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SUITABILITY OF MANGANESE SLAG AS A HIGHWAY MATERIAL

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Abstract –*Manganese is a qualitative ore material having various industrial alloy uses, particularly in manufacturing of stainless steel which in turn leads to generation of manganese slag. Currently, India is the second largest producer of steel in the world. Some of the Highway materials that occur naturally are Soil, Fine aggregate, Coarse aggregate and Bitumen. But due to the insufficient availability of natural highway materials, alternative materials have been tested for their suitability. In this present work manganese slag is obtained from Bellary used as coarse aggregate.*

The main objective of this study is to carry out the laboratory tests like Specific gravity, Water Absorption, Aggregate Impact Value, Los Angeles Abrasion, Shape Test on both natural aggregates and Manganese slag as per MoRT&H specifications. From the overall test results it is found that Manganese slag is more efficient and cost effective than natural coarse aggregates. Thus Manganese slag is recommended to use as coarse aggregates in Highway Construction.

Key Words: **Manganese slag, MoRT&H, Los Angeles Abrasion, Aggregate Impact Value, Specific gravity, Shape test.**

1. INTRODUCTION

Manganese is a metal known for its alloy properties. It is usually found in combination with laterite, iron. It is an important material in manufacturing of steel. Manganese in the form of Ferro-manganese acts as a de-sulphuriser and de-oxidiser in steel industry.

Around 2.2 lakh tonnes of ferro-manganese is produced in India per year which is more than the world's average. And nearly around 0.62 lakh tonnes of manganese is lost as slag every year. At present, this slag is dumped as waste on useful landscape.

Manganese slag with rock like appearance is also obtained from the mining process of manganese ore. But for now, there are no methods to dispose them. It acquires the useful landscape and poses environmental pollution. In practice, Manganese Slag has been using by some local agencies as construction material in Bellary district.

Some of the highway materials are Soil, Bitumen, Fine aggregates, Coarse aggregates. The coarse aggregates are used in the construction of various pavement layers such as (i) Bituminous pavement layers of flexible pavements (ii) Cement concrete mixes used for cc pavement slab and also for cross drainage structures (iii) Granular base course (iv)Granular sub-base course or lean cement concrete sub-base and (v) Drainage layer.

Thus coarse aggregates form one of the important components of highway materials and therefore the properties of aggregates are of considerable significance to the highway construction.

Since the naturally available aggregates are exhaustible in nature, there is a need of alternative material which can be used in highway construction.

2. MATERIALS

MANGANESE SLAG:

Manganese slag with rock like appearance is obtained from the mining process of manganese ore.

Manganese slag aggregates of size 19mm-4.75mm is used as replacement to virgin coarse aggregates. It is collected from Bellary.

Fig -1: Manganese slag used for the study

NATURAL AGGREGATES:

Coarse Aggregates greater than 4.75mm IS Sieve size are used in the study. These are collected from Quarry near Peresandra, Chikkaballapura District.

Fig-2: Natural Aggregates used in the study

3. METHODOLOGY

All the laboratory tests conducted on manganese slag and coarse aggregates as per MoRT&H specifications. Tests like Specific gravity, Water absorption, Aggregate Impact Value, Los Angeles Abrasion Value, Shape test.

The present study focuses on Physical properties of the aggregates such as toughness, hardness, good shape factors, strength characteristics, durability, air voids.

Toughness is determined by using Impact test.

Presence of air voids, durability, strength characteristics are determined by Specific gravity and water absorption tests. Hardness is determined by using Los Angeles Abrasion tests. Good shape factors are determined by using Shape test by means of Flakiness Index, Elongation Index.

Specific gravity and water absorption tests are conducted as per IS: 2386 (Part III).

Aggregate Impact Value test is conducted as per IS: 2386 (Part IV). Los Angeles Abrasion test is conducted as per IS: 2386 (Part V). Shape test is conducted as per IS: 2386 (Part I).

4. RESULTS AND DISCUSSION

Various laboratory have been conducted on Manganese slag and natural coarse aggregates as per MoRT&H specifications. The objective of the current study is to investigate the specific gravity, water absorption, aggregate impact value, abrasion value, shape factors.

From water absorption test, slag has better resistant to moisture than natural aggregates shown in table 1 and 2.
From Specific gravity test, slag is more durable than natural aggregates shown in table 1 and 2.
From Impact test, Slag is tougher than natural aggregates shown in table 1 and 2.
From Abrasion test, Slag is harder than natural aggregates shown in table 1 and 2.
From Shape test, Slag has good shape factor compared to natural aggregates shown in table 1 and 2.

