Stabilization of Subgrade Soil by using Alccofine and Waste Bottle Plastic Strips

Chetan Sharma, Amit Goel , Amanpreet Tangri

Abstract: ***If the suitable earth is not available at the construction site, so it becomes an option to select soil stabilization. Soil stabilization is the process by which the strength and stability of a soil mass is improved and increased with the use of controlled compaction or addition of suitable stabilizing agents like cement, lime, cementitious material and waste material such as fly ash, waste plastic etc. Since the use of waste material such as chairs, bottles, polythene bags etc has been speedily increase day by day and its disposal has been creating a problem for environment concern so here is the new technique or way to reduce quantity disposing waste as well as environment effect by using plastic as soil stabilizer which cement is best material. The main objective of this review paper is to focus on stabilization of soil using plastic waste and alccofine is cementitious material to understand the behavior of soil properties.***

Keywords: Soil Stabilization, Alccofine, plastic Strips and Environment.

I. INTRODUCTION

Soil stabilization is a method of transforming a natural soil into a purpose of engineered construction material and this is done by changing engineering properties of soil and thus making it more stable for use.

Its need when the available soil for construction is not suitable for intended purpose. Material is added in soil for the purpose of soil stabilization is cementitious or chemical.

The main purpose of stabilization is to reduced permeability, compressibility of the soil to increase its shear strength and to improve the natural soil for the construction of highway.

Now days the quantity of plastic increasing everywhere from industrial areas and disposal quantity also increasing show the one more way to reduce it by using plastic bottle strips or using more additives such as lime, rice husk ash, asphalt, cement and lime stone has largely become one of the most popular method to enhance the properties of soil in addition to that Alccofine can be used with plastic waste as a addition in order to improve the soil properties.

A. Subgrade

The prepared natural layer of earth surface on which the payment structure is placed.

The well designed subgrade provide strength, prevent settlement and distribute the load of overlying different layers.

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B. Subgrade performance

Some great performance is commonly depends on interrelated characteristics

- LOAD BEARING CAPACITY

  Subgrade should be able to support and distribute the load from the payment structure and The load bearing capacity of subgrade generally affected by degree of compaction. A good considered subgrade which can support large amount of loading without excessive settlement.

- VOLUME CHANGES

  Excessive moisture present in the soil results in change in volume, some of the clay soil shrink and soil depending upon the moisture content the moisture content directly react with high amount of fine content and it will tend to the formation of crack on any payment.

C. Methods to improve subgrade performance

When the subgrade soil is not suitable to support the traffic load then additional work should be done to build over unstable soil there are various method used to improve subgrade performance:

- Removal and replacement of poor subgrade soil with high quality fill.
- Stabilization with addition of an appropriate material such as lime, Portland cement or emulsified asphalt can reduce swelling tendency and increase subgrade stiffness.
- Additional base layers.

II. LITERATRE REVIEW

A. Stabilization with plastic waste

P Manjusha et al(2017)[1] Studied the effect of lime and % of plastic strips on CBR values.

The study concluded that:

- The CBR value of soil is improved with addition of optimum content of lime and waste bottle plastic strips.

- CBR percentage goes on increasing up to 4% plastic content in the soil and after it decreases with increases in plastic content and the 4% plastic and 5% lime is the optimum content of stabilization.

Tom Damino et al(2016)[2] Analysed the test results that has been found on adding plastic strips into soil with percentage by weight of soil 0.25%, 0.5% and 1% for aspect ratio 1(10mm×10mm), 3(30mm×10mm) & 4(40mm×10mm). They also concluded the maximum CBR value is obtained when 0.5% plastic strips by weight added at aspect ratio 3 into soil.

Anas Ashrof et al(2011)[3] Determined the experiment on soil stabilization by adding plastic bottle strips and They observed from test the CBR value improved from 1.967-2.479 with 0.6% of plastic and Thus after decreased. The optimum percentage of plastic strips was 0.6%. It was also observed that the reduction in CBR value from 1.967 for plain soil to 1.687 on adding 0.2% plastic.

