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Enhancement of Soil Properties by Adding Stone Dust & Scrap of Crushed Aggregate

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Abstract:-

Aggregate crusher units produce enormous quantities of stone dust, a waste product produced during crushing of rubble. Disposal becomes a serious problem due to scarcity of land, due to growing concern with environmental issue & increasing interest in conservation of energy and resources, every country has to face the challenging problem that how to use dispose this by product within framework of its economic structure. Many procedures have been developed to improve mechanical properties of soil by incorporating a wide range of stabilizing agents. In this paper attempt has been made to utilize industrial waste like stone dust. Many properties like optimum moisture content, liquid limit, plastic limit, C.B.R.(California Bearing Ratio) has been studied with the addition of stone dust 5%, 10%, 15%, 20%, 25%. It shows maximum increase in strength characteristics.

Key words:-

California Bearing Ratio, stone dust, optimum moisture content etc.

Introduction:-

California bearing ratio (CBR) is an empirical test and widely applied in design of flexible pavement over the world. This method was developed during 1928-29 by the California Highway Department. Use of CBR test results for design of roads, introduced in USA during 2nd World War and subsequently adopted as a standard method of design in other parts of the world, is recently being discouraged in some advanced countries because of the imperialness of the method (Brown, 1996). The California bearing ratio (CBR) test is frequently used in the assessment of granular materials in base, sub base and sub grade layers of road and airfield pavements. The CBR test was originally developed by the California State Highway Department and was thereafter incorporated by the Army Corps of Engineers for the design of flexible pavements. It has become so globally popular that it is incorporated in many international standards ASTM 2000.The significance of the CBR test emerged from the following two facts, for almost all pavement design charts, unbound materials are basically characterized in terms of their CBR values when they are compacted in pavement layers and the CBR value has been correlated with some fundamental properties.

Literature review:-

1. K.S. Gill & J. N. Jha & A. K. Choudhary[1]:-

They studied that, the conventional CBR testing method is expensive, time consuming and its repeatability is low additionally it is very difficult to mould the sample at the desired in-situ density in the laboratory CBR test. Values of in-situ density are under estimated due to local dampness of surface water percolation and stress release while taking out the sample.

2. M.M.E. Zumrawi[2]:-

He studied that, to predict the field CBR of different types of soils. Since CBR can't be easily measured in the field, prediction of CBR from other simple tests such as Dynamic Cone Penetrometer (DCP) and soil properties is a valuable alternative. Various soils have been compacted at different initial state conditions (i.e. water content and dry density) then using laboratory and field equipment to enable the measurement of unsoaked CBR and DCP of these soils. Analysis of the experimental data indicated that there is a very good linear relationship of the measured soil strength (i.e. unsoaked CBR and DCP) with the soil initial state factor as described by the combination of initial dry density, water content and void ratio.

3. Younis Farooq & Ajay K Duggal[3]:-

They studied that, the paper is revealing the results of a laboratory study carried out to find the correlations between the Dynamic Cone Penetration test value and the unsoaked CBR value at different moisture content. A series of test was carried out different types of soil (sand,silt,clay) at different moisture content, for each soil sample to find out the correlation in CBR value. Samples were compacted manually (Standard proctor compaction) to obtain the pre-determined conditions.

4. Rodrigo Salgado[4]:-

He studied that, the standard penetration test (SPT) and the cone penetration test (CPT) are two typical in-situ penetration tests. The dynamic cone penetration test shows features of both the CPT and the SPT. The DCPT is performed by dropping a hammer from a certain fall height and measuring penetration depth per blow for each tested depth. The DCPT is a quick test to set up, run, and evaluate on site. Due to its economy and simplicity, better understanding of DCPT results can reduce efforts and cost for evaluation of pavement and subgrade soils. Present practice in determining the adequacy of a compacted subgrade is to determine the dry density and water content by either the sand-cone method or the nuclear gauge. The use of the resilient modulus has recently become mandatory for pavement design. To find the a time-consuming test is required which demands significant effort. Therefore, a faster and easier alternative for compaction control in road construction practice is desired.

5. Deepika Chukka & Chakravarthi V. K[5]:-

She studied that, the performance of pavements depends to a large extent on the strength and stiffness of the sub grades. Sub grade strength (CBR) plays a major role in pavement design. Since determination of CBR value in field requires need of equipment and also time consuming alternatively one can be predict CBR value of sub grade in field from other soil support tests namely Dynamic Cone Penetrometer Index (DCPI) which has evolved as the most versatile rapid, in situ evaluation device currently available for use in determining sub grade properties.

