PERFORMANCE AND EVALUATION STUDY ON PAVEMENT SUB GRADE THICKNESS BY USING PREPARED GEO-MATERIAL

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Abstract: In ground improvement methods, waste materials are also used to improve geotechnical properties of soil. Waste materials such as scrap tires, ETP sludge and fly ash offers a viable alternative from economical, technical and environmental stand points. Discarded tyres are becoming globally problematic because recycling them may cause environment related problems. Thus, making use of them needs to be considered, and solutions must be sustainable. Nowadays, the waste tyres are increasingly being considered as construction material. Crumb rubber is recycled rubber produced from automotive and truck scrap tires. During the recycling process, steel and tire cord (fluff) are removed, leaving tire rubber with a granular consistency This work investigated the utilization of crumb rubber as geo materials by mixing them with low-strength soil and stabilized by cement for road and embankment construction. Two standard test methods were conducted: (1) California Bearing Ratio test and (2) Unconfined Compressive Strength test.

Keywords:compaction,ucs.crumb rubber, cbr.

I.INTRODUCTION

Road aggregates have become rare and costly in many places in India due to massive construction activities required for the development of new infrastructure facilities The pavement industry looks for ways of improving lower quality materials that are readily available for use in roadway construction.Solid waste management is one of the major environmental concerns worldwide. India being one of the developing countries, there has been rapid annual increase in the number of vehicles leading to steady increase in the volume of consumption waste rubber tyres year by year it has been observed that the production of tyres and tube has been increased year wise.Discarded tyres are becoming globally problematic because recycling them may cause environment related problems. Nowadays, the waste tyres are increasingly being considered as construction material. This is because their basic properties are desirable for engineers the potential of using rubber from worn tyres in many civil engineering works has been studied for more than 30 years. Applications where tyres can be used have proven to be effective in protecting the environment and conserving natural resources.

The motives for such studies have been and still are:

• The high cost, the continuous reduction in supplies and the negative environmental Impact from the use of natural aggregates
• Legislation, which bans the disposal of wastes in landfills.
• Recycling in general, as is demanded by the requirement for sustainable development.

Crumb rubber is the name given to any material derived by reducing scrap tires or other rubber into uniform granules with the inherent reinforcing materials such as steel and fiber removed along with any other type of inert contaminants such as dust, glass, or rock. Crumb rubber is manufactured from two primary methods 1.Tire buffings, 2.Scrap tire rubber. 3.Tire buffings, a byproduct of tire retreading Scrap tire rubber comes from three types of tires 1.Passenger car tires 2.Truck tires 3.Off-the-road tires

II.LITERATURE REVIEW

Panu Promputthangkoon Geomaterial prepared from waste tyres, soil and cement this work investigated the utilisation of used tyres as geomaterials by mixing them with low-strength soil and stabilized by cement for road and embankment construction

Baykal et al, (1992) mixed clay and fly ash samples with used tyre obtained from retarding industry and hydraulic conductivity tests were conducted using water gasoline as permeates. The strength of soil tyre chip mixture decreases once the rubber content exceeds 30% in the mixture because soil tyre chip mixture behaves less like reinforced soil and more like a tyre chip mass with sand inclusion

Foose, (1996) Falling head permeability tests were conducted on rubber mixed soil samples and it was observed that when water permeated through samples, a slight increase in hydraulic conductivity was observed

Lee et al., (1999) also determined the shear strength and stress strain relationship of tyre chip and a mixture of sand and tyre chips. They found out the stiffness and strength properties for tyre sheds and rubber sand mixture

Rao and Dutta, (2001) conducted studies on sand mixed with rubber chips. Compressibility tests and triaxial tests were conducted. The stress strain relations and strength parameters were studied. It was found that the value of Jirasit suggested that concrete made with a cementitious material content of 300 kg/m3 and incorporating 50% fly ash as partial replacement for cement could resist a 3% H2SO4 solution. internal friction and effective cohesion of sand increased with increase in percentage of rubber up to 15%. The aim of this study was to investigate the possibility of the utilization of industrial waste crumb rubber to stabilize soils.

III.METHODOLOGY

Soil

The non-swelling clay bed used in this study was collected from Chitrada of the state of A.P, India, from a depth of 1.5m – 2.0m below the ground surface. The soil had a maximum dry unit weight 16.1kN/m^3 at optimum moisture content (OMC) of 21% as determined from the compaction test.

The disturbed soil samples collected from above location was air dried and pulverized thoroughly prior to laboratory testing. An initial screening is done and soil is made free from grass and weeds. Thus, prepared soils are bagged and used in laboratory for determination of properties and for installing GPs in large moulds.

Properties of soil are shown in Table 3.1 IS Code procedures were adopted to determine the properties of soil samples.