The study concluded that:

- MDD is obtained when 0.25% plastic granules was added into the soil and OMC corresponding to 0.25% is less as compare without plastic added.

- California Bearing Ratio value decreased when 0.5% of plastic is added and Shear Stress is maximum at 0.25% of plastic added.

B. Stabilization with Alccofine

Lovedeep Singh et al(2018)[4] Studied the effect of solid waste namely fly ash and Alccofine in clay soil on the variation of index properties, shear strength, compaction and CBR values were analyzed. The maximum dry density increases from 197 kilo Newton per meter cube to 21 1 kilo Newton per meter cube in case of addition of mixture on soil and the value of undrained cohesive value was increased 30 KN/m^2 to 35.5 KN/m^2. The unsoaked CBR value of soil increased from 3 % to 8% and soaked CBR value from 4 % to 8% in case of addition of mixture to clay soil.

Jeevan Singh et al(2018)[5] Laboratory investigation on red soil stabilization using silica fumes and Alccofine. They concluded that addition of mixture 20% silica and 10% Alccofine to the red soil increases CBR strength by 70%. They also determined the significant decrease in the swelling of the soil and at the increase of mixture to the red soil increases OMC and decrease maximum Dry density. With the increasing of mixture also increases the unconfined compressive strength from 160 KN/m^2 to 180 KN/m^2 approximately 18% increases.

Sachin dev et al(2017)[6] Presented the study on the stabilization of soil with marble dust and Alccofine. They concluded that the OMC increases and MDD decreases with increases in the percentage of marble dust value of unconfined compressive strength increases as more percentage of soil replaced with marble dust. When the percentage of marks contest increased by 4% strength starts decreasing and the improvement in strength with marble dust and 5% Alccofine .Both soaked and unsoaked CBR value of soil increases as the marble dust content increases with 5% Alccofine. They concluded that proportion of 10% Alccofine and 8% marble dust together in a soil is best combination of material having maximum soaked CBR value.

Abhineet Godayal et al(2018)[7] they concluded that the use of Alccofine alone as a stabilizer shows little improvement in CBR and A binder is also needed in combination with Alccofine in order to obtain the satisfactory Results.

III. MATERIAL USED

A. Alccofine

Alccofine 1108SR is a cementitious micro fine material and It is applicable in field for soil stabilization, grouting etc and the particle size of this material is much finer than other hydraulically setting material like Ordinary Portland Cement (OPC).

Table A (1): Under laboratory condition at 27^0C

PROPERTY	VALUE
Form	Dry fine powder
Component	Single
Particle size D_{95}	<15 microns
Fineness	>8000 cm/gm
Specific gravity	2.9-3.0
Bulk density (kg/m^3)	600-700

B. PLASTIC

Plastic waste strips of the type of polyethylene Terephthalate (PET) used as a reinforcing material in soil for the proposed research. The waste plastic bottles obtained from Sachdeva Polypack industries in Chandigarh. PET waste bottle strips transparent in coloand their size ranged 5mm width and length (10mm to 15mm).

C. Soil

In this study the soil used is obtained from jhanjeri, Punjab, India.

IV. METHODOLOGY

The following experiments are carried out in this study:

- Sieve analysis
- Plastic limit (PL)
- Liquid limit (LL)
- Plasticity index (PI)
- Specific gravity test
- Free swelling index
- Permeability test
- Standard proctor test
- CBR test

Table IV (1): PHYSICAL PROPERTIES OF SOIL

S.No.	Properties	Result
	Grain size analysis	
	D_{10}	14 µ
1	D_{30}	32 µ
	D_{60}	95 µ
	Cu	6.7
	Cc	0.76
	Sand+Gravel (%)	54
	Silt+Clay (%)	46
2	Specific gravity G	2.45
3	**Consistency limits**	
	Liquid limit (LL) %	42
	Plastic limit (PL) %	22
	Plasticity index (PI) %	20
4	**Standard Proctor Test**	
	Maximum dry density (MDD) (g/cc)	1.76
	Optimum moisture content (OMC) (%)	16.1
5	**CBR value %**	
	2.5mm Penetration	2.2
	5mm Penetration	2.1
6	Swelling Index	40%
7	Coefficient of permeability k (cm/sec)	3.46×10^{-6}

B. Standard proctor test

Table B (1): Compaction Test Results for Soil: Alccofine

Soil: Alccofine	MDD(g/cc)	OMC%
100:0	1.76	16.1
97:3	1.71	16.8
94:6	1.69	17.6
91:9	1.65	18.6
88:12	1.62	19

V. EXPERIMENTS AND RESULTS

Standard proctor test and CBR test have been carried out on soil admixed with Alccofine and Plastic strips with various percentage by weight of soil.

