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Design of Flexible Pavement using Industrial Waste

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Abstract:- The large amount of Industrial wastes as increased year by year and disposal becomes a very serious problem. . Steel slag is a waste material generated as a by-product during the manufacturing of steel from steel industries. The quantity of creation is around 12611.8 T per year from different steel industries in the India. Presently, it has no applications and dumped randomly on the land available near the plants .It is necessary to exploit the steel slag waste effectively with technical development in each field. By utilizing this slag in roads, the waste material will be used and slag won't cause any harmful impact on the environment.

In this project, a typical steel slag was collected from a Steel industry and its feasibility for use in subgrade of road construction was investigated. To improve its Geotechnical engineering properties, the Steel Slag material was mechanically stabilized with locally available soil in the range of 1% - 10%.

The soil samples were collected from two sources (in Krishnan koil and in vatrap) and the CBR tests were conducted for the raw samples and mixed with steel slag with different proportions. Within this we identified that the CBR values are increased by adding the steel slags with the proportions of 9.5% and 4% with the soil samples 1&2 respectively having high value of CBR. Therefore the thickness of the pavement with steel slag are also reduced from 85cm to 70cm and 80cm to72cm respectively with cost effective manner.

Keywords:- *steel slag, red soil, minimize flexible pavement thickness.*

I. INTRODUCTION

The sub grade is the foundation of the pavement structure, on which the sub base is laid. The load-bearing strength of sub grade is measured by California Bearing Ratio (CBR) test, falling weight deflect meter back calculation and other methods. The sub grade is the in suit material upon which the pavement structure is been placed. The load is transferred by the sub-grad effectively to the earth mass. However the locally available earth is used to construct the sub-grad but it becomes necessary that the sub-grad should be of required strength. Although there is a tendency to look at pavement performance in terms of pavement structure and mix design alone the sub-grade can often be the overriding factor in the pavement performance. Urbanization and industrial development in India need to concentrate on construction techniques of highways, airports and residential building. For these constructions should need good soil conditions for foundations and embankments. Here the red soils are more durability and shear strength. We have undergone many tests for finding the strength to support on the sub grade of the road structure to improve by addition of steel slag. Sub grade is commonly compacted before the construction of a road, pavement or railway track, and is stabilized by the addition of asphalt, lime, Portland cement or other modifiers.

II. LITERTAURE REVIEW

Sandip.S.patil, S.S.Bachhav, D.Y.K.Shirsagar , investigated feasibility for use of steel slag in different layers of road construction was investigated. To improve its geotechnical engineering properties, the steel slag material was mechanically stabilized with locally available soil in the range 25%.www.ijeit.com/vol%205/issue%2011/ijeit1412201605_05.pdfwww.ijeit.com/Vol%205/Issue%2011/IJEIT1412201605_05.pdf

Use of Steel slag in bituminous road construction, mithun sawanth, yash lokhande, pratik lokhande, identified t he chemical specification of slag where developed for utilization in the construction of embakement, sub-grade, sub-base, upper layer of the road pavement.
www.irjet.net/archives/V4/i5/IRJET-V4I5558.pdf

Steel slag as a road construction, mohd.rosli hainin, Md.Maniruzzaman A. Aziz, ZulfiqarAli. reviewed the engineering properties of steel slag and its utilization for road construction in different layers.
www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/4282

A review on use of industrial waste in sub base of flexible pavement, Chirag jain, Gyanebdra Sharma, Govind vaishnav , reviewed the use of the material blast furnace slag, coal fly ash, glass, reclaimed concrete pavement, reclaimed asphalt pavement, scrap tires etc. In sub-base layer of pavement during construction will be a technical, economical and ecological blessing with all the limitation and gap. www.internationaljournalssrg.org/IJCE/2016/Volume3-Issue5/IJCE-V3I5P155.pdf

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Steel slag as a road construction material, mohd. Rosli haini, MD. Maniruzzaman A. Aziz, Zulfiqar Ali, Successively recycled as an aggregate for the construction of road, soil stabilization, and base and for the surfacing of flexible pavement.
www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/4282

A Review on use of industrial waste in sub base of flexible pavement, Chirag jain, Gyanendra Sharma, Govind Vaishnav, Ishu Khanna, and Mohit Jaiman, India has a large network of industries which deals with variety of products among which many more are planned for distant future. This amount increases with poor material and construction techniques which is worthless. This paper presents a deep review on the use of waste materials i.e. Blast Furnace Slag, Coal fly ash, Glass, Reclaimed concrete pavement, Reclaimed Asphalt Pavement, Scrap tires etc. in sub base layer of pavement.
www.ijiert.org/admin/papers/1437309783_Volume%202%20Issue%207.pdf

