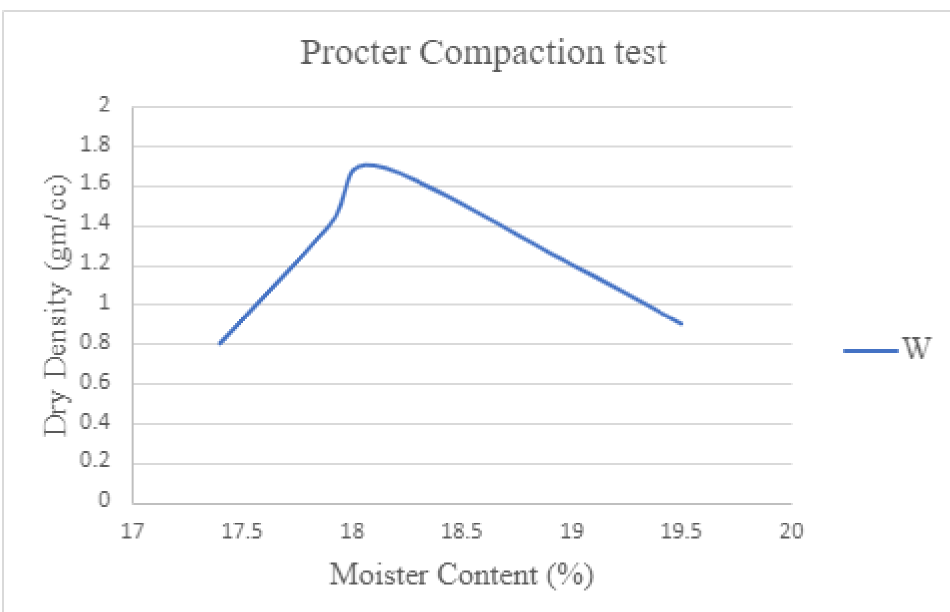

Fig.4.7.1 -Proctor compaction test for strip width 10mm with content 1.5%

Result: 1) Optimum Moisture Content = 18.10%

2) Dry Density = 1.70 gm/cc

4.7.2. California bearing ratio (CBR) Test-

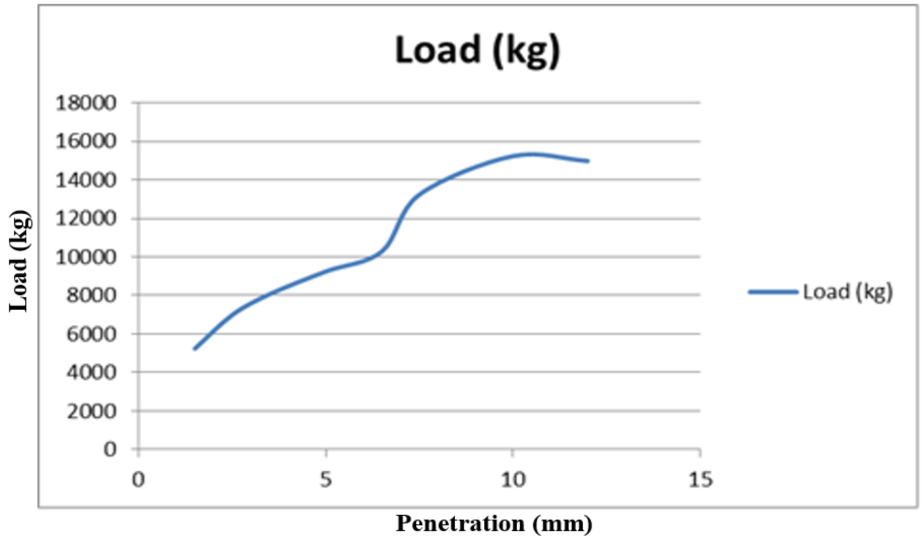

Fig.4.7.2- California bearing ratio test for strip width 10mm with content 1.5%

This test was conducted on a soil sample having 10mm size with 1.5% by weight of shredded facemask. In comparison to the CBR test, the $CBR_{2.5}$ value decreases, so the trend is reversed on the bearing capacity of the soil. The previous value of $(CBR)_{2.5}$ and $(CBR)_5$ were 5.40 and 5.30, respectively; now, values have decreased to 5.10 and 5.21. Overall, the CBR value decreased by mixing 1.5% of shredded facemask by weight. Hence bearing capacity of augmented soil decrease. So, obtained data conclude that if a varying percentage of shredded facemasks, maximum bearing capacity of augmented soil is obtained at 1% of facemasks.

Results:

$CBR)_{2.5} = PP_{2.5}/1370$ $(CBR)_5 = PP_5/2055$

$= 6987/1370$ $= 10244/2055$

$= 5.10$ $= 5.21$

4.7.3- Direct shear test-

This direct shear test was conducted on a soil sample having 10mm size of fiber with 1.5% by weight of shredded facemask. In comparison to the previous direct shear test value of C decreased from 4.32 to 4.20 KN/m2, and the ϕ value decreased from 12.01° to 11.46°; hence, the value of C decreased, and the value of ϕ decreased then the overall value of shear strength decrease. Hence at 1% shredded facemask, the maximum value of shear strength is obtained. On considering the size of the strip and comparing data of previous direct shear test having 5mm strip size with 1.5 % facemasks content show C values 4.01 KN/m2 and 4.20 KN/m2. So, the value of C increases with the increasing size of the strip but ϕ decrease.