A. Mix proportions: In first step of study, only Alccofine was added in soil as stabilizer and the percentage was 3%, 6%, 9%, 12% by weight of soil. In second step, plastic was used as stabilizer in which its percentage was 0.25% ,0.50%, 0.75%, 1% by weight of soil and last step was the combination of both Alccofine and Plastic having ratio 100:0:0, 94.75:5:0.25, 94.50:5:0.50, 94.25:5:0.75, 94:5: respectively was used.

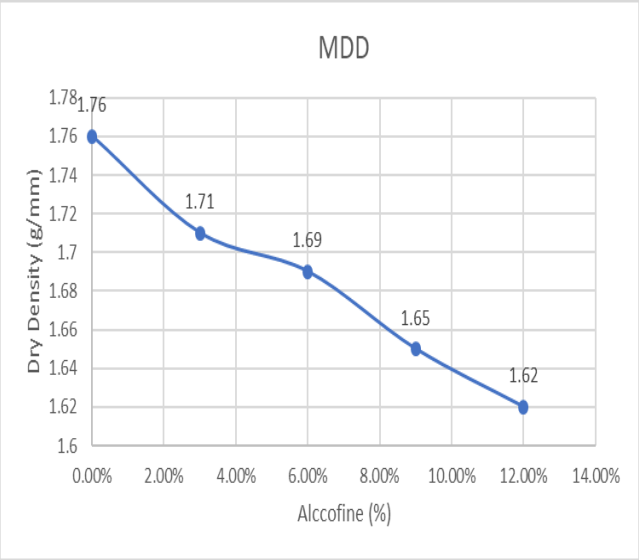


Fig. B (1): Variation of MDD with Alccofine

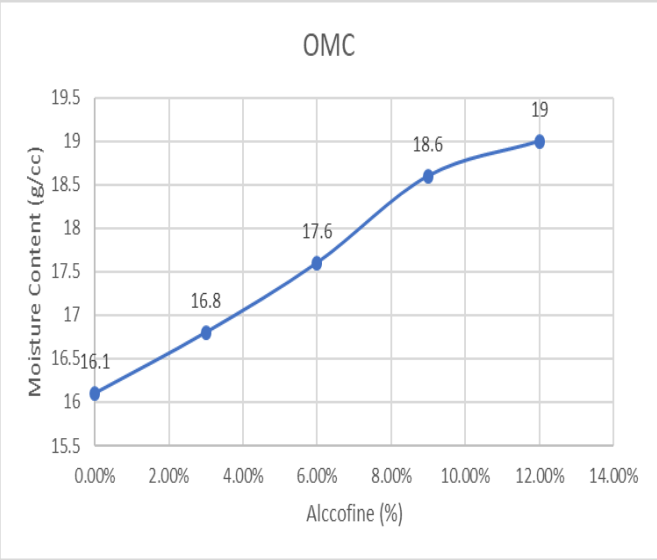


Fig. B (2): Variation of OMC with Alccofine

Fig.B(1) shows that the maximum dry density of soil decreases with the addition of alccofine up to 12% and

Fig.B(2) shows that the optimum moisture content of soil increases with the addition of alccofine up to 12%.