S. No	Property	Value
1	Differential Free Swell(%)	30
2	Specific Gravity	2.59
3	**Grain Size Distribution:** Sand(%) Silt(%) Clay(%)	 16 38 46
4	**Atterberg Limits** Liquid Limit(%) Plastic Limit(%) Plastic Index(%)	 52.5 26.12 26.40
5	IS Classification	CI
6	**Compaction Properties** Optimum Moisture Content, O.M.C(%) Maximum Dry Density, M.D.D(kN/m^3)	 21 16.1
7	**Triaxial Test results** Cohesion, C (kPa) Angle of Internal Friction(Ø)	 60 0^0

Table 3.1 Properties of Non-Swelling Soil

Crumb rubber Crumb rubber is recycled rubber produced from automotive and truck scrap tires. During there cycling process, steel and tire cord (fluff) are removed, leaving tire rubber with a granular consistency.

Fig.3.1

California bearing ratio test

The CBR test is a penetration test which gives a measure of the load spreading ability of the pavement. This is only justified in the case of flexible pavements. The CBR tests were performed as per IS : 2720 Part 16.To prepare the samples for CBR test, different mixes chosen were compacted statically in standard moulds at optimum moisture content and maximum dry density. The dimension of the soil sample for CBR test is taken as 150mm diameter and 125mm height. Surcharge weight of 25N was used during the testing. A metal penetration plunger of diameter 50 mm and 100 mm long was used to penetrate the samples at the rate of 1.25 mm/minute using computerized CBR testing machine. Soaked CBR tests were conducted after 96 hours soaking. For soaking samples were placed in a tank maintaining constant water level throughout the period. Soaked CBR tests, after a curing period of 7 days, are conducted in the laboratory as per IS specification.

Fig 3.2 Unconfined compressive strength test

The effect of the various additives on the strength of stabilized soil has little direct application to pavement design. Compressive strength test has been used to determine the relative response of materials to cement and lime stabilization and to give an overall picture of the quality of stabilized materials. It is generally assumed that the higher the compressive strength the better the quality of stabilized mixes. In this study the unconfined compressive strength tests were performed in accordance with test method IS 2720 Part10 (1991) to determine the effect of adding various additives, of different proportions and at various rates of application, to different soils. The unconfined compressive strength tests were conducted on the reference mixes obtained from standard compaction test. The sizes of the samples prepared were of aspect ratio 2 i.e., 38 mm diameter and 76 mm length and the strain rate of 0.60 mm/minute is used for testing. The samples were prepared by compacted sample with the help of a tamping rod in three layers at optimum moisture content and maximum dry density in the UCS mould of standard dimension.

Fig 3.3 Unconfined compressive strength on sample

The experimentation program of the present work was conducted in to steps.

Step 1:

- The first step finding the properties of the Virgin Soil.
- These properties include Differential Free Swell Index (DFSI), Atterberg Limits, Specific Gravity, Compaction and Tri-axial characteristics are find out.

Step 2:

In second step soil treatment is divided into **three phases**

Phase 1

In phase one the soil treated with different proportions of crumb rubber (2%, 5%, and 10%) conducted tests:

- Compaction test
- California bearing test
- Unconfined compressive strength test

Phase 2

In phase two the soil treated with different proportions of cement (2%, 5%, and 10%) conducted tests:

- Compaction test
- California bearing test

- Unconfined compressive strength test

Phase 3

In phase three soil treated with combination of cement and crumb rubber with equal proportion (2%,5% and10%) conducted tests:

- Compaction test
- California bearing test
- Unconfined compressive strength test

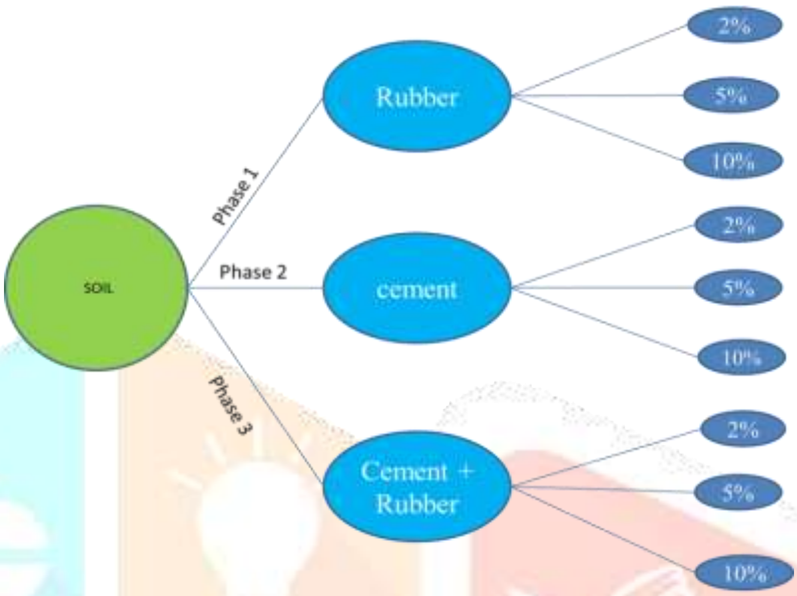


Fig 3.4

IV. RESULTS AND DISCUSSIONS

RESULTS OF THE LABORATORY TESTING COMPACTION CURVES FOR SOIL VS RUBBER (2%, 5%, AND 10%)