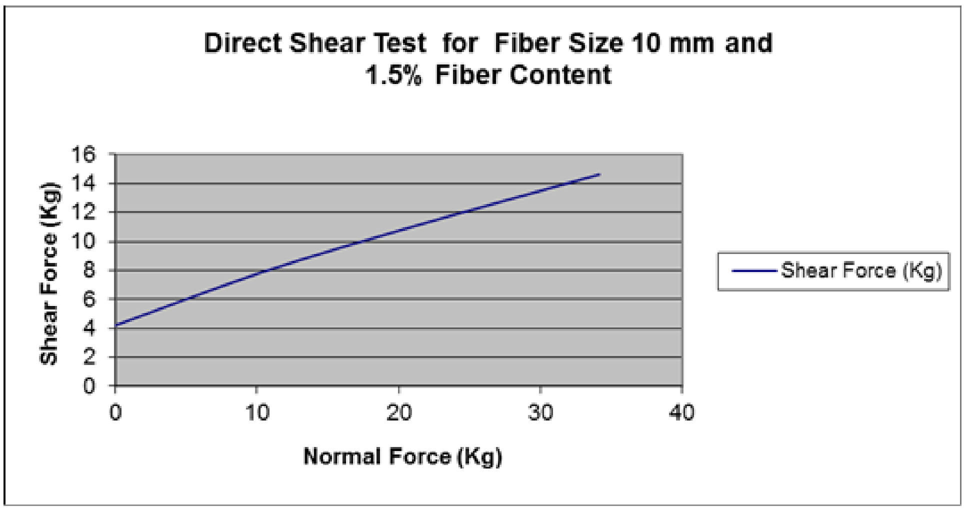

Fig-4.7.3-Direct Shear Test for strip width 10mm with content 1.5%

Result: C = 4.20 KN/m_2

$\Phi = 11.46°$

4.8- Result of test conducted on soil augmented with polypropylene by mixing 0.5% shredded facemask by weight and shredded masks length 15 mm

4.8.1- Proctor compaction test-

Proctor compaction test was conducted on a soil sample having 15mm size of fiber with 0.5% by weight of shredded facemask. In comparison to the previous Proctor compaction test (facemask strip size 10mm and 0.5%) value of dry density increases. The value of dry density in this test is

1.70gm/cc. So, considering the size of the strip, and comparing data of previous direct shear test with 10mm strip size and with 0.5% of facemasks content, dry density is 1.69 gm/cc, and current (strip size 15mm & 0.5% facemasks content) dry density is 1.70. Hence on increasing strip size, dry density also increases.

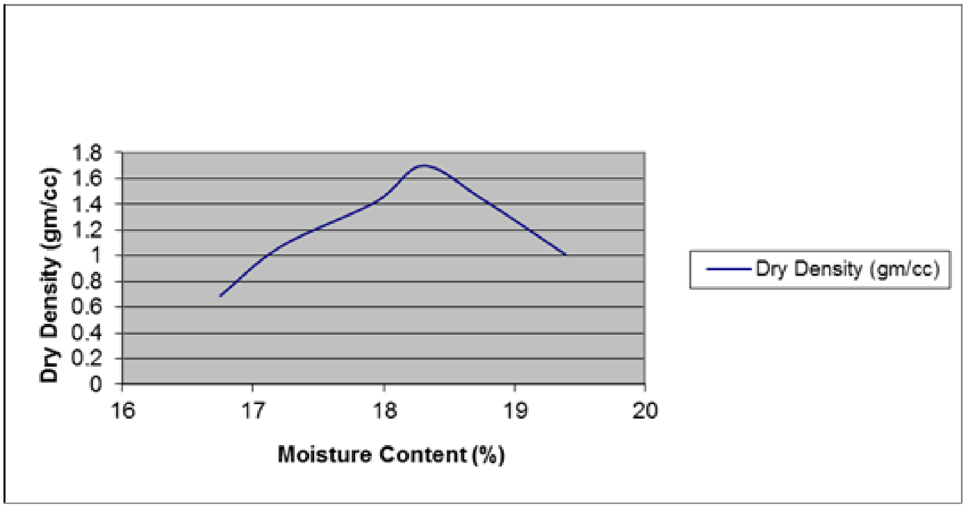

Fig.4.8.1-Proctor compaction test for strip width 15mm with content 0.5%

Result: 1) Optimum Moisture Content = 17.80%

2) Dry Density = 1.70 gm/cc

4.8.2- California bearing ratio (CBR) Test-

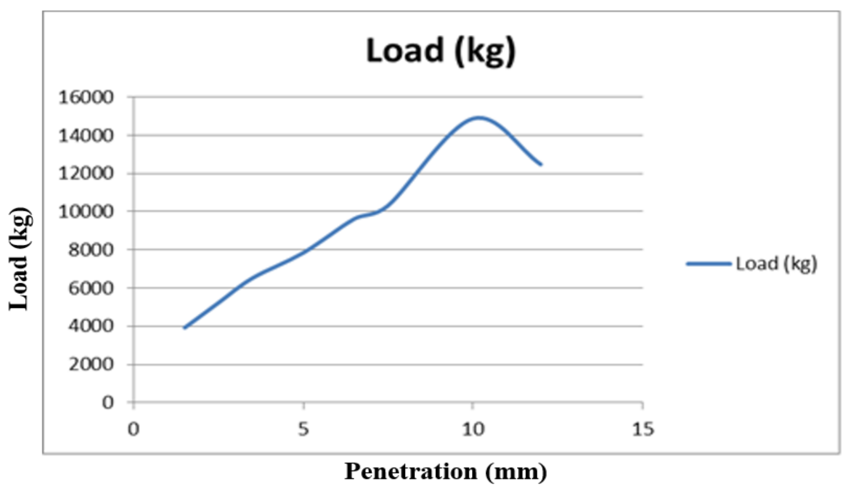

Fig.4.8.2- California bearing ratio test for strip width 15mm with content 0.5%

This test was conducted soil sample having 15mm size with 0.5% by weight of shredded facemask. In comparison to the previous CBR test (strip size 10mm with 0.5% of shredded facemask by weight), the CBR value decreased so that on increasing the size of the strip, soil bearing capacity decreased. The previous value of $(CBR)_{2.5}$ and $(CBR)_5$ are 4.2 and 4.56; respectively, now values have decreased to 3.82 and 3.85.