Table B (2): Compaction Test Results for Soil: Plastic

Soil: Plastic	MDD(g/cc)	OMC%
100:0	1.76	16.1
99.75:0.25	1.76	16
99.50:0.50	1.77	15.5
99.75:0.75	1.74	15.9
99:1	1.69	16.5

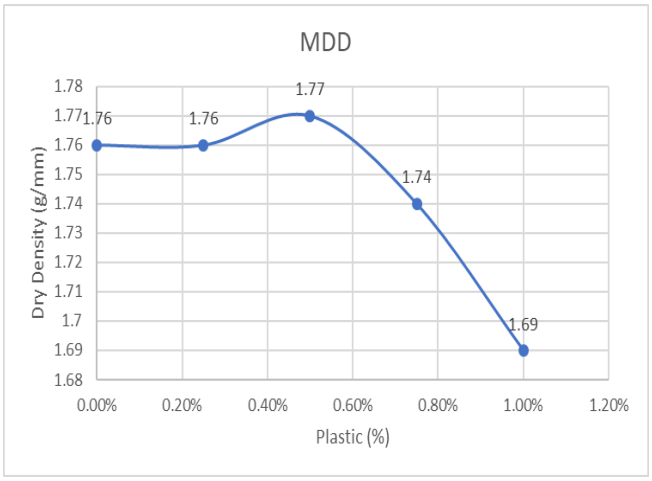


Fig. B (3): Variation of MDD with Plastic

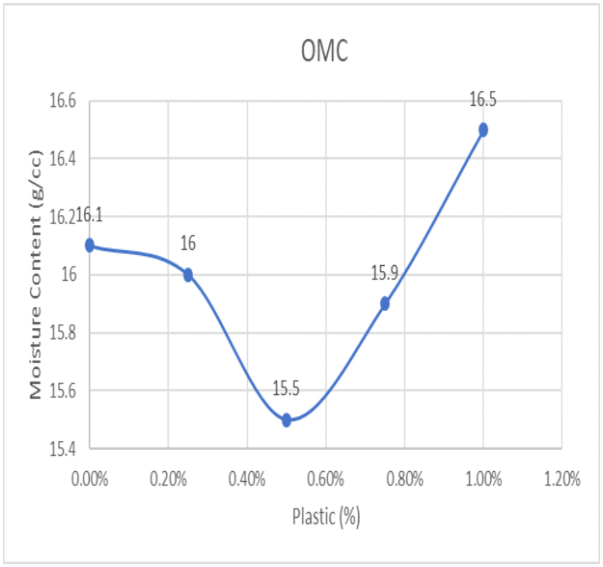


Fig. B (4): Variation of OMC with Plastic

Table B (3): Compaction Test Results for Soil: Alccofine: Plastic

Soil:Alccofine:Plastic	MDD(g/cc)	OMC(%)
100:0:0	1.76	16.1
94.75:5:0.25	1.70	17.1
94.50:5:0.50	1.70	17.5
94.25:5:0.75	1.66	18.1
94:5:1	1.64	18.8

Fig.B (3) shows that the maximum dry density of soil increases with the addition plastic up to 0.5% after that decreases and Fig.B (4) shows that the optimum moisture content of soil decreases with the addition of plastic up to 0.5% after that increases.