Experimental Study on the Utilization of Fine Steel Slag on Stabilizing High Plastic Sub grade Soil, Hussien Aldeeky and Omar Al Hattamleh, The three major steel manufacturing factories in Jordan dump their by-product, steel slag, randomly in open areas, which causes many environmental hazardous problems. Then 0%, 5%, 10%, 15%, 20%, and 25% dry weight of soil of fine steel slag (FSSA) were added and mixed into the prepared soil samples. From the test results, it is observed that 20% FSSA additives will reduce plasticity index and free swell by 26.3% and 58.3%, respectively. Furthermore, 20% FSSA additives will increase the unconfined compressive strength, maximum dry density, and CBR value by 100%, 6.9%, and 154%.
www.hindawi.com/journals/ace/2017/9230279/

Utilisation of Steel Slag in Roads of Marathwada Region, Shubhada S. Koranne, S. S. Valunjkar, This slag is crushed; steel is again extracted from the slag, which is held in pores in the slag. About 18Percent steel slag of it has been wasted (1percent finer slag and 1percent

Steel). After studying the properties of steel slag by geotechnical engineering point of view, the engineering properties of slag are too similar as compared to the natural aggregates. *Also the CBR* value is found more than that of the natural aggregate. By utilizing this slag in roads, the waste Material will be used and slag won't cause any harmful impact on the environment. www.ijer.in/ijer/publication/v5si1/37.pdf

III. METHODOLOGY

- Problem Identification
- Literature review
- Collection of soil samples and steel slags
- Testing of soil samples
  - Without steel slag
  - With steel slag with different proportions
- Analysis and discussion

IV. COLLECTION OF SOIL SAMPLES AND STEEL SLAG

Soil samples wre collected from two places. About 120kg of excavated soil samples were collected from two places, labelled properly and stored in the laboratory. Soil samples were air dried before using them for testing purpose. The steel stags were collected from Salem Sree Rengaraaj Ispat (p) limited 5 roads Salem and also from welding workshops in Salem. steel slag was sieved under 4.75mm sieve Physical properties of the soil where determined as per IS specifications.

Fig 1:- Collection of Soil Samples and Steel Slag

A. Tests Done On Collected Soil Samples

The tests such as sieve analysis, optimum moisture content and California Bearing Ratio Test(CBR) were conducted on both collected soil samples. Based on the obtained CBR values the thickness of pavements are identified using CBR chart. Then the steel slag is added with both the soil samples with different proportions and the corresponding CBR values were found out.

- *Sieve Analysis*

A sieve analysis is a practice or procedure used in civil engineering to assess the particle size distribution of a granular material. The size distribution is often of critical importance to the way the material performs in use of 4.75mm sieve

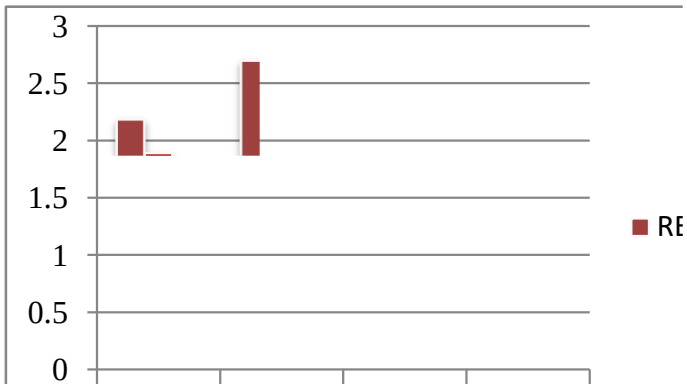
B. Optimum Moisture Content Test (OMC)

The optimum water content of soil is the water content at which a maximum dry unit weight can be achieved after a given compaction effort. A max dry unit weight would have no voids in the soil. The test was useful in finding the water content present in the collected soil samples, where the soil is sieved and dried in open surroundings for finding the moisture content in the soil.

Then we have taken 3kg of soil sample and added 2% to 10% of water in increasing order where the result was correct in 8%. Then the OMC was constant for the soil sample1 and for soil sample-2 the OMC was 6%.3kg of soil sample is taken for testing moisture content. OMC result for tested soil is 8%. Then, the water content has been specified and used for the CBR test for finding the shear using 5kg of red soil sample.