Results:

$CBR)_{2.5} = PP_{2.5}/1370$ $\qquad$ $(CBR)_5 = PP_5/2055$

$= 5233/1370$ $\qquad$ $= 7950/2055$

$= 3.82$ $\qquad$ $= 3.85$

4.8.3- Direct shear test

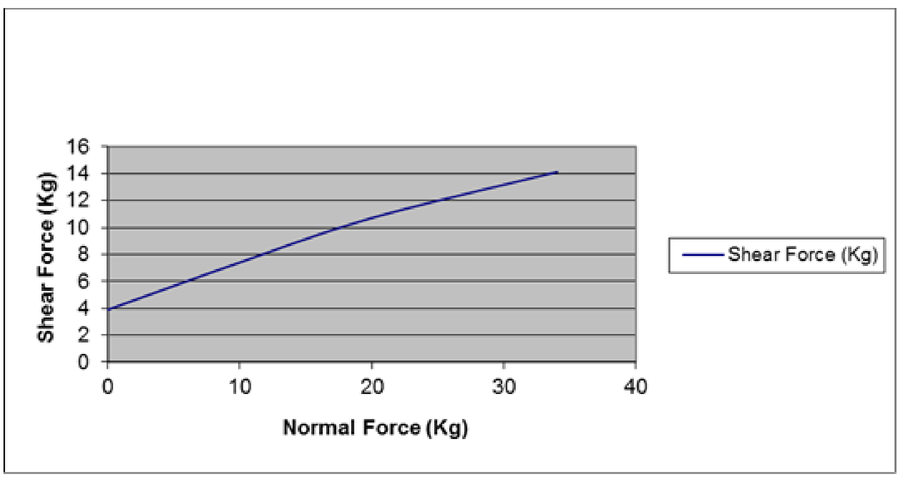

Fig-4.8.3-Direct Shear test for fiber strip width 15mm with content 0.5%

This direct shear test was conducted on a soil sample having 15mm size of fiber with 0.5% by weight of shredded facemask. In comparison to the previous direct shear test (strip size 5mm with 0.5% of shredded facemask by weight), the value of C increased from 3.80 to 3.90 KN/m2, and the ϕ value increased from 13.22° to 13.34°. So, increase the size of strip, C and ϕ increase.

Result: C = 3.90 KN/m^2 $\qquad$ Φ = 13.34°

4.9- Result of test conducted on soil augmented with polypropylene by mixing 1% shredded facemask by weight and shredded masks length 15 mm

4.9.1- Proctor compaction test-

This Proctor compaction test was conducted on a soil sample having 15mm size of fiber with 1% by weight of shredded facemask. In comparison to the previous Proctor compaction test, value of dry density decreased. In the previous sample, augmented soil MDD was 1.70gm/cc, but after1% adding a facemask, the MDD value decreased up to 1.52gm/cc. So, here further decrease dry density. But on considering strip size, dry density increases in comparison to the Proctor test (strip size 5mm and 1%).

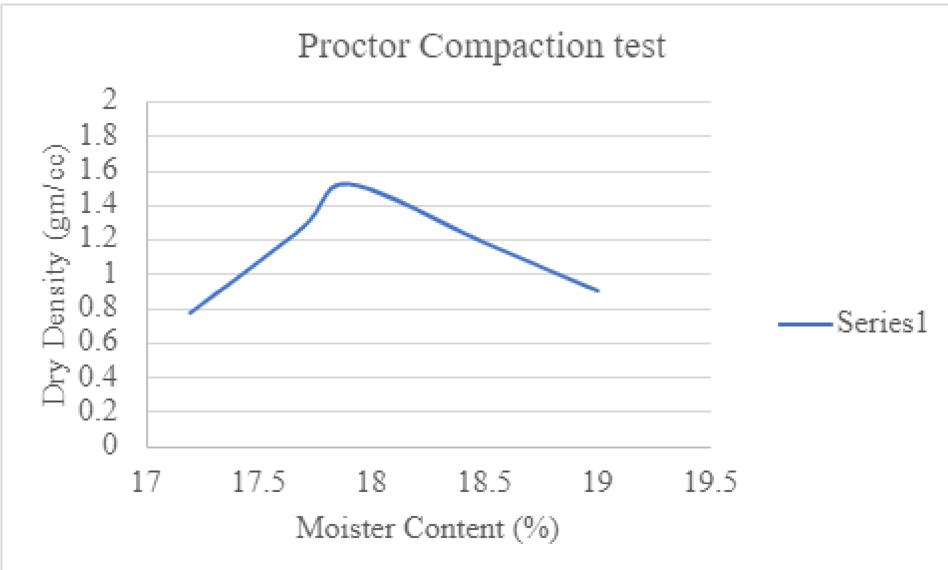

Fig-4.9.1- Proctor compaction test for strip width 15mm with content 1.0%

Result: 1) Optimum Moisture Content = 17.90%

2) Dry Density = 1.52 gm/cc

4.9.2- California bearing ratio (CBR) Test-

This test was conducted soil sample having 15mm size with 1% by weight of shredded facemask. In comparison to the previous CBR test, the CBR value increases so that positive impact on the bearing capacity of the soil. The previous value of $(CBR)_{2.5}$ and $(CBR)_5$ are 3.82 and 3.85; respectively, now values have increased to 5.06 and 4.92. Overall CBR value increased till now on increasing percentage of a shredded facemask by weight. Hence bearing capacity of augmented soil increases.