TYPE	OMC%	MDD(gm/cc)
Soil	22	1.611
Soil+2% Rubber	21.44	1.594
Soil+5% Rubber	23.27	1.688
Soil+10% Rubber	22.91	1.598

TABLE . 3.1

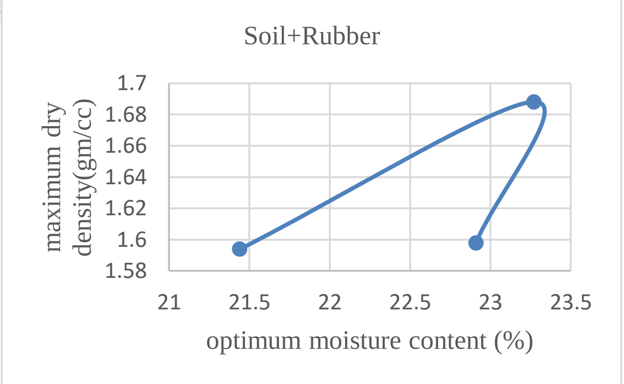


Fig. 3.5

COMPACTION CURVES FOR SOIL VS CEMENT (2%, 5%, AND 10%)

TYPE	OMC%	MDD(gm/cc)
Soil +2%cement	22.65	1.665
Soil+5%cement	22.85	1.689
Soil+10% cement	24.94	1.723

Table 3.2

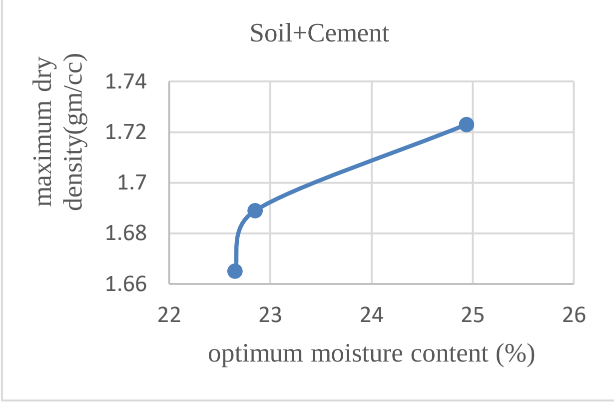


Fig: 3.6

COMPACTION CURVES FOR SOIL VS (CEMENT + CRUMB RUBBER) (2%, 5%, AND 10%)

TYPE	OMC%	MDD(gm/cc)
Soil+(2% cement) + (2%Crumb Rubber)	22.8	1.543
Soil+(5% (cement) + (5%Crumb Rubber)	22.97	1.551
Soil+(10% cement) + (10%Crumb Rubber)	23.04	1.691

Table 3.3

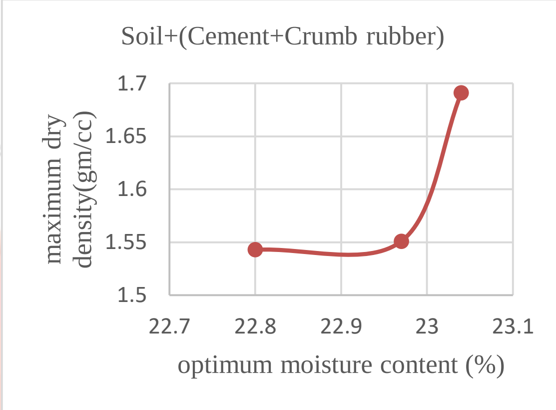


Fig. 3.7

CBR TEST RESULTS OF UNTREATED SOIL

TYPE	2.5MM	5MM	(%)
UNSOAKED	1.34	1.19	1.34
SOAKED	0.89	1.19	1.19

Table 3.4

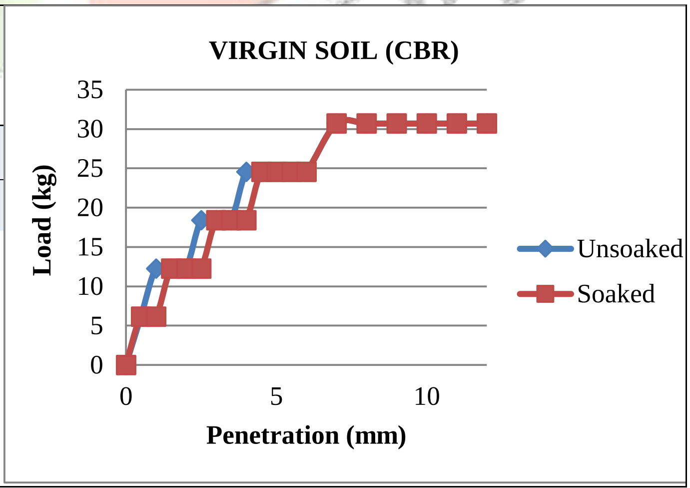


Fig 3.8

CBR TEST RESULTS OF SOIL TREATED WITH RUBBER (2%, 5%, and 10)

