Experimental Study on Use of Steel Slag Aggregate in Construction of Flexible Pavement

M. Reeva[1] M. N. Rubaesh[2] S. Srinidhi[3] C. P. Sugumaran[4] M. Saranya[5]
[1,2,3,4]B.E Student [5]Assistant Professor
[1,2,3,4,5]Department of Civil Engineering
[1,2,3,4,5]Valliammai Engineering College, Kattankulathur

Abstract— In the current scenario, reducing and reusing of wastes has become more cardinal. Reuse of waste generated is as essential as reduction in generation of new wastes. Industrial waste accounts to about 60 % of the total waste generated. Steel slag is one of the major industrial waste being dumped without being processed. There comes the need to effectively process and reuse this major Industrial waste to use it as an alternative in the fast growing construction field. This steel slag, a hard and porous material can be broken to the size of aggregates and can be used as a replacement for conventional aggregates in different layers of bituminous road construction. The steel slag aggregate tends/ to be an effective alternative for natural aggregates. In this study the steel slag aggregates are collected and preliminary tests were performed to evaluate their properties. The percentage of replacement of natural aggregate with steel slag aggregate is optimized for durable and cost effective construction.

Key words: SSA, HMA, VG binder

I. INTRODUCTION

Steel slag aggregate (SSA) is a byproduct of the production of steel in an electric arc furnace. The high iron oxide content of the aggregate results in an aggregate that is very hard and very dense (SSA is 20-30% heavier than naturally occurring aggregates such as basalt and granite). It also contains a high content of calcium and magnesium oxides, which make it expand when it comes into contact with moisture. It is very angular and porous material.

The electric arc furnace steel slag has the highest iron oxide content of any of the slag, which accounts for its increased hardness and higher density as compared to the other slag.

Advantages when used in bituminous pavements (HMA, SMA and chip seals) ; High skid resistance, Resistant to wear, High stability, Resistant to stripping in the presence of moisture.

A. Objective of the Study

The main objective of the study are

- To study the engineering properties of steel slag aggregate.
- To collect and conduct the basic tests on raw materials of flexible pavement to access its quality.
- To Optimize the of percentage of natural aggregate replacement in flexible pavement.

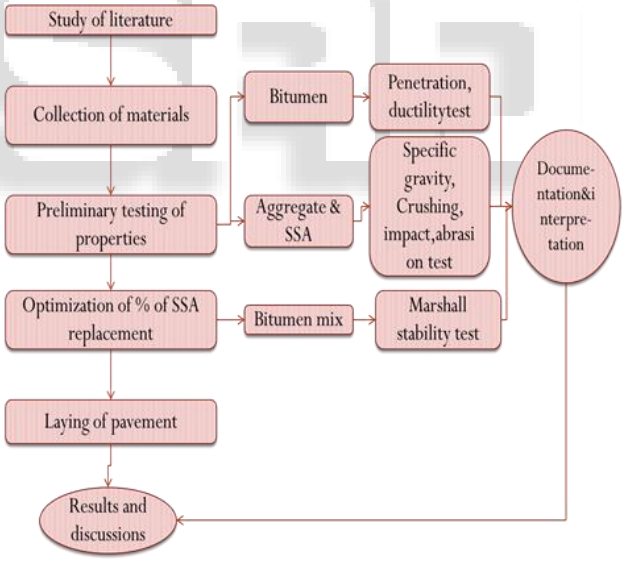
B. Scope of the Study

The scope of the study are

- Utilization of industrial wastes in higher standard of construction.
- Effective alternative for the non-renewable natural sources (conventional aggregates).
- Cost effective and durable flexible pavement construction technique.

II. METHODOLOGY

The sequence of works carried out in the experimental study, for replacement of conventional aggregate in flexible pavements are



III. LITERATURE REVIEW

To know about the previous studies carried out in this topic, various journals by different authors are collected, read and referred. It gives an idea to proceed the work in sequence and know the standard values. None of the states allow the use of SSA in cement concrete applications due to concerns for expansion. Moist curing of SSA or an expansion test is required when the SSA is used for non-HMA applications. Some states use uncured SSA in HMA surface course mixes, others only use it in base course. More states use SSA as high friction aggregate in surface courses.

IV. EXPERIMENTAL STUDY

A. Preliminary Tests

1) Test on Bitumen:

a) Penetration Test

The consistency of bituminous materials varies depending upon several factors such as constituents, temperature. To determine the hardness or softness of given .

The average penetration value of a given bitumen sample is 58 and therefore the grade of bitumen is 60/70.

b) Softening Point Test

To determine the softening point of given bitumen sample.