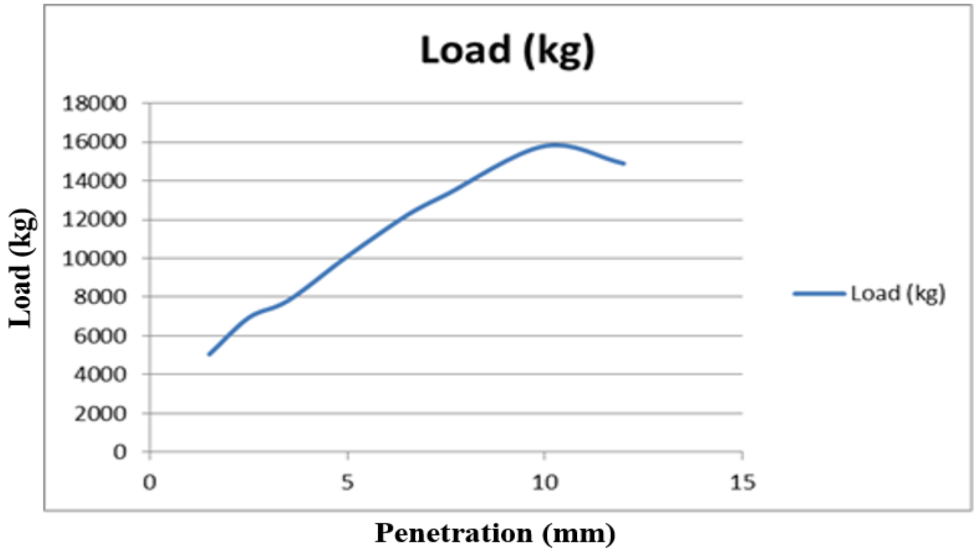

Fig-4.9.2- California bearing ratio test for strip width 15mm with content 1.0%

Result:

CBR)$_{2.5}$ = PP$_{2.5}$/1370 = 6940/1370 = 5.06

(CBR)$_5$ = PP$_5$/2055 = 10110/2055 = 4.92

4.9.3- Direct shear test-

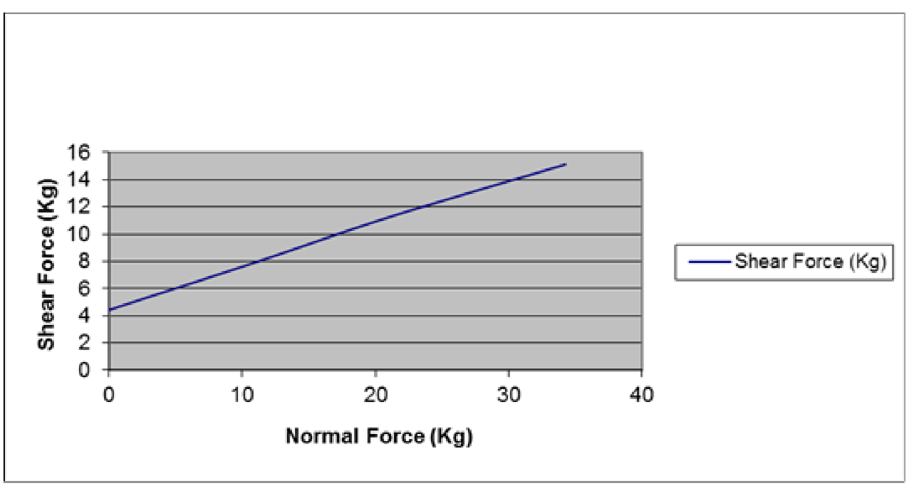

Fig-4.9.3- Direct Shear test for strip width 15mm with fiber content 1.0%

This direct shear test was conducted on a soil sample having 15mm size of fiber with 1% by weight of shredded facemask. In comparison to the previous direct shear test value of C increased from 3.90 to 4.42 KN/m2, and the ϕ value decreased from 13.13° to 12.01°; hence the value of C increased, and the value of ϕ was positive then the overall value of shear strength increase. On considering the size of the strip, the value of the direct shear test (10mm strip and 1% shredded facemask content), C value increased from 4.32 to 4.42 KN/m2, and the ϕ value decreased from 12.01° to 12.13°. Overall, shear strength increases.

