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Improvement of Geotechnical parameters fine soils using Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE) and Geo-textile admixtures

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Abstract:- *Due to rapid increase in plastic waste from bottles, polythene bags and packing strips the waste disposal is becoming a problem. Attempts been made to utilize this waste plastic as a geotechnical material to solve both the geotechnical as well as environmental problem. Soil reinforcement is used for a wide range of ground improvement schemes in geotechnical engineering applications that include backfill for earth retaining structures, failed slopes, landfill liners and covers, stabilization of soil and sub-grades for footings and pavements. The aim of the research is to study the effect of the additives (Low density polyethylene (LDPE), High density polyethylene (HDPE) and Polypropylene) on the stability and the increase of bearing capacity of selected soil. The physical, chemical and designing properties of soil was contemplated and the soil was treated with added admixtures of LDPE, HDPE and polypropylene with the goal of stabilizing the local soil. The stabilization or modification of soil is done by blending of additives with the soil at the rate of 5%, 10%, 15%, and 20% individually. The tests conducted to evaluate soil behavior are Atterberg limits (liquid limit, Plasticity index, Plastic limit), Moisture content, specific gravity, sieve analysis and Direct shear test. The results demonstrated that the gradation of soil is fine grained from the particle size analysis. Plasticity index (P.I), Liquid limit (L.L) and plastic limit (P.L) were shown reduction with the addition of admixtures. It was discovered that the Cohesion C diminished, the angle of internal friction was improved with the addition of admixtures. It was concluded that the parameters are increasing with the addition of these admixtures up to some limit and then shows reduction in their content. The investigation demonstrated that the best stabilizer for the contextual investigation is Low density polyethylene (LDPE), High density polyethylene (HDPE) and Geo-textile (Polypropylene).*

Keywords: *stabilization, Modification, LDPE, HDPE and Geo-textile*

1 Introduction:

Waste plastics impart huge environmental problems. Apparently they are not serious harmful materials in respect of public health but they require huge amount of space in landfills and consume high amount of energy for its production. Scavenge plastic also poses clogging of drainage conduits and as such often observed rainwater detention and waste logging cities and towns. All the plastics are not recyclable due to their thickness of material. A common problem with recycling plastics is that they are often made up of more than one kind of polymer (heterogeneous character) or some sort of fibers added to the plastics (a composite) to give added strength. The above characteristics are helpful for using the waste materials in soil of poor strength to improve geotechnical properties of soil.

The principle of soil reinforcement first developed by Henri Vidal in1966 involves introducing tensile resisting materials into the soil to enhance its strength properties so as improve soil stability, increase bearing capacity and reduce lateral deformation. Various investigators used different synthetic fibers like nylon, glass, asbestos, metallic fiber etc. and natural fibers like coir, sisal, bamboo etc. as reinforcement in soil. Experimental work done by various investigators from last many years has established beyond doubt that addition of fiber in soil improves the overall engineering performance of soil. The notable improvement properties that found are shear strength, ductility, toughness, isotropy etc.

Waste material are currently being recognized as a potential source of soil reinforcement. For instance, the use of old tyres to increase the bearing capacity and shearing strength of a soil has been studied (Hataf and Rahimi , 2006) recycling of plastic water bottles is very low. This project was therefore, undertaken to investigate whether such plastic bags and bottles were capable of increasing soil strength and consequently could be in corporate in projects such as those requiring strengthening of foundations and embankments. The study was not intended to prove this type of reinforcement to be better than established methods like geo-synthetic reinforcement. Those conventional methods, however, are expensive and inaccessible to the majority of developing countries. Plastic bags, in contrast, are cheap and abundant as a waste material. Finding a new application for them in the civil engineering works could cut down the waste that goes into landfill sites.

2 Materials used for the study:

2.1 Soil:

The soil sample in this study were collected from Peshawar region of KPK

Table 1: Geotechnical Properties of soil sample:

Soil Properties	Values
Moisture content (%)	6.70
Liquid Limit (%)	25.96
Plastic Limit (%)	24.30
Plasticity Index (%)	1.70
Specific Gravity	2.60
Maximum Dry Density (kN/m^3)	2.272
Optimum Moisture Content (%)	8.9
USCS Classification	CL-ML

2.2 Low Density Polyethylene(LDPE), High Density polyethylene(HDPE) and polypropylene :

The LDPE and HDPE were collected from local industrial area where the waste plastic bottle were crushed down into smaller size and polypropylene are available in local market in Pakistan which can used for different other purposes. Experiments were conducted on the samples Mixed with these admixtures at different percentages.