UNSOAKED				SOAKED			
TYPE	2.5MM	5.0 MM	PERCENTAGE (%)	TYPE	2.5M	5.0MM	PERCENTAGE (%)
Soil+2% Rubber	1.79	2.03	2.09	Soil+2% Rubber	1.34	2.09	2.03
Soil+5% Rubber	2.68	2.98	2.98	Soil+5% Rubber	1.34	1.49	1.49
Soil+10% Rubber	2.24	2.09	2.24	Soil+10% Rubber	1.34	1.195	1.34

Table 3.5

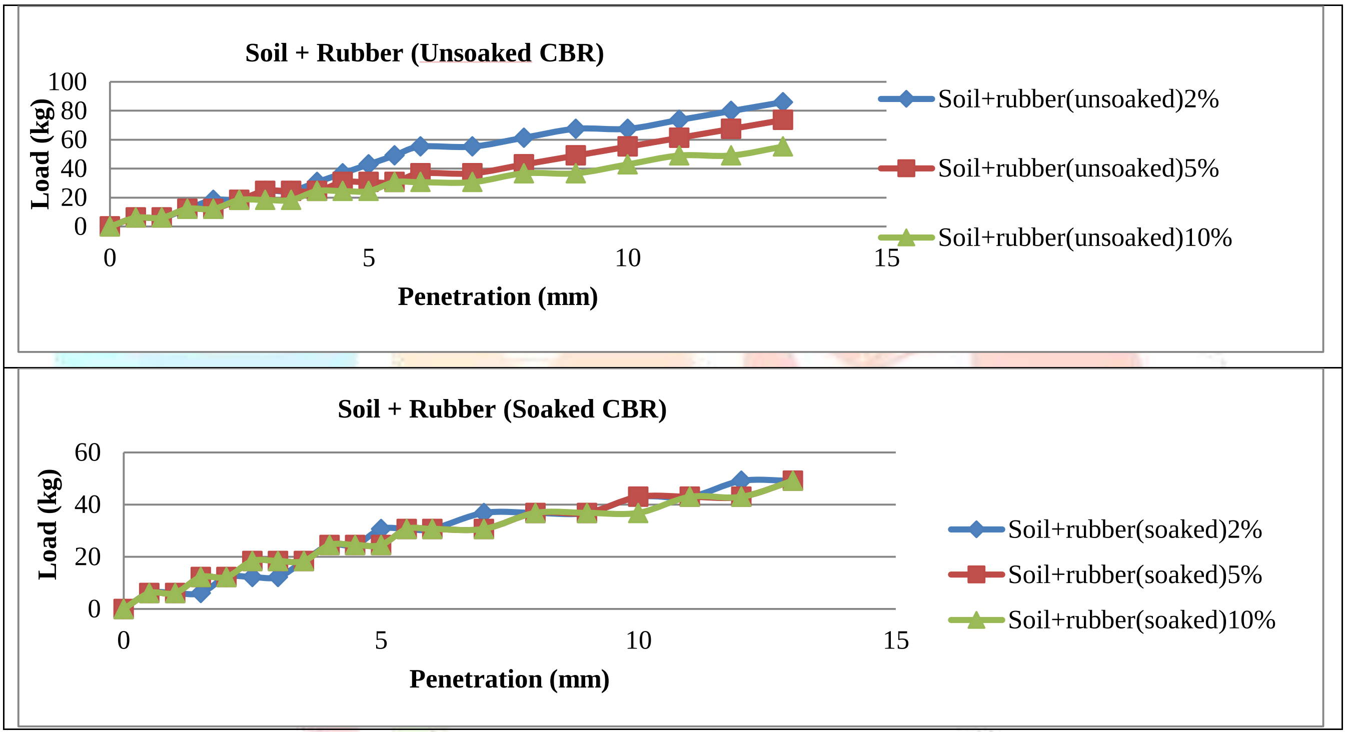
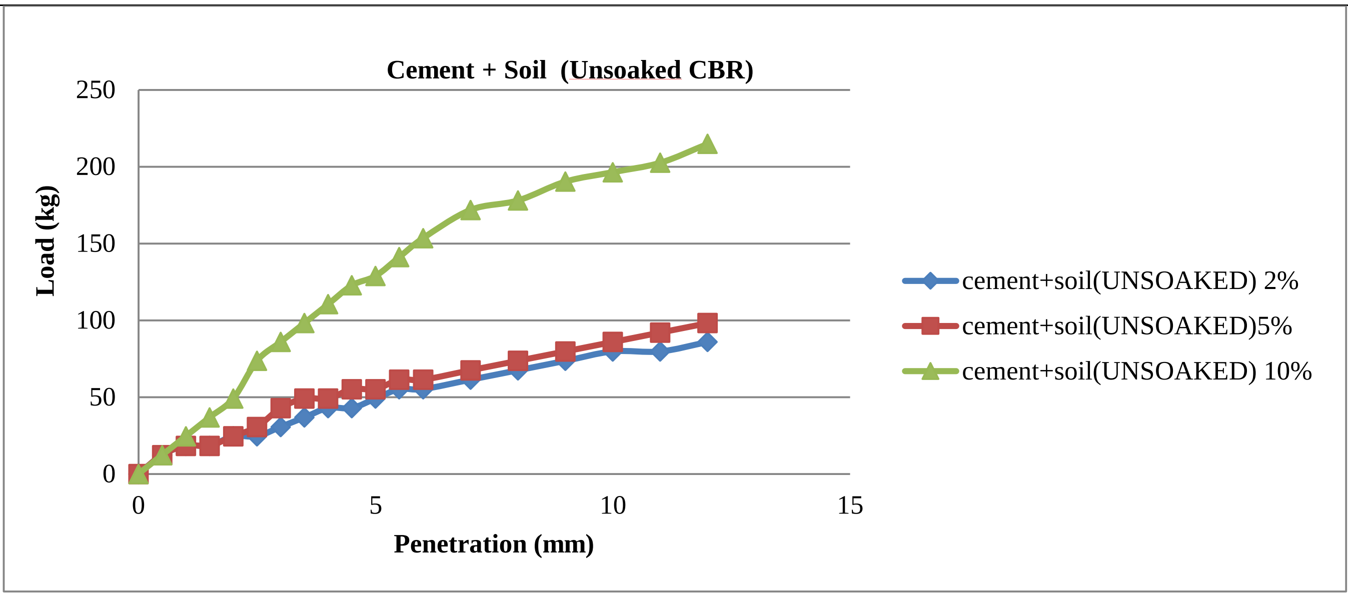