Result: C = 4.42 KN/m_2

Φ = 12.13°◦

4.10- Result of test conducted on soil augmented with polypropylene by mixing 1.5% shredded facemask by weight and shredded masks length 15 mm

4.10.1- Proctor compaction test-

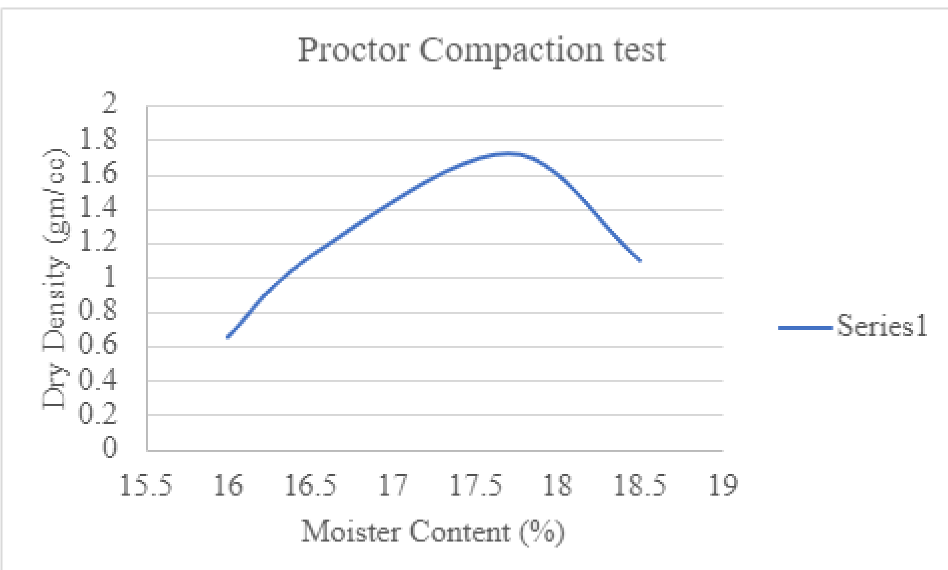

Fig-4.10.1- Proctor compaction test for strip width 15mm with fiber 1.5 %

This Proctor compaction test was conducted on a soil sample having 15mm size of fiber with 1.5% by weight of shredded facemask. In comparison to the last previous Proctor compaction test, value of dry density increased, but in the previous Proctor compaction test, dry density decreased continuously on the increased percentage of a shredded facemask by weight, so it indicates adding 1.5% of shredded facemask is good for required soil sample. In the previous sample, augmented soil MDD was 1.52gm/cc, but after1.5% adding a facemask, the MDD value increased up to 1.72gm/cc. Here dry density is comparatively high for both cases, 0.5% and 1% shredded mask.

Result: 1) Optimum Moisture Content = 17.70%

2) Dry Density = 1.72 gm/cc

4.10.2- California bearing ratio (CBR) Test-

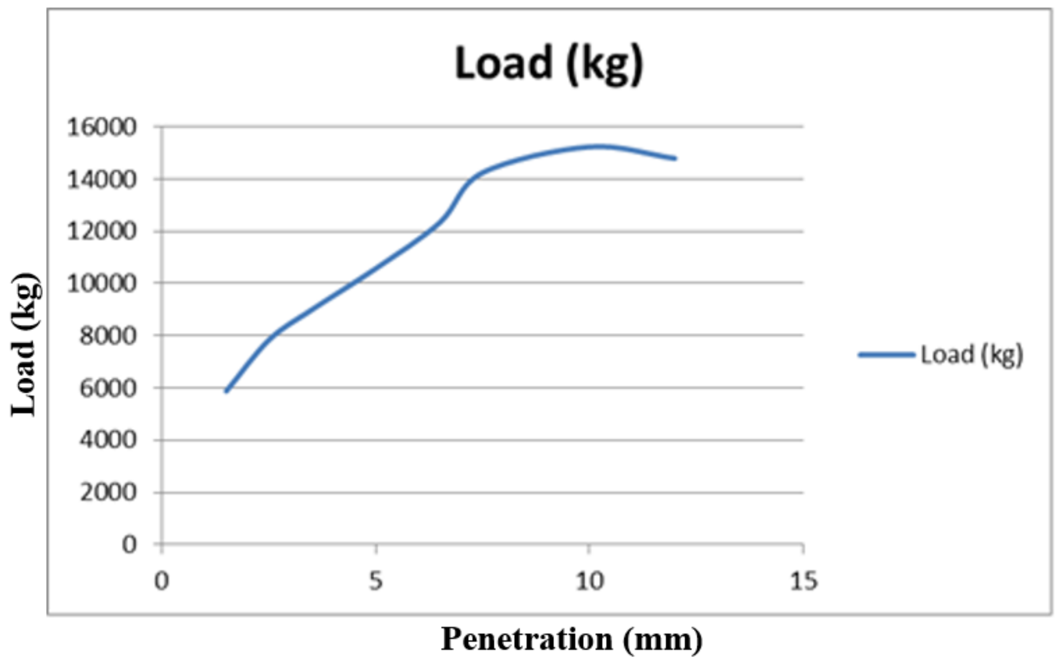

Fig-4.10.2- California bearing ratio test for strip width 15mm with content 1.5 %

This test was conducted soil sample having 15mm size with 1.5% by weight of shredded facemask. In comparison to the CBR test, the CBR value increases. The previous value of $(CBR)_{2.5}$ and $(CBR)_{5}$ were 5.06 and 4.92, respectively; now, values have increased to 5.72 and 5.24. Overall CBR value increased by mixing 1.5% of a shredded facemask by weight. Hence bearing capacity of augmented soil increase. So, obtained data conclude that if the varying percentage of shredded facemasks, maximum bearing capacity of augmented soil is obtained at 1.5% of facemasks.

Results:

$CBR)_{2.5} = PP_{2.5}/1370$ $(CBR)_5 = PP_5/2055$

$=7837/1370$ $= 10573.56/2055$

$=5.72$ $= 5.24$

4.10.3- Direct shear test-

This direct shear test was conducted on a soil sample having 15mm size of fiber with 1.5% by weight of shredded facemask. In comparison to the previous direct shear test value of C decreased from 4.42 to 4.30 KN/m2, and the ϕ value decreased from 12.13° to 11.58°; hence the value of C decreased, and the value of ϕ decreased then the overall value of shear strength decrease. Hence at 1% shredded facemask, the maximum value of shear strength is obtained. On considering the size of the strip, comparing data of previous direct shear test having 10mm strip to size with 1.5 % facemasks content, C value was 4.20 KN/m2 and now 4.30 KN/m2. So, the value of C increases with the increasing size of the strip but ϕ decrease.