3 Results and Discussions:

Experiments were conducted on the samples mixed with different percentages of admixtures individually i.e 5%, 10%, 15% and 20% in order to determine the engineering properties of the modified soils. The samples parameters were determined according to ASTM standards.

3.1 Gradation Test:

Gradation curve of soil sample is shown in Figures 1 and 2. The soil sample is essentially a fine grained material and is classified as CL-ML according to unified soil classification system (USCS).

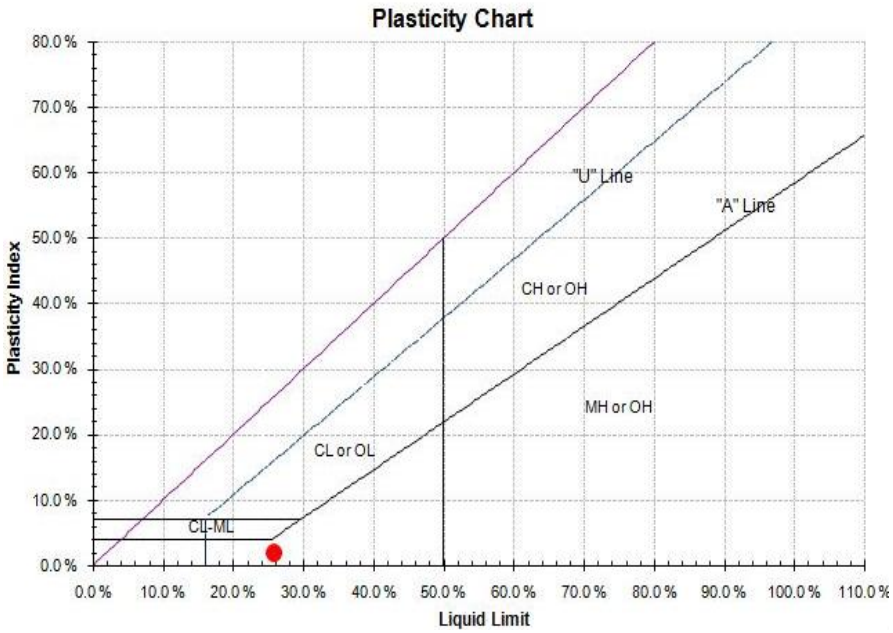

Figure 1: Liquid and Plastic limits

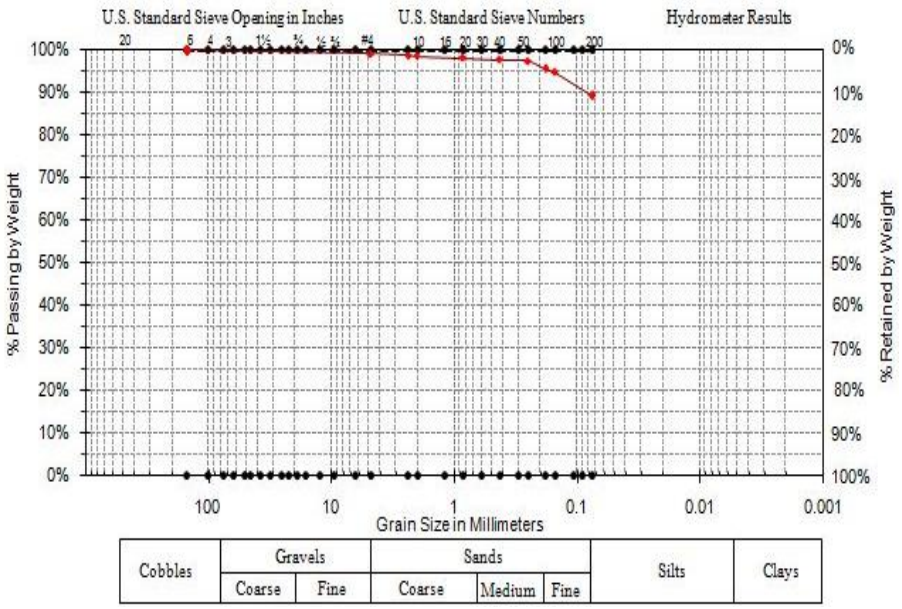

Figure 2: Grain size plot

3.2 Atterberg Limits Test:

Liquid limit, plastic limit and plasticity index of normal soil and with different percentage of admixtures are shown in below table