Fig 3.9

CBR TEST RESULTS OF SOIL TREATED WITH CEMENT (2%, 5%, and 10)

UNSOAKED				SOAKED			
TYPE	2.5MM	5.0 MM	PERCENTAGE (%)	TYPE	2.5MM	5.0 MM	PERCENTAGE (%)
Soil+2% Cement	1.79	2.39	2.39	Soil+2% Cement	4.03	5.37	5.37
Soil+5% Cement	2.24	2.68	2.68	Soil+5% Cement	7.17	6.27	7.17
Soil+10% Cement	5.37	6.27	6.27	Soil+10% Cement	12.99	11.35	12.99



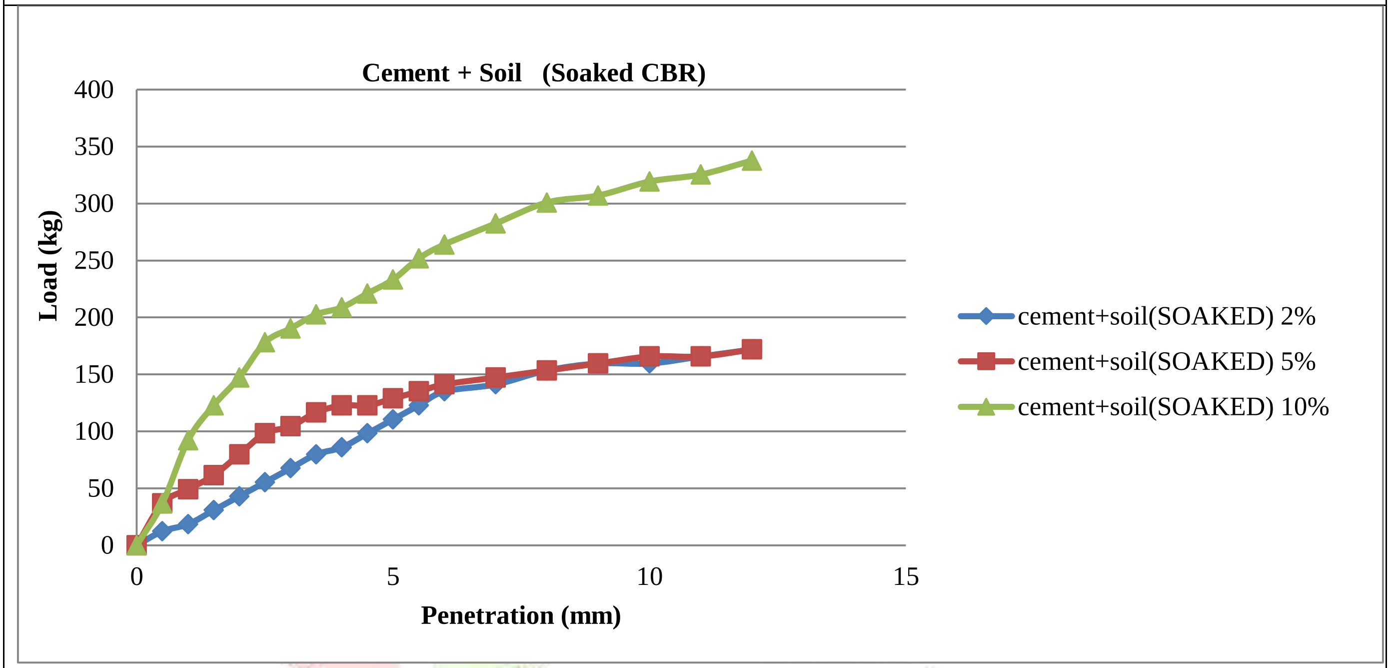
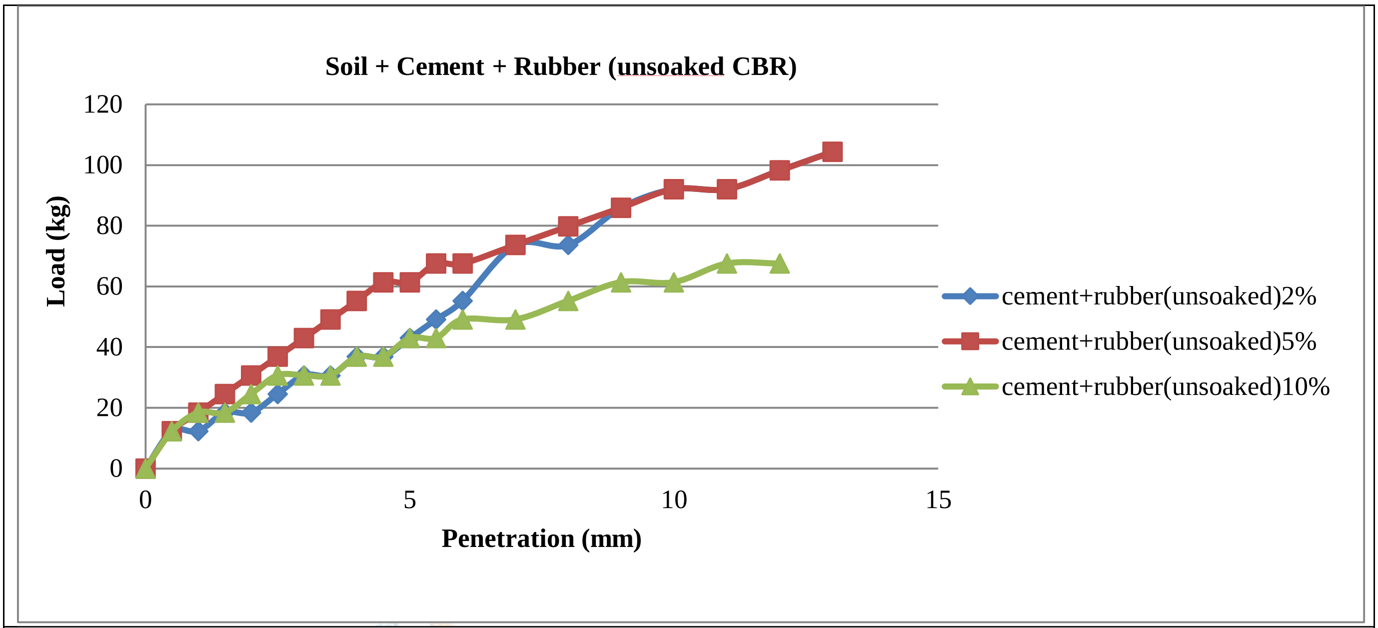