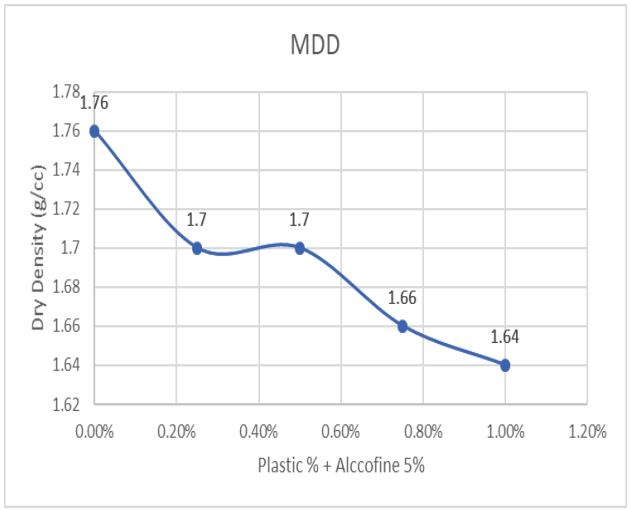


Fig. B (5): Variation of MDD with Alccofine & Plastic

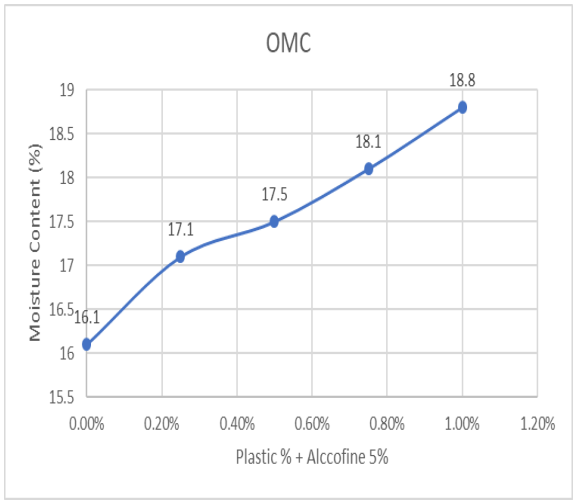


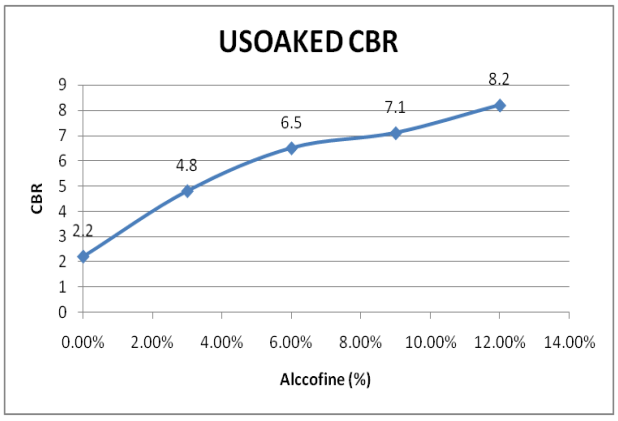
Fig. B (6): Variation of OMC with Alccofine & Plastic

Fig.B(5) shows that the maximum dry density of soil decreases with the addition of alccofine & plastic up to (alccofine 5% & plastic 1%) and Fig.B(6) shows that the optimum moisture content of soil increases with the addition of alccofine & plastic up to (alccofine 5% & plastic 1%).
The effect of alccofine and waste bottle plastic strips of the MDD of treated soil may be decrease in density of treated soil may be due to variation of specific gravity of virgin soil. Addition of water causes bulking of soil which may be responsible for lower density of treated soil. The capillary force resisting the rearrangement of particles against the compressive energy may be responsible for low unit weight. Standard proctor test result show the optimum moisture content OMC for raw soil was increased on addition of 12% alccofine to virgin soil. The result for compaction test obtained when plastic was added with alccofine in virgin soil sample proves that OMC increased. The increase in OMC for diff. cases of treated soil may be due to high req. of water for exothermic reaction which take place b/w CaO and pozzolonic material.

C. CBR Test Results

Table C (1): California Bearing Ratio test Results for Alccofine

Alccofine (%)	UNSOAKED CBR	SOAKED CBR
0	2.2	0.17
3	4.8	16.3
6	6.5	20.5
9	7.1	28.2
12	8.2	33.0



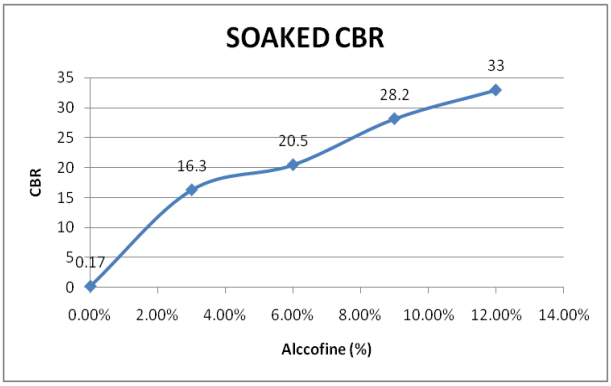


Fig. C (1): Graph showing test values of alccofine on CBR

The CBR experimental results shows in Fig. C (1) with alccofine on soaked and unsoaked respectively Fig. C (1) shows that CBR value increases with addition of alccofine upto 12%.