Table: 2 Liquid Limit, Plastic Limit and polypropylene values

Test performed	Normal soil	HDPE	LDPE	Polypropylene
Liquid limit (%)	25.9	24.8	24	25.5
Plastic limit (%)	20.0	14.1	14.5	18.8
Plasticity index (%)	1.7	10.8	9.5	6.7

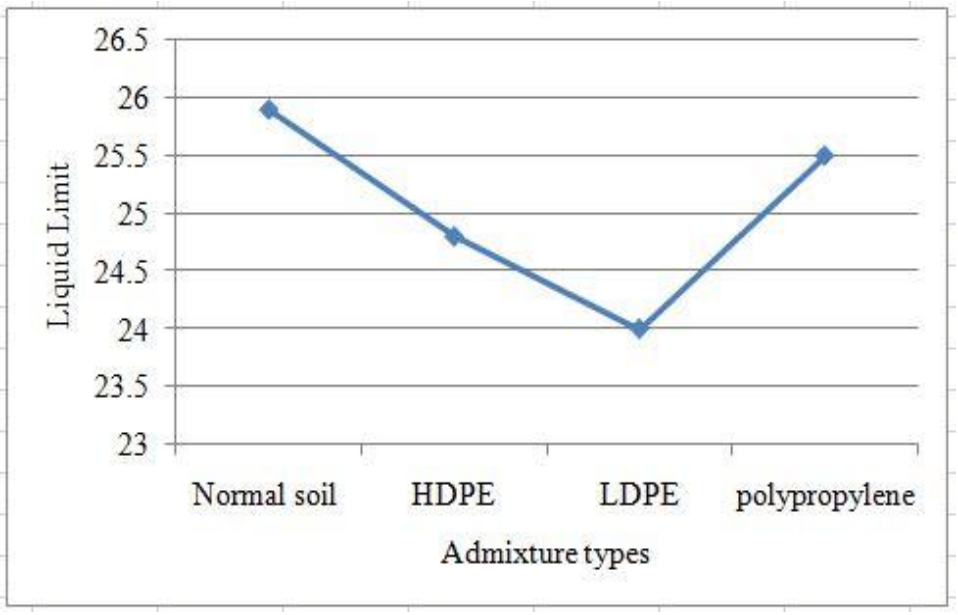

Figure: 3(a) Liquid limit vs admixtures

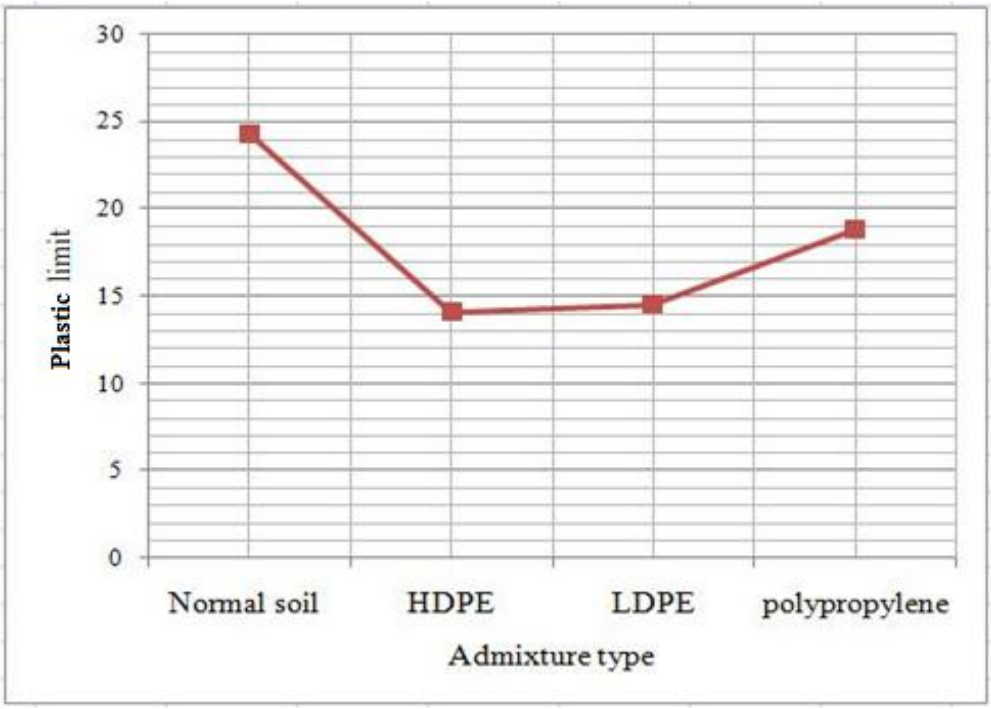

Figure 3(b): Plastic limit vs admixtures

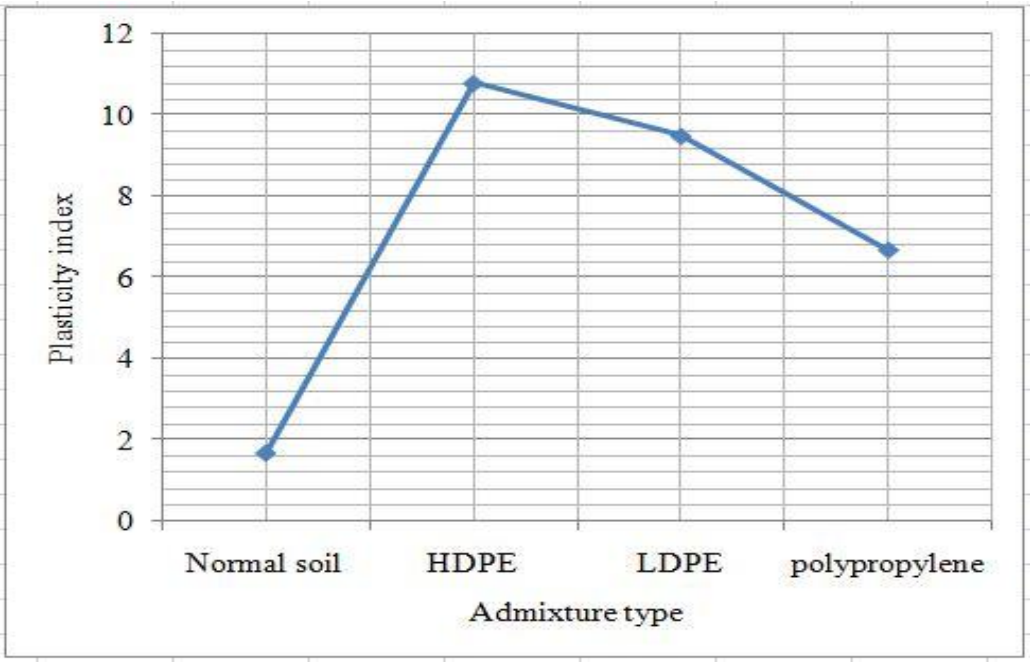

Figure 3(c): Plasticity index vs admixtures

The Percentage of variation of liquid limit, plastic Limit and Plasticity index to the admixture is shown in figures. It is observed that as the percentage of admixture increases, the liquid limit, plastic limit and plasticity index goes on decreasing.

3.3 Direct Shear Test:

Direct shear test was first conducted for genuine soil without admixture having values of C=0.02 and ϕ=20 degree. Now we have to find out it for admixtures to compare with it.

High density polyethylene (HDPE), Cohesion and angle of internal friction values with different percentages

Table 3: C and Pi values with percentages

Percentage of admixture	C(Cohesion)	Phi(Angle of internal friction)
5%	0	24.3
10%	0.05	25.3
15%	0	27
20%	0	26.2