I. Design of flexible pavement by C.B.R. method

The Indian Road Congress vide IRC-37-1984 has revised the guidelines for the design of flexible pavement. The guidelines are based on the concept of cumulative std axel loads rather than the total number of all commercial vehicles In the case of road with the design traffic more than 1500 commercial vehicles per day. The design traffic in terms of the cumulative number of std axle load 8160kg carried out during the design life of the road.

II. California Bearing Ratio (CBR)

CBR is defined as the ratio of the test load to the std load. The penetration resistance of the plunger into a std sample of crushed stone for the corresponding penetration is called std load. The std load adopted for different penetration for the std material with a CBR value of 100% are given in following table.

Penetration of plunger in (inch)	Standard load	Penetration of plunger in (mm)	Standard Load in (kg)
0.10	3000	2.50	1370
0.20	4500	5.00	2055
0.30	5700	7.500	2630
0.40	6900	10.00	3180
0.50	7800	12.50	3600

CBR is probably the most widely used method for the design of flexible pavement.

III. Design of flexible pavement by C.B.R. method

The IRC has revised guidelines for the design of flexible pavement. The guidelines are based on the concept of cumulative std axel loads rather than the total number of vehicles. In case of road with the design traffic more than 1500 commercial vehicle per day.

The design traffic is a define in turns of a the cumulative no of standard axle load 8160 kg carried out during the design life of the road. The mixed commercial vehicles with different axel loads are to be converted in terms of the cumulative number of the standard axle load (Ns) can be computed by using the equation.

$$Ns = 365 * A [(1+r)^n -1] *F/r$$

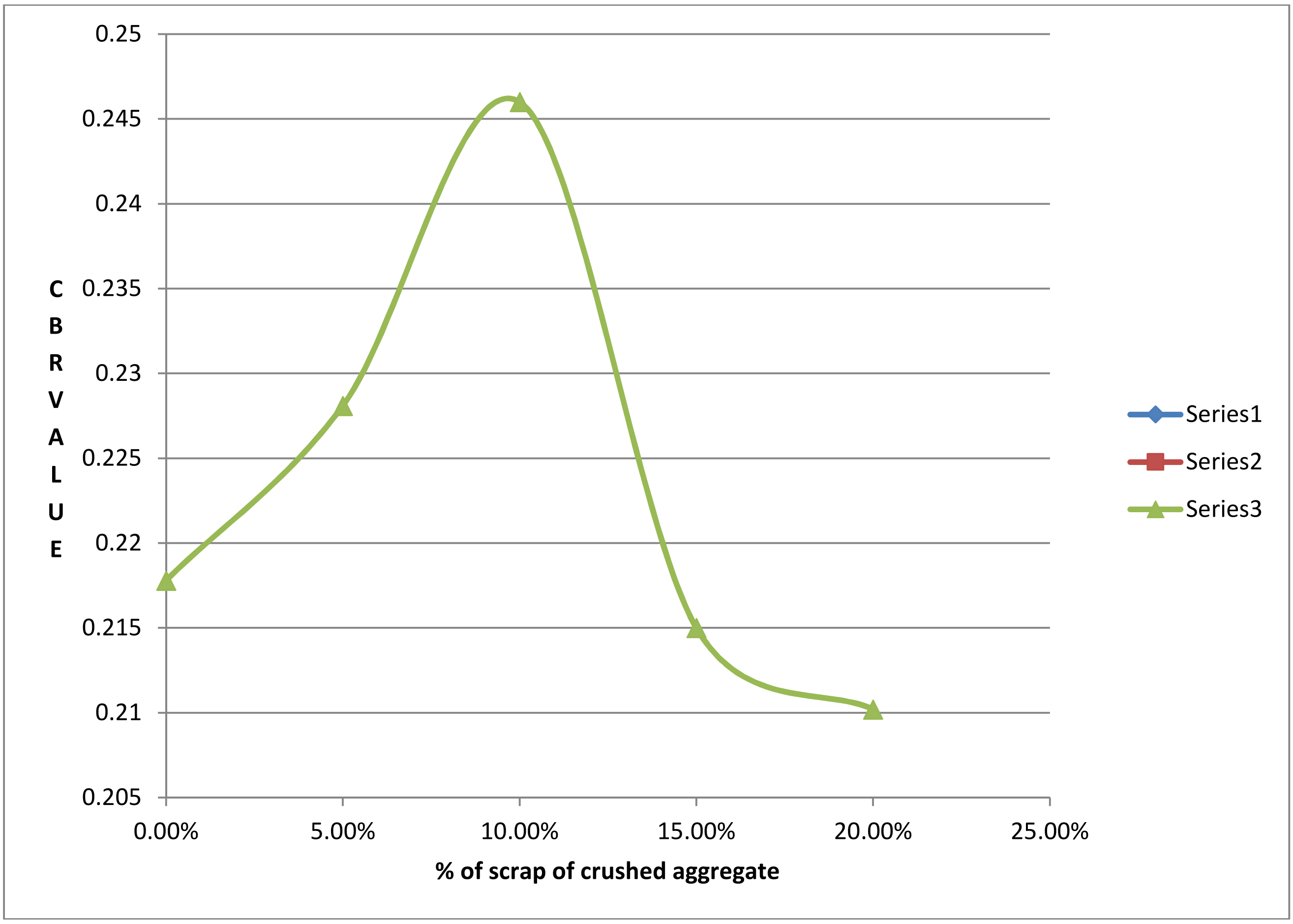
IV. CBR value and its significance in a road design