Table C(2): California Bearing Ratio test Results for Plastic

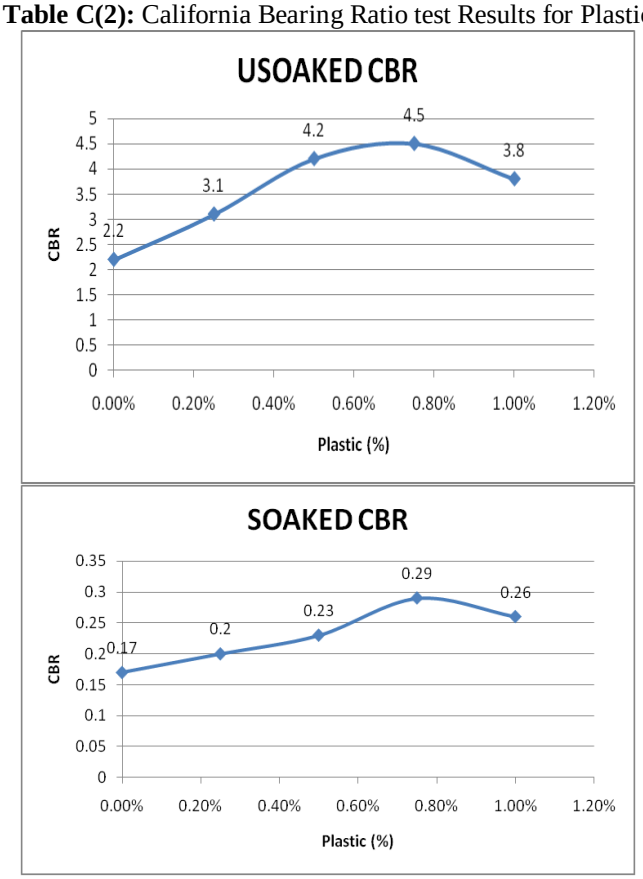


Fig. C (2): Graph showing test values of Plastic on CBR

The CBR experimental results shows in Fig. C(2) with plastic on soaked and unsoaked respectively Fig. C(2) shows that CBR value increases with addition of plastic upto 0.75%.

Table C (2): California Bearing Ratio test Results for Plastic and Alccofine

Alcoofine (%)+Plastic (%)	UNSOAKED CBR	SOAKED CBR
0	2.2	0.17
5+0.25	6.4	21.9
5+0.50	7	23
5+0.75	7.2	24.4
5+1	6.2	24.1