Fig.3.10

CBR TEST RESULTS OF SOIL TREATED WITH (CEMENT+CRUMB RUBBER) (2%, 5%, and 10)

UNSOAKED				SOAKED			
TYPE	2.5MM	5.0 MM	PERCENTAGE (%)	TYPE	2.5MM	5.0 MM	PERCENTAGE (%)
Soil+2% CEMENT+CRUMB RUBBER	1.79	2.09	2.09	**Soil+2% CEMENT+CRUMB RUBBER**	6.27	5.97	6.27
Soil+5% **CEMENT+CRUMB RUBBER**	2.68	2.98	2.98	Soil+5% **CEMENT+CRUMB RUBBER**	7.17	7.17	7.17
Soil+10% **CEMENT+CRUMB RUBBER**	2.24	2.09	2.24	Soil+10% **CEMENT+CRUMB RUBBER**	**5.82**	**5.97**	**5.97**

Table 3.7



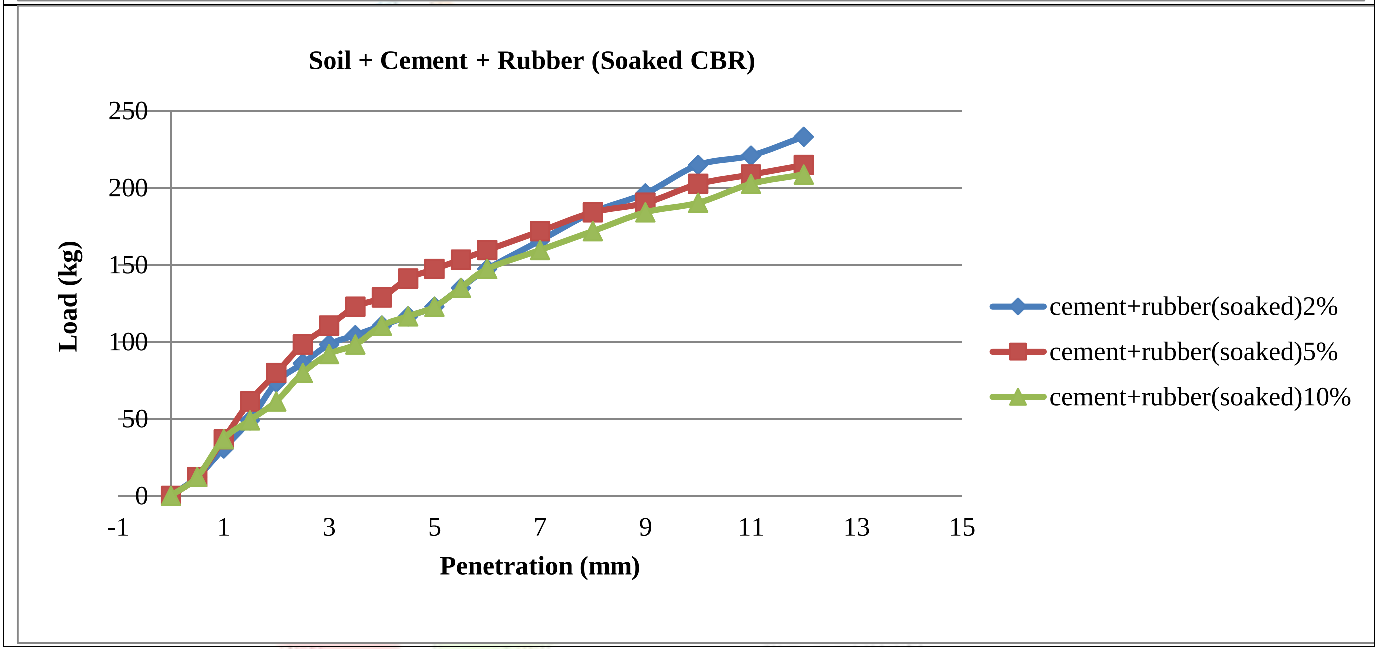


Fig. 3.11

Unconfined Compressive Strength RESULTS OF UNTREATED SOIL

Type	Unconfined Compressive Strength (kpa)
Virgin soil	99.49

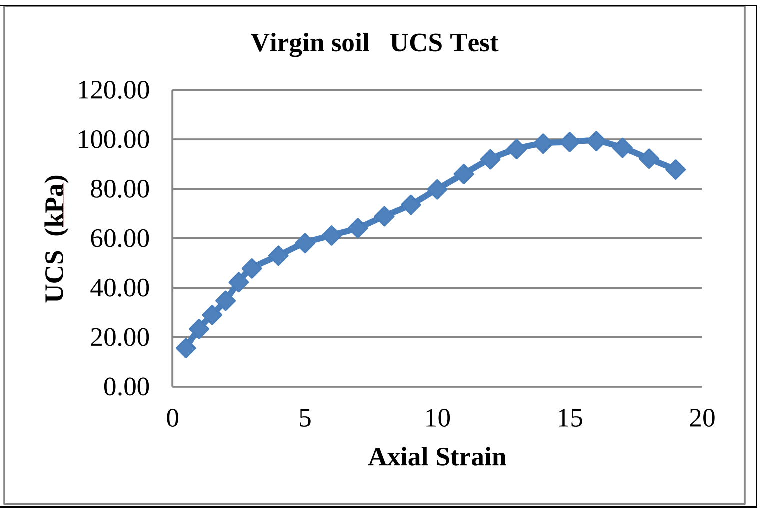


Fig 3.12

Unconfined Compressive Strength SOIL TREATED WITH RUBBER (2%, 5%, and 10)

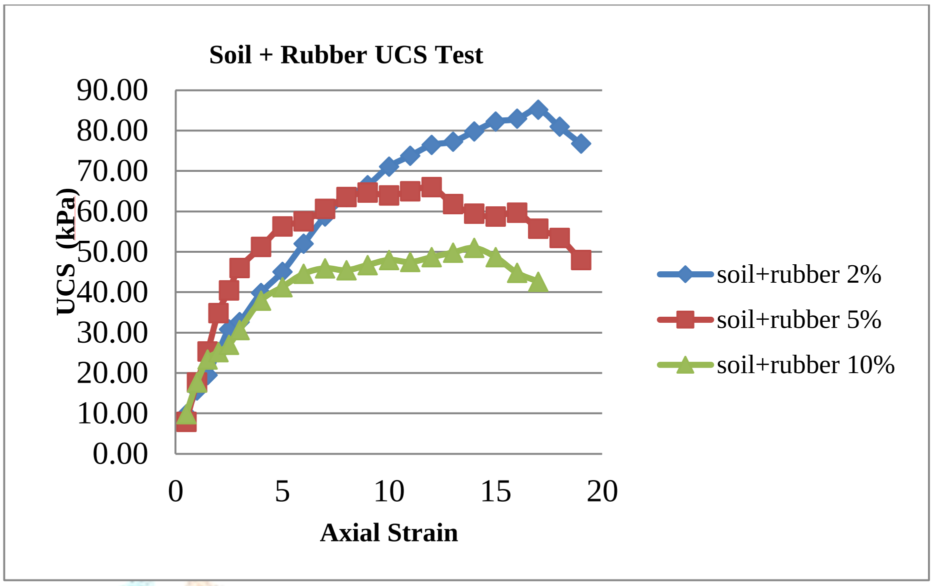


Fig.3.13

Unconfined Compressive Strength RESULTS OF SOIL TREATED WITH CEMENT (2%, 5%, and 10)