CBR value is the resistance offered by the soil on penetration of standard plunger. It indicates the strongest or weakness of the soil. Higher the CBR value stronger is the material. While designing the pavement thickness, the CBR value is consider in terms of Msa .the pavement thickness is more for less CBR value and pavement thickness is less for higher value.CBR value and its significance in road design is shown in following table.

CBR value	Sub-grade strength	Comments
2% and less	Poor	Capping layer required
2% to 5%	Normal	Widely encountered CBR range capping consider according to road category
5% to 15%	Good	Capping normaly unnecessary.

Result and Discussion:-

SR NO.	TYPE OF SOIL	OPTIMUM MOISTURE CONTENT	C.B.R. VALUE	% INCREASE IN C.B.R.
1.	BLACK COTTON SOIL	12.3867%	21.78%	0.00%
2.	B.C.S.+5% scrap of crushed aggregate	12.3867%	22.81%	1.03%
3.	B.C.S+10% scrap of crushed aggregate	12.3867%	24.6%	2.82%
4.	B.C.S.+15% scrap of crushed aggregate	12.3867%	21.50%	-0.28%
5.	B.C.S.+20% scrap of crushed aggregate	12.3867%	21.02%	-0.76%



Graph 1

SR NO.	TYPE OF SOIL	OPTIMUM MOISTURE CONTENT	C.B.R. VALUE	% INCREASE IN C.B.R.
1.	Plain SOIL	10.0%	20.33%	0.00%
2.	soil+5% stone dust	10.0%	21.34%	1.01%
3.	soil+10%stone dust	10.0%	21.70%	1.37%
4.	soil+15% stone dust	10.0%	24.43%	4.1%
5.	soil+20% Stone dust	10.0%	27.34%	7.01%
6.	Soil+25% stone dust	10.0%	25.12%	4.79%

TABLE NO.2

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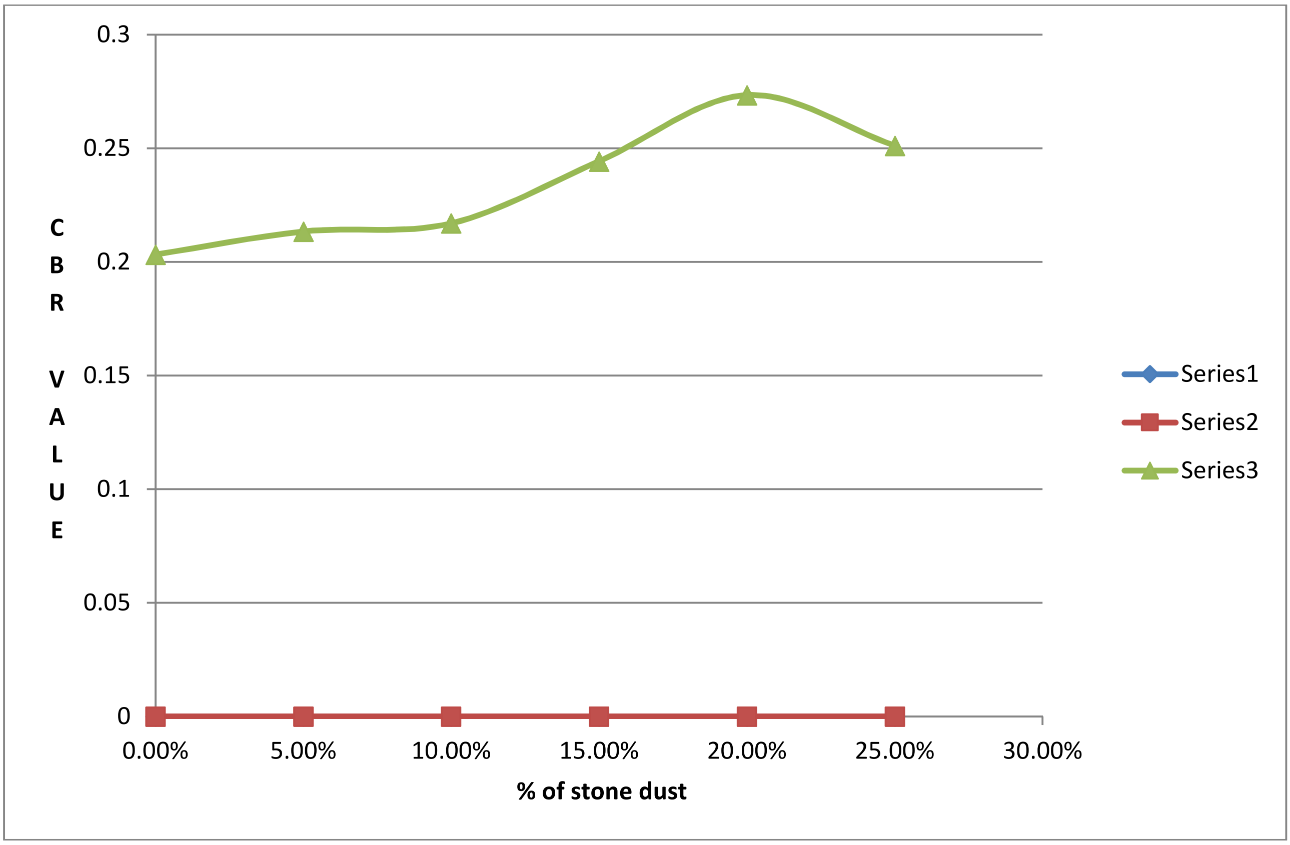