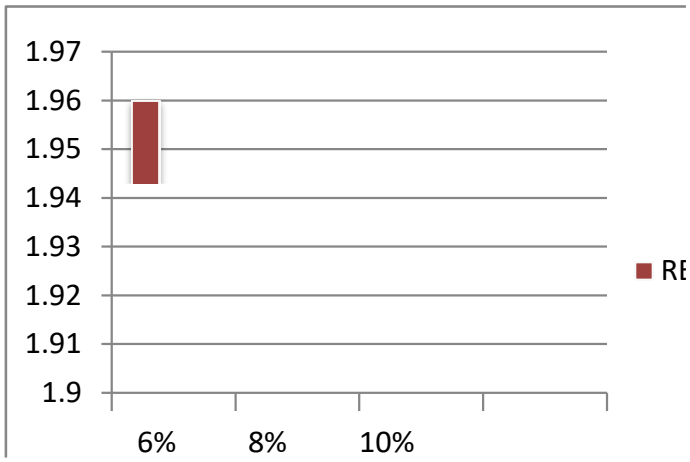
Result of OMC for soil sample-1

AMOUNT OF WATER IN %	WATER IN ML	WEIGHT IN KG
6%	180	6236
8%	240	6612
10%	300	6442



For soil sample-2

AMOUNT OF WATER IN %	WATER IN ML	WEIGHT IN KG
6%	180	6495
8%	240	6410
10%	300	6380



C. California Bearing Ratio Test (CBR)

Penetration	Without steel slag	WITH STEEL SLAG			
		8%	9%	9.5%	10%
2.5mm	3.0	3.24	3.70	4.4	2.32
5mm	3.7	3.45	4	5.49	2.90

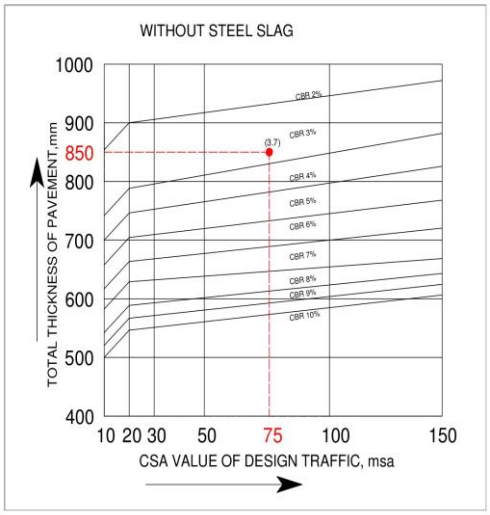
The California bearing ratio test is penetration test meant for the evaluation of sub grade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of the pavements and its component layers. This is the most widely used method for the design of flexible pavement.

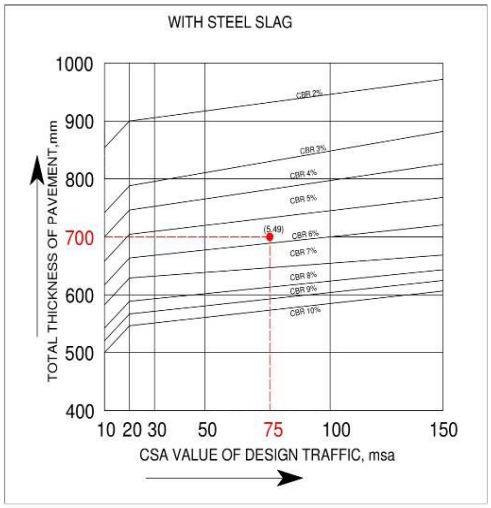
California bearing ratio test were carried out with 5kg soil sample the soil were taken and added with 8% water and compacted in the mould with three layers and processed for testing. During the testing process penetration in soil were been noted from 0 to 12.5mm penetration and values residing to 2.5mm and 5mm where proceeded foe calculation.

The CBR rating was developed for measuring the load-bearing capacity of soils used for building roads. The CBR can also be used for measuring the load-bearing capacity of unimproved airstrips or for soils under paved airstrips. The harder the surface, the higher the CBR rating, A CBR of 3 equates to tilled forml and, a CBR of 4.75 equates to turf of moist clay, while moist sand may have a CBR of 10. High quality crushed rock has a CBR over80. The standard material for this test is crushed. California limestone which has a value of 100, meaning that it is not UN usual to see CBR values of over 100 in well compacted areas.
= CBR [%]
= measured pressure for site soils [N/mm2]
= pressure to achieve equal penetration on standard soil [N/mm2]