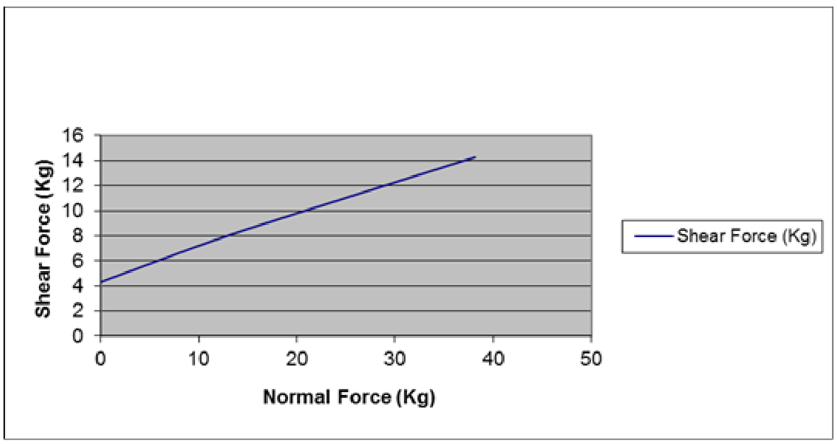

Fig-4.10.3- Direct Shear test for strip width 15mm with content 1.5 %

Result: $C = 4.30\ KN/m^2$ $\Phi = 11.58^o$

Summary of test result's

Sample		Procter compaction test		CBR Test		Direct shear test	
Parameter		MDD(gm/cc)	OMC(%)	CBR2.5	CBR5	C(kN/m2)	Φ(°)
Soil(without facemask)		1.70	18.50	3.12	3.13	3.10	14.98
Soil with shredded mask of size 5mm	0.5%	1.68	18.60	4.24	4.58	3.70	13.10
	1%	1.652	18.65	5.645	5.235	4.28	12.10
	1.5%	1.69	18.48	5	5.554	4.01	11.50
Soil with shred ded mask of size 1mm	0.5%	1.69	18.20	4.2	4.751	3.80	13.22
	1%	1.67	18.30	5.40	5.30	4.32	12.01
	1.5%	1.70	18.10	5.10	5.21	4.20	11.46
Soil with shred ded mask of size 15mm	0.5%	1.70	17.80	3.82	3.85	3.90	13.34
	1%	1.52	17.90	5.06	4.92	4.42	12.13
	1.5%	1.72	17.70	5.72	5.24	4.30	11.58

A test study presented in this thesis evaluated the effectiveness of one-time use facemask at different percentages of different sizes in enhancing some engineering properties of clayey soil. Based on the results of the test, the following conclusions were drawn.

1. Initially, maximum dry density (MDD) decreases on increasing weight percentage of shredded facemask in soil and reaches a minimum at 1%. After that, further adding shredded masks, dry density increase. Consider the size of the facemask strip, and then maximum dry density (MDD) increases on the increase in the size of the strip continuously so that the maximum value meets at eighter soil without a facemask, and for shredded facemask augmented soil sample has 15mm size strip with the content of shredded facemask content 1.5% is1.72 and minimum value found at soil sample augmented with 5mm strip size shredded facemask having content 1% by weight is 1.652

2. Optimum moisture content (OMC) initially increases on the increase in the percentage of shredded facemask in the augmented soil and reaches a maximum value at 1% of shredded facemask after that, further adding shredded masks it decreases. If varies size, the size of strip

increased Optimum moisture content (OMC) decreases continuously, so consider both variations simultaneously, then maximum and minimum values are 18.65% & 17.70%.

3. $(CBR)_{2.5}$ and $(CBR)_5$ values initially increase on the increase in weight percentage of shredded facemask in soil and reach a maximum value at 1% after that, further adding shredded masks it decreases. If we consider only the size of the strip, then these values decrease continuously with the increased size of the facemask strip. So, the maximum values of CBR)2.5 and (CBR)5 obtained at 1% of shredded facemask of 5 mm strip size are 5.645 and 5.234. Minimum values CBR)2.5 and (CBR)5 are 3.82 & 3.85.

4. In comparison to ordinary soil (without a shredded facemask), the shear strength parameter(C) increases after adding a shredded facemask. In the case of shredded facemask, soil shear strength parameter(C) increases on adding shredded facemask and reaches a maximum value at 1% shredded facemask by weight. Based on the size of the shredded facemask, soil shear parameter(C) increases on the increasing the size of the facemask strip and maximum value meets at 15 mm. So, consider both factors simultaneously the size of a shredded facemask and the percentage of a shredded facemask by weight the maximum shear parameter found at a 15 mm size strip mixed with soil in 1% by weight is 4.42 KN/m2.

5. Angle of internal friction (Φ) of augmented decrease with increase in the amount of shredded facemask in percentage by weight in the soil and based on the size of the facemasks strip, strip size increase, the angle of internal friction (Φ) increases so that the optimum value of angle of internal friction (Φ) found at 15 mm strip size having content of 0.5% is 13.34.