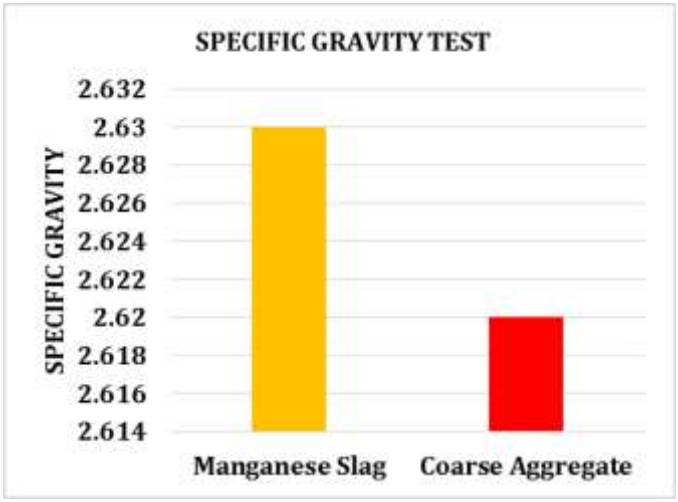

Chart -1: Comparison of Specific gravity of Manganese slag vs Coarse aggregates

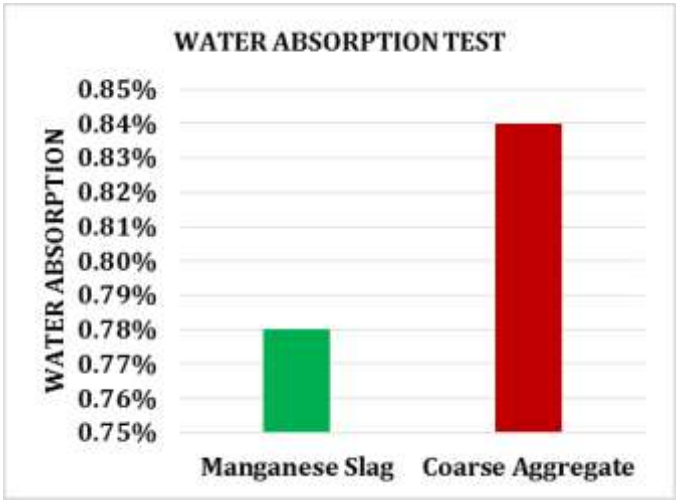

Chart -2: Comparison of Water absorption values of Manganese slag vs Coarse aggregates

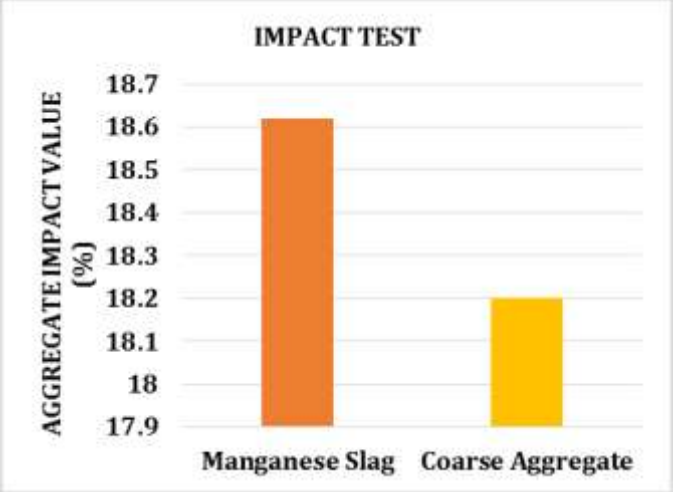

Chart -3: Comparison of Impact values of Manganese slag vs Coarse aggregates

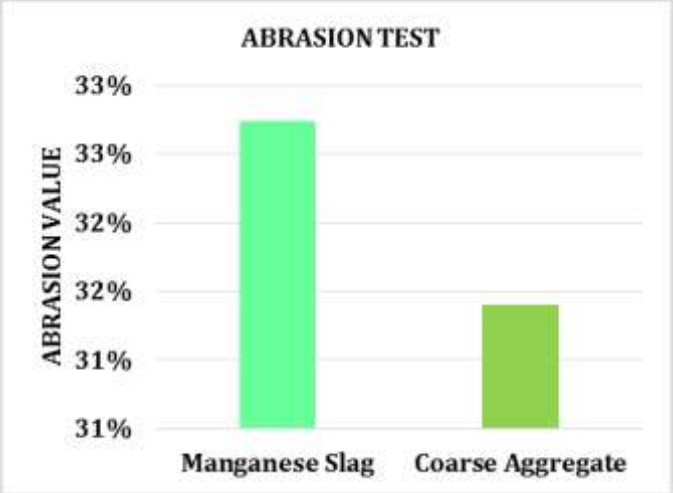

Chart -4: Comparison of Abrasion values of Manganese slag vs Coarse aggregates