Graph 2

TYPE OF SOIL	C.B.R. VALUE
Brick soil+20% wheat straw ash	17.00%
Brick soil+20% wheat straw ash+20% stone dust	20.00%

LIQUID LIMIT & PLASTIC LIMIT TEST:-

NO. OF BLOWS	WATER CONTENT (%)
24	46.67
20	48.95
29	43.92
35	47.54
26	51.898

BRICK SOIL TABLE NO. 3

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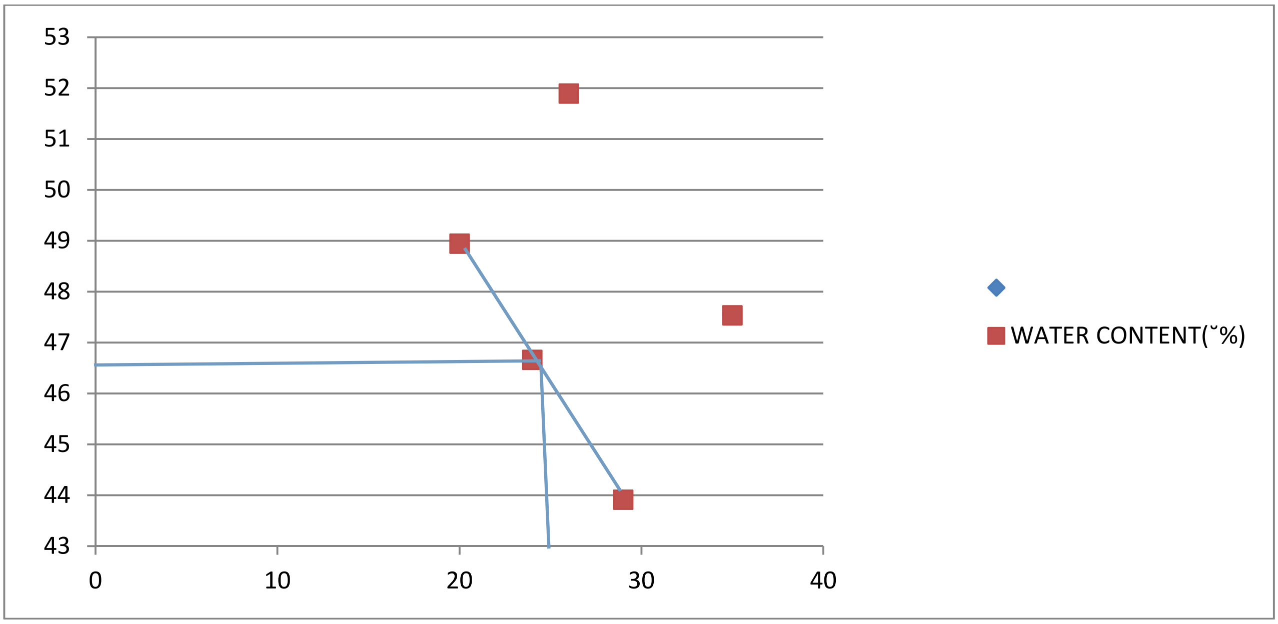
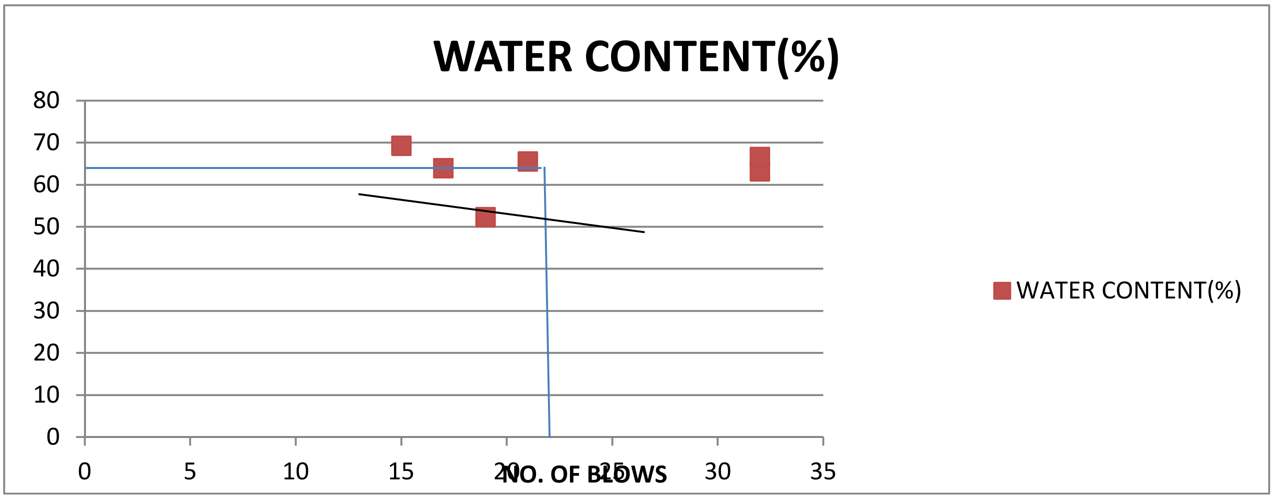