CHAPTER –5

CONCLUSION

CHAPTER –5
Conclusion

The purpose of this study is short out the weakness and demerits of landfill liners, such as landfill liquid waste and rainwater falling on the landfill then passing through landfill waste and goes to the underground water reservoir through the bottom landfill liner due to this soil and underground water contaminant by harmful chemicals of landfill wastes, so protect or safety purpose of underground water, this study tries to make better quality of bottom landfill liner to reducing permeability by using shredded surgical facemasks. The second purpose is to make landfill top cover stronger so landfills can be used as public parks and residential area.

This study concludes that the adding of the shredded facemask to soil, increases the dry density, bearing capacity, and shear strength of augmented soil, thereby improving the required properties of soil.

1. The dry density of augmented soil decreases initially on adding shredded facemasks with soil, and reaches a minimum value after that on further adding shredded mask, dry density increase. Hence, adding shredded facemasks with an increasing percentage meet a maximum value of dry density, and on the increasing size of facemask strip mixed with soil, the dry density of augmented soil continuously increases, permeability decreases so that landfill liner act as a good barrier for the waste liquid of landfill, and rainfall water.
2. To analyse the bearing capacity of augmented soil, a CBR test was conducted. As the CBR value increase, then the bearing capacity of the soil increase, and as the CBR value decrease, the bearing capacity decrease. So, on adding shredded facemasks in soil, CBR value initially increases and reaches a maximum value, and on further adding shredded facemasks, CBR value decreases. So, add shredded facemask up to CBR reach maximum. Based on the size of the facemask strip, strip size increases, the CBR value decrease. So, select the sample of best combination of strip size and percentage to maximize bearing capacity.
3. Shear strength changes of augmented soil analysed by conducting a direct shear test of augmented soil. In comparison to ordinary soil (without a shredded facemask) shear strength parameter(C) increases after adding a shredded facemask in the and reaches

maximum value after that on further adding of a shredded facemask with soil, the value of C decrease, and angle of internal friction (Φ) also has positive value so that overall shear strength value of augmented soil is increase. Based on the size of the shredded facemask strip if the size of the strip increases shear parameter(C) also increases. Hence, shredded facemasks are also helpful in improving landfill liner shear strength.

4. The study concludes that facemask is one of the major components of biomedical and is mostly found littered. Hence require proper disposal.
5. This project report has presented the uses of the facemask in the preparation of landfill liners.
6. The augmented soil sample fared well.

The outputs of tests indicate that silty soil mixed with three varying percentages of SFM with three sizes, satisfied the stiffness, Permeability, and strength essential for landfill liner.

5.1- Future scope

The future scope of this project is being suggested as follows:

- Further work can be enhanced by using different alignments of facemasks in soil sample, such as masks placed horizontally, vertically, and inclined, and analysis of different results.

- The extraction of fibers from facemasks should be studied.

- The cost-effectiveness of using facemask as a reinforcing material instead of virgin polypropylene fiber should be studied.

- How to convert a used mask into a hygienically safe mask so in future use, used masks in making landfill liner.

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ANNEXURES

ANNEXURES

1. Proctor compaction test of soil having no content of shredded facemasks

Sl. No.	Weight of mould + wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	5125	17.33	0.939	0.943
2	5726	18	1.54	1.371
3	6196	18.50	2.01	1.70
4	5632	19.89	1.45	0.90

2. California bearing ratio (CBR) test of soil having no content of shredded facemasks

SL. No	Penetration in mm	Proving ring reading	Load (kg)	Standard load	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	737	3142		
5	2	872	3714		
6	2.5	1002	4270	1370	3.12
7	3	1207	5142		
8	4	1475	6285		
9	5	1505	6412	2055	3.13
10	7.5	1978	8428		
11	10	2112	9000		
12	12.5	2380	10142		

3. Proving ring reading for direct shear test of having no content of shredded facemask.

Sl. No.	Horizontal displacement in mm	Normal load of 10 kg		Normal load of 20 kg		Normal load of 30 kg	
		division	Load	division	load	division	load
1	0.5	5	1.37	10	1.89	25	3.45
2	1	13	2.37	19	2.34	44	4.67
3	1.5	17	2.89	22	2.67	53	5.22

4	2	22	3.67	27	3.11	62	6.34
5	2.5	29	4.01	34	3.56	68	6.99
6	3	36	4.66	38	3.79	74	7.21
7	3.5	38	5	44	4.36	80	7.88
8	4	44	5.6	50	4.99	86	8.45
9	4.5	47	6.25	56	5.45	95	8.90
10	5	46	5.23	61	5.98	103	9.21
11	5.5			65	6.22	111	9.88
12	6			70	6.87	118	10.34
13	6.5			74	7.44	125	10.78
14	7			78	8.21	133	11.22
15	7.5			81	8.67	137	11.67
16	8			78	9.25	133	12

4. Direct shear test of having no content of shredded facemask.

Sl. No.	Normal load in kg	Shear load in kg
1	10	6.25
2	20	9.00
3	30	12.00

5. Proctor compaction test for fiber length 5mm with fiber content 0.5%

Sl. No.	Weight of mould +wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	5105	17.31	0.959	0.929
2	5708	18.10	1.52	1.426
3	6178	18.60	1.96	1.68
4	5614	19.88	1.43	0.875

6. California bearing ratio test of soil for fiber length 5mm with fiber content 0.5%.

SL. No.	Penetration in mm	Proving ring reading	Load (kg)	Standard load	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	1017	4333		

5	2	1134	4833		
6	2.5	1363	5808	1370	4.24
7	3	1486	6333		
8	4	2209	9413		
9	5	2856	12166	2055	4.58
1	5.5	3090	13166		
11	6.5	2906	12383		