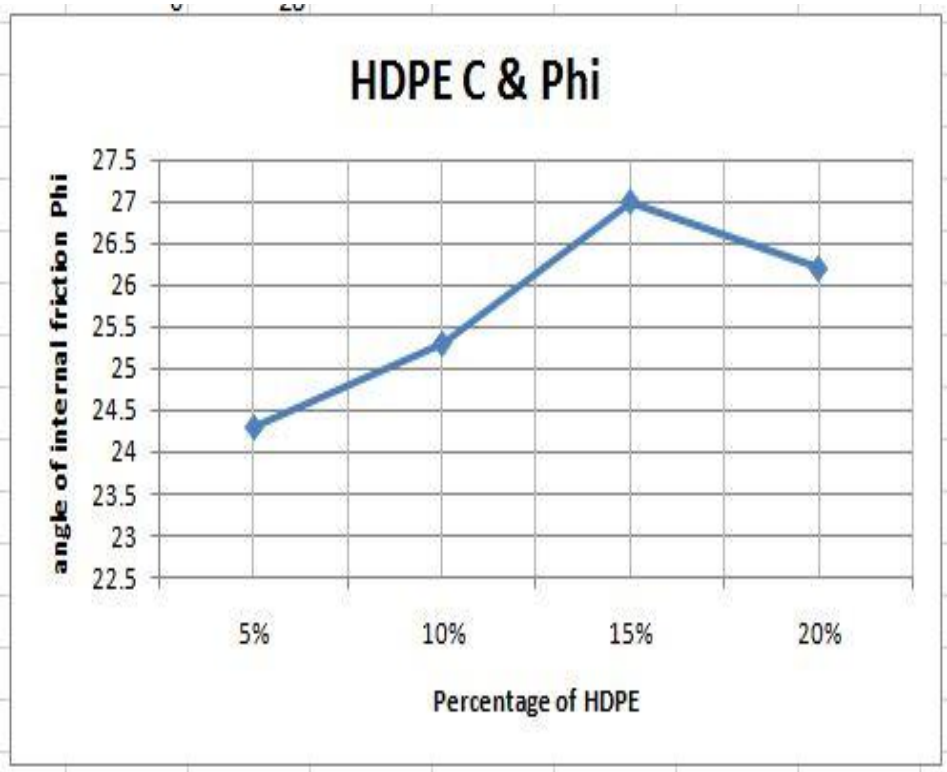

Figure 4: HDPE percent Vs Angle of internal friction

Low density polyethylene (LDPE), Cohesion and angle of internal friction values with different percentages

Table 4: C and Phi values with percentages of admixtures

Percentage of admixture	C(Cohesion)	Phi(Angle of internal friction)
5%	0.06	21
10%	0.15	24
15%	0	28.1
20%	0.04	25.1

Relation between low density polyethylene percentage as a compared to angle of internal friction are shown

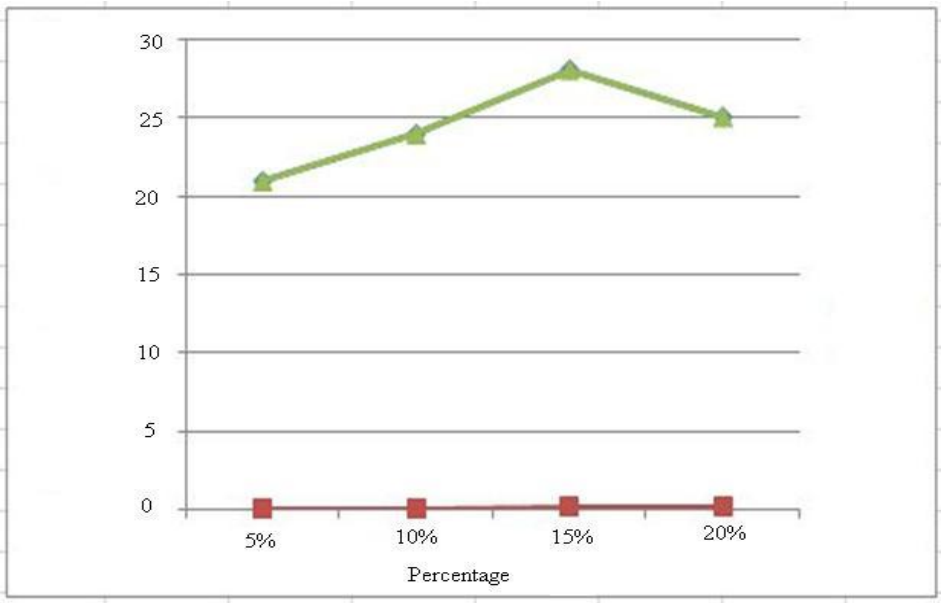

Figure 5: LDPE Vs angle of internal friction

Polypropylene, Cohesion(C) and angle of internal friction(Phi) values with different percentages