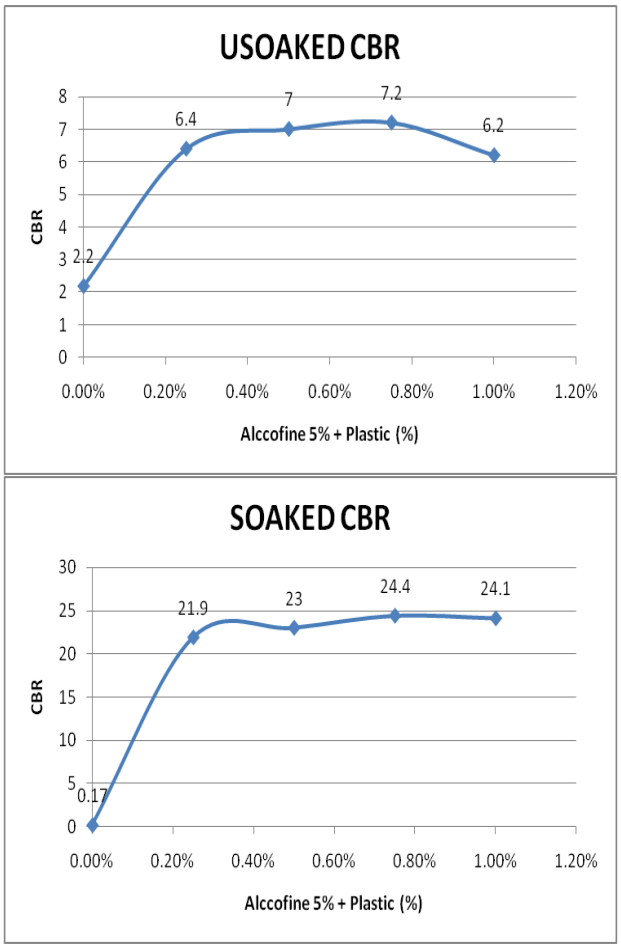


Fig. C (3): Graph showing test values of soil with and Alccofine Plastic on CBR

The CBR experimental results shows in Fig. C(3) with alccofine and plastic on soaked and unsoaked respectively Fig. C(3) shows that CBR value increases with addition of alccofine and plastic upto 5% alccofine and 0.75% plastic.

CBR value after 7days curing

Table C (4): CBR test results for soil with alccofine & plastic after 7 days curing

Alccofine(%)+Plastic(%)	CBR value after 7 days curing
5	25.40
5+0.25	26.80
5+0.50	27.91
5+0.75	28.84
5+1	28.70

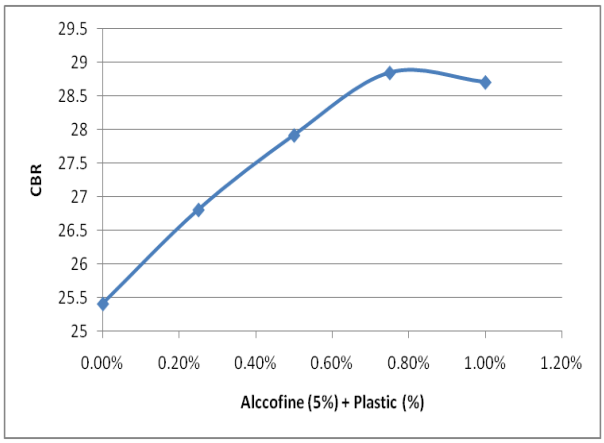


Fig. C (4): Graph showing effect of alccofine and Plastic on CBR value after 7 days curing

The CBR experimental results shows in Fig.C(4) with alccofine and plastic after (7 days curing) respectively Fig.C (4) shows that CBR value increases with addition of alccofine and plastic upto 5% alccofine and 0.75% plastic.
CBR test results show that there is minor improvement in the CBR value of soil i.e. CBR value increases from 2.0 for virgin soil to 4.5 for soil on the addition of 0.75% plastic. Therefore, this amount of increment of CBR is not satisfactory and there is need to add a good binding material that is alccofine with plastic to obtain better results. On the addition of plastic with alccofine give good results in which the CBR value is increased maximum to 7.2 for unsoaked & 24.4 for soaked on addition of 5% alccofine and 0.75% plastic. It is obtained that this proportion gives the maximum improvement in the CBR value of soil. On the other hand, after (7 days of curing) of samples the maximum value of CBR obtained is 28.84 on the addition of 5% alccofine and 0.75% plastic.

VI. CONCLUSION

The strength characteristics of soil, waste bottle plastic strips and alccofine mix was studied. The main conclusions are given below:

- The use of waste bottle plastic strips alone as a stabilizer shows little improvement in the CBR value of soil. Therefore, a binder is needed in combination with waste bottle plastic strips, in order to obtain the satisfactory results.

- The dosage of 0.75% waste bottle plastic strips and 5% alccofine by weight of soil can be taken as optimum to stabilize the soil.

- There is increase in CBR of soil from 2.2 for virgin soil to 7.2 & 24.4 unsoaked & soaked (without curing), 28.84 (7 days curing) for 0.75% waste bottle plastic strips and 5% alccofine, Results show that there is 65% increment in CBR 71.4% & 90.48% for unsoaked & soaked without curing and CBR value increased by 92.36% after 7 days curing.

- With the increase in percentage of alccofine the maximum dry density (MDD) decreased and optimum moisture content (OMC) increases. Same results were obtained when the waste bottle plastic strips was also added with alccofine

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