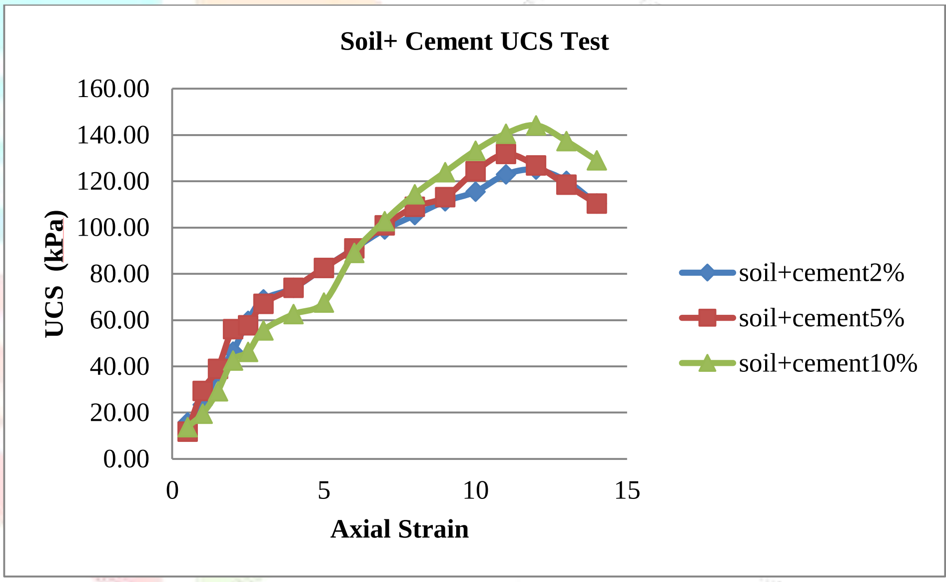


Fig.3.14

Unconfined Compressive Strength RESULTS OF SOIL TREATED WITH (CEMENT+CRUMB RUBBER) (2%, 5%, and 10)

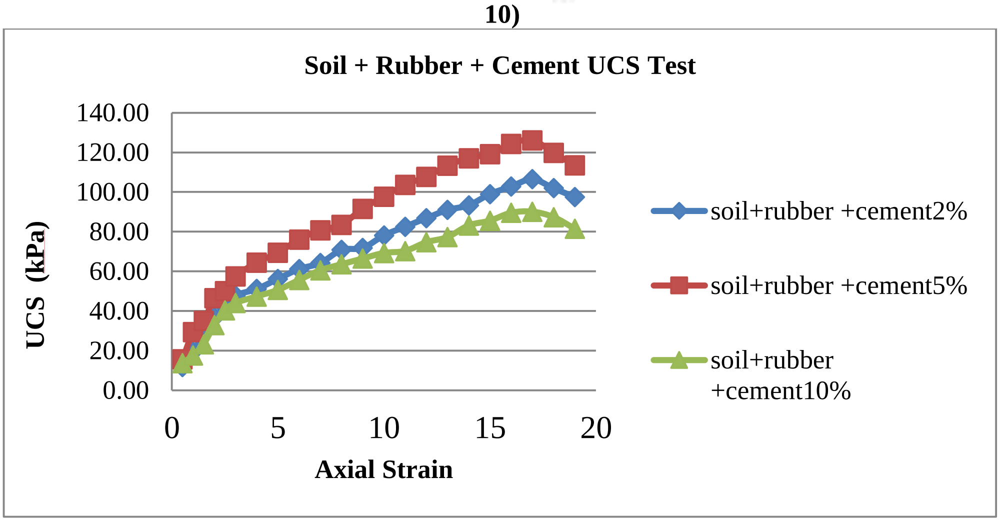


Fig.3.15

CONCLUSION

The following conclusions are drawn based on the laboratory studies carried out in this work.

- When crumb rubber powder is added up to 5%, there is a considerable decrease in MDD values. Whereas further increase of crumb rubber powder leads to increase in MDD values
- When soil is treated with 5% crumb rubber powder and 5% cement , both un-soaked and soaked CBR values increases
- When soil is treated with 10% crumb rubber powder and 10% cement , both un-soaked and soaked CBR values decreases
- Since rubber is compressive material, it does not give strength to soil. But when rubber is mixed with binding material like cement the strength of soil increases which is greater than soil + cement material strength.
- It is also observed that, if the rubber percent increases the soil strength decreases because of the nature (Compressive) of rubber is dominate in soil.
- When rubber powder is added up to 5%, there is a decrease in MDD values. Whereas further increase of rubber powder leads to increase in MDD values.
- Due to the percentage variation of cement, it is observed that the values of Soaked CBR are greater that the Un-soaked CBR.

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