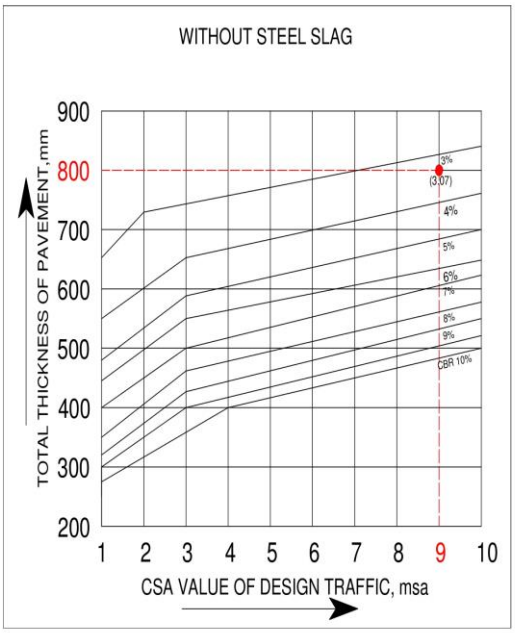
Fig 2: CBR load-bearing

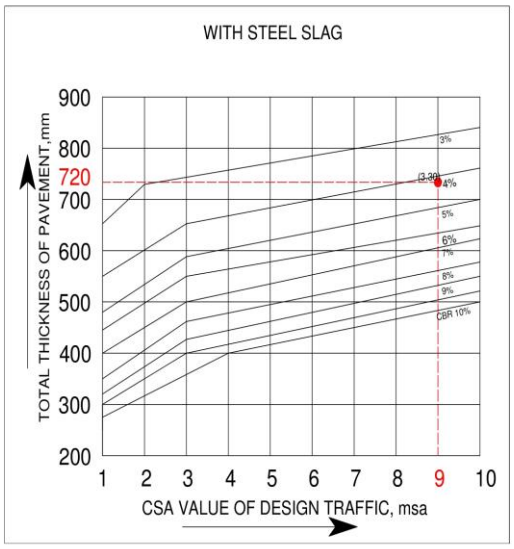
The CBR Values for SAMPLE-I





The CBR Values for SAMPLE-II





V. CROSS SECTION OF PAVEMENT

- *Designed Thickness of 820mm*

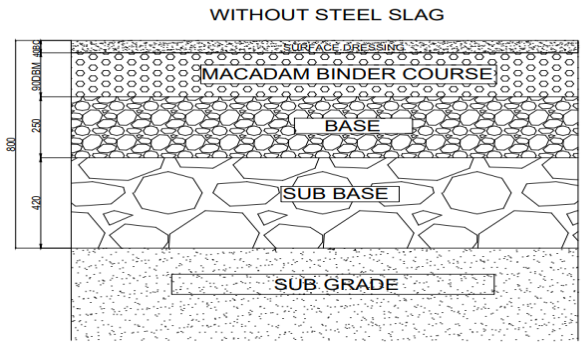


Fig 3:- Designed Thickness of 820mm

Penetration	Without steel slag	WITH STEEL SLAG			
		4%	**6%**	7%	8%
2.5mm	2.71	3	**3.07**	2.63	2.19
5mm	3.07	3.30	**3.15**	3.08	3

- *Designed Thickness of 720mm*

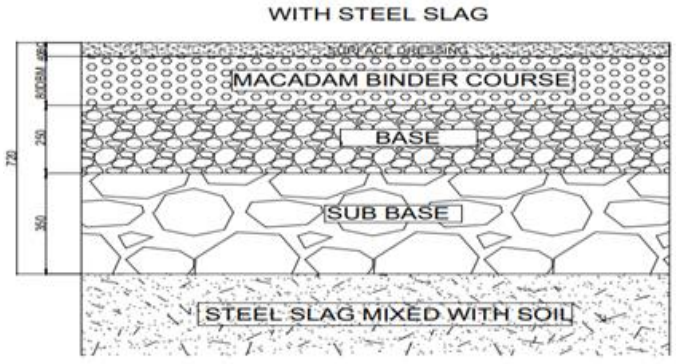


Fig 4:- Steel Slag

VI. RESULTS AND DISCUSSION

From the CBR values by using the IRC chart the pavement thickness were identified for both the samples. From this we found out that by adding steel slag the thickness of the pavement is reduced from 85cm to 70 cm for the sample1 with 9.5% of steel slag and 80cm to 72cm for the sample 2 with 6% of steel slag. Therefore we can conclude that the waste materials from steel industries can be used effective manner with economic consideration.

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