Test property	No. of observations
Temperature in℃ at which 1st ball touch the bottom plate	62˚C
Temperature in℃ at which 2nd ball touch the bottom plate	68˚C
Final softening point temperature	65˚C

Table 1: Softening Point Test Readings

The softening point value of given bitumen sample is 65 ºC.

c) Ductility Test

Ductility is the property of bitumen that permits it to undergo great deformation or elongation. To determine the ductility value of a given sample of bitumen.

Description value	Value
Ductility value	64.5cm

Table 2: Ductility Test Readings

The Ductility value of given bitumen sample is 64.5 cm.

2) Test on Aggregates:

a) Crushing Strength Test

This is one of the major Mechanical properties required in a road stone. The test evaluates the ability of the Aggregates used in road construction to withstand the stresses induced by moving vehicles in the form of crushing. To determine crushing strength of a given aggregate.

The value of crushing strength of aggregate is 8.3 % and of steel slag aggregate is 13.9 %.

Sample	Total weight of dry aggregate (w_1), kg	Weight of fines passing through 2.36mm sieve(w_2), kg	Aggregate crushing value (%)
Natural aggregate	3.613	0.300	8.3
Steel slag aggregate	2.653	0.369	13.9

Table 3: Crushing Strength Test Readings

b) Impact Strength Test

Toughness is the property of a material to resist impact. Due to moving loads the aggregates are subjected to pounding action or impact. To determine the aggregate impact value of given aggregate as per I.S-2386 Part IV.

The Aggregate impact Value of the given aggregate is 24.35 % and of steel slag aggregate is 26.25 %.

c) Specific Gravity Test

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. The specific gravity test helps in the identification of stone.

Specific gravity of the steel slag aggregate sample is 2.94.

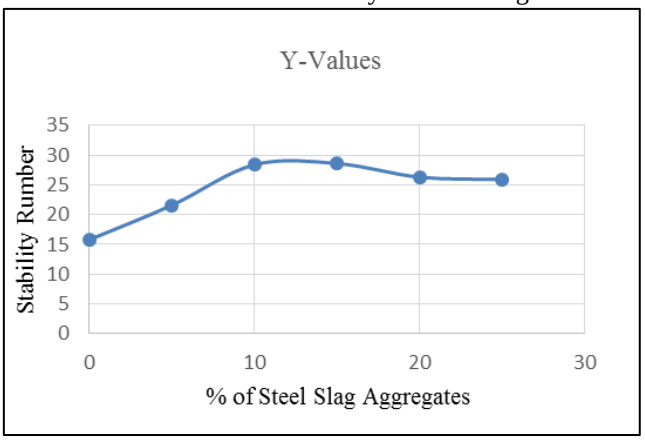
V. OPTIMIZATION OF REPLACEMENT %

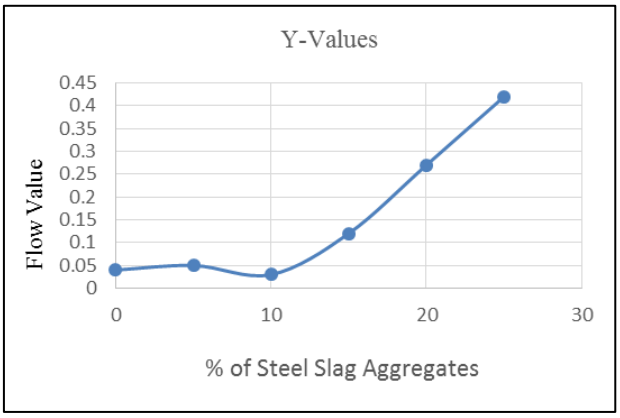
A. Marshall Stability Test

Marshal test is extensively used in routine test programs for the paving jobs. The stability of the mix is defined as a maximum load carried by a compacted specimen at a standard test temperature. To optimize the percentage of replacement of steel slag aggregate for conventional aggregates.

% OF STEEL SLAG AGGREGATE	STABILITY NUMBER	FLOW VALUE
0	15.8	0.04
5	21.6	0.05
10	28.4	0.03
15	28.6	0.12
20	26.3	0.27
25	25.9	0.42

Table 4: Marshal Stability Test Readings





From this graph it is analyzed that the optimum percentage of replacement of conventional aggregate by steel slag aggregate if found to be 10%. This ratio of mix proves to be durable and cost effective.

VI. CONCLUSION

From the results of the test conducted, it is made clear that SSA is an effective alternative for conventional aggregate with an optimum percentage of 10. This step takes an advantage of both finding an alternative for the conventional aggregates and also processing and reuse of major industrial waste i.e., Steel Slag.

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