Graph 3

The maximum water content at 25 blows of hammer is 46.50%

NO. OF BLOWS	WATER CONTENT (%)
15	69.33
17	64
32	63.218
19	52.32
32	66.67
21	65.59

BLACK COTTON SOIL TABLE NO. 4



Graph 4

The maximum water content at 25 blows of hammer is 63.0%

SHRINKAGE LIMIT TEST

- Volume of shrinkage bowl = 27.037cm^3

SR NO.	TYPE OF SOIL + (% of stone dust)	SHRINKAGE OF PLAIN SOIL	% REDUCTION IN SHRINKAGE
1.	Plain	53.76%	0.00%
2.	Plain + 5%	53.76%	50.06%
3.	Plain + 10%	53.76%	50.06%
4.	Plain + 15%	53.76%	46.369%
5.	Plain + 20%	53.76%	40.82%

BRICK SOIL TABLE NO. 5

- After adding 20% stone dust % reduction in shrinkage = 13%

SR NO.	TYPE OF SOIL + (% of stone dust)	SHRINKAGE OF PLAIN SOIL	% REDUCTION IN SHRINKAGE
1.	Plain	66.71%	0.00%
2.	Plain + 5%	66.71%	63.01%
3.	Plain + 10%	66.71%	51.91%
4.	Plain + 15%	66.71%	50.06%
5.	Plain + 20%	66.71%	44.52%

BLACK COTTON SOIL TABLE NO. 6

- After adding 20% stone dust % reduction in shrinkage = 22.18%

Conclusion:-

To observe the effect of scrap of crushed aggregate & stone dust on soil properties by adding these admixtures up to 10.0% and 20.0% respectively to the soil. From obtained results it is seen that,

1. California Bearing Ratio also increases with increase in percentage of these admixtures.

2. As the percentage of admixtures increases, there is a marked reduction in liquid limit and plastic limit of soil tested.

3. For 10.0% scrap of crushed aggregate and 20.0% stone dust unsoaked C.B.R. increases with increase in optimum percentage of these admixture.

4. From the results, it is clearly understood that there is a great improvement in strength with 10.0% scrap of crushed aggregate and 20.0% stone dust so these admixtures can be effectively adopted in stabilization of soil as a road pavement without much cost.

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