Table 5: C and Phi values with different of admixtures

Percentage of admixture	C(Cohesion)	Phi(Angle of internal friction)
1.5%	0.02	27.7
3%	0.01	27.9
4.5%	0	28.3
6%	0	28

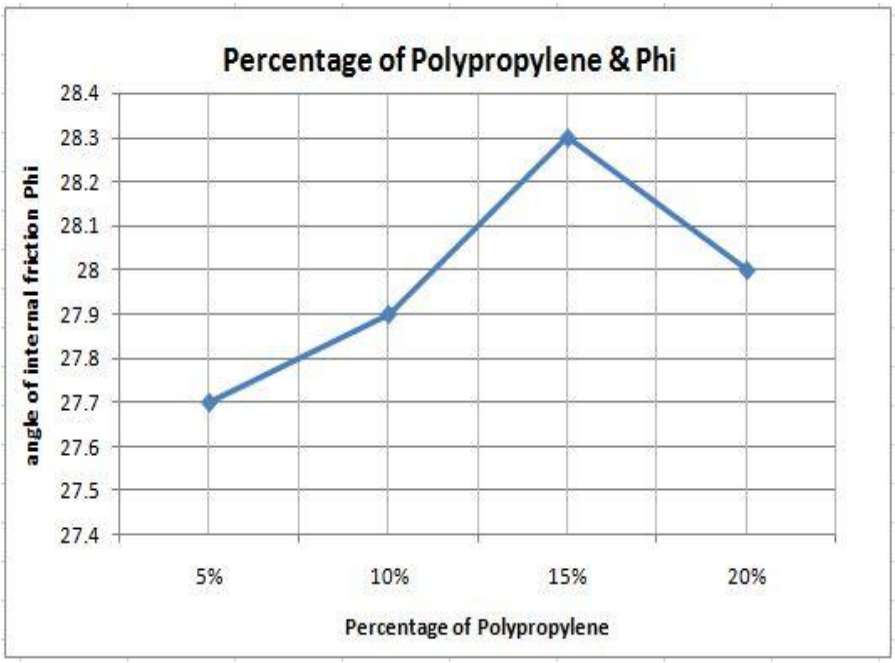

Figure 6: Angle of internal friction vs percentage of polypropylene

4 Conclusions:

- The Liquid Limit, Plastic Limit and Plasticity Index are on decreasing with addition of admixtures in different percentages.
- The Specific gravity are increasing by increasing the percentage of admixtures.
- From direct shear test, the angle of internal friction increases by increasing the percentage of admixtures while cohesion c decreases with the addition of percentage of admixtures but after 15% addition its values gradually decreasing.
- LDEP and HDPE a product from crusher unit of waste plastic material consists of mainly different size particles and is having good tensile strength. Thus, the waste material and geo-textile(polypropylene) itself can be considered as a good sub base material. Hence it can be used for construction of road embankment.
- Important point of this research is to reuse of the waste material is economically advantages and does not bring any environmental hazards.

5 References

Vidal, H., 1969. The principle of reinforced earth. Highway research record, (282).
Hataf, N. and Rahimi, M.M., 2006. Experimental investigation of bearing capacity of sand reinforced with randomly distributed tire shreds. Construction and Building Materials, 20(10), pp.910-916.
Sarsby, R.W., 2007. Use of 'Limited Life Geotextiles' (LLGs) for basal reinforcement of embankments built on soft clay. Geotextiles and Geomembranes, 25(4), pp.302-310.
Mandal, J.N. and Labhane, L., 1992. A procedure for the design and analysis of geosynthetic reinforced soil slopes. Geotechnical and geological engineering, 10(4), pp.291-319.
Floss, R. and Bräu, G., 2004. Design fundamentals for geosynthetic soil technique. Technische Universität München, Zentrum Geotechnik, Germany.
Hejazi, S.M., Sheikhzadeh, M., Abtahi, S.M. and Zadhoush, A., 2012. A simple review of soil reinforcement by using natural and synthetic fibers. Construction and building materials, 30, pp.100-116.