7. Direct Shear Test of soil for fiber length 5mm with fiber content 0.5%.

Sl. No.	Normal load in kg	Shear load in kg
1	10	6.533
2	20	9.143
3	30	12.154

8.California bearing ratio test for masks strip width 5mm with fiber content 1.0%

SL. No.	Penetration in mm	Proving ring reading	Load (kg)	Standard load	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	1237	5272		
5	2	1451	6181		
6	2.5	1674	7132	1370	5.645
7	3	2048	8727		
8	4	2475	10545		
9	5	2525	10757	2055	5.235
10	7.5	3073	13090		
11	10	3286	14000		

9.Direct Shear Test for masks strip width 5mm with fiber content 1.0 %

Sl. No.	Normal load in kg	Shear load in kg
1	10	7.40
2	20	10.733
3	30	14.00

10.Proctor compaction test for strip width 5mm with content 1.5%

Sl. No.	Weight of mould +wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	5125	17.21	0.929	0.717
2	5726	17.98	1.53	1.30
3	6196	18.48	2.00	1.69
4	5632	19.94	1.23	0.798

11.California bearing ratio test for strip width 5mm with fiber content 1.5%.

SL. No.	Penetration in mm	Proving ring reading	Load (kg)	Standard load	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	1251	5393		
5	2	1486	6333		
6	2.5	1600	6850	1370	5.000
7	3	2034	8666		
8	4	2425	10363		
10	5	2679	11413	2055	5.554
11	7.5	3364	14323		
12	10	3600	15349		

12.Direct Shear Test for Fiber Size 5 mm with fiber content 1.5%.

Sl. No.	Normal load in kg	Shear load in kg
1	10	7.58
2	20	10.616
3	30	13.463

13.Proctor compaction test for strip width 10 mm with content 0.5%.

Sl. No	Weight of mould +wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	6188	16.65	0.839	0.617
2	6728	17.5	1.54	1.371

3	8200	18.20	2.00	1.69
4	7635	19.16	1.25	0.90

14.California bearing ratio test for fiber length 10 mm with fiber content 0.5%.

SL. No	Penetration in mm	Proving ring reading	Load (kg)	Standard load	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	686	2923		
5	2	1047	4461		
6	2.5	1350	5754	1370	4.2
7	3	1444	6153		
8	4	1796	7692		
9	5	2291	9763	2055	4.751
10	7.5	2925	12461		
11	10	3286	14000		
12	12.3	2961	12615		

15.Direct Shear Test of soil for strip width 10 mm with content 0.5%.

Sl. No.	Normal load in kg	Shear load in kg
1	10	7.165
2	20	9.97
3	30	12.582

16.Proctor compaction test of soil for strip width 10mm with fiber content 1.0%

Sl. No	Weight of mould +wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	6239	17.40	0.931	0.79
2	6422	18	1.53	1.31
3	6487	18.3	2.002	1.67
4	7341	19	1.456	1.27

17.California bearing ratio test for strip width 10mm with fiber content 1.0%.

SL. No	Penetration in mm	Proving ring reading	Load (kg)	Standard load (kg)	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	1103	4700		
5	2	1408	6000		
6	2.5	1815	7733	1370	5.645
7	3	1920	7860		
8	4	2018	8600		
9	4.5	2525	10757		
10	5	3169	13500	2055	5.235
11	5.5	3523	15010		
12	6.5	3039	12950		

18.Direct Shear Test for Fiber Size 10 mm with fiber content 1.0%.

Sl. No.	Normal load in kg	Shear load in kg
1	10	7.82
2	20	10.91
3	30	13.638

19.Proctor compaction test of soil for strip width 10mm with content 1.5%.

Sl. No	Weight of mould +wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	5125	17.40	0.939	0.79
2	5726	17.9	1.54	1.40
3	6196	18.1	2.01	1.77
4	5632	19	1.45	1.20

20.California bearing ratio test for strip width 10mm with content 1.5%.

SL. No	Penetration in mm	Proving ring reading	Load (kg)	Standard load (kg)	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	1323	5636		
5	2	1461	6227		
6	2.5	1607	6850	1370	5.00
7	3	1808	7704		
8	4	1984	8454		
9	4.5	2679	11413		
10	5	3092	13175	2055	5.55
11	5.5	3677	15660		
12	6.5	3446	14681		

21.Direct Shear Test of soil for strip width 10mm with content 1.5%.

Sl. No.	Normal load in kg	Shear load in kg
1	10	7.68
2	20	10.799
3	30	13.46

22.Proctor compaction test of soil for strip width 15mm with content 0.5%.

Sl. No	Weight of mould +wet soil in gm	Moisture content (%)	Wet density in gm/cc	Dry density in gm/cc
1	7125	17.33	0.939	0.926
2	7726	18	1.54	1.363
3	8196	18.5	2.01	1.70
4	7632	19	1.45	1.482

23.California bearing ratio test of soil for strip width 15mm with content 0.5%.

SL. No.	Penetration in mm	Proving ring reading	Load (kg)	Standard load (kg)	CBR value
1	0.00	0	0.00		
2	0.5	0	0.00		
3	1	0	0.00		
4	1.5	938	4000		
5	2	1088	4636		
6	2.5	1228	5233	1370	3.82
7	3	1280	5454		
8	4	1541	6545		
9	5	1881	8014	2055	3.90
10	7.5	2432	10363		
11	10	3491	14872		
12	12.5	2646	11272		

24.Direct Shear test of soil for fiber strip width 15mm with content 0.5%.

Sl. No.	Normal load in kg	Shear load in kg
1	10	7.33
2	20	10.667
3	30	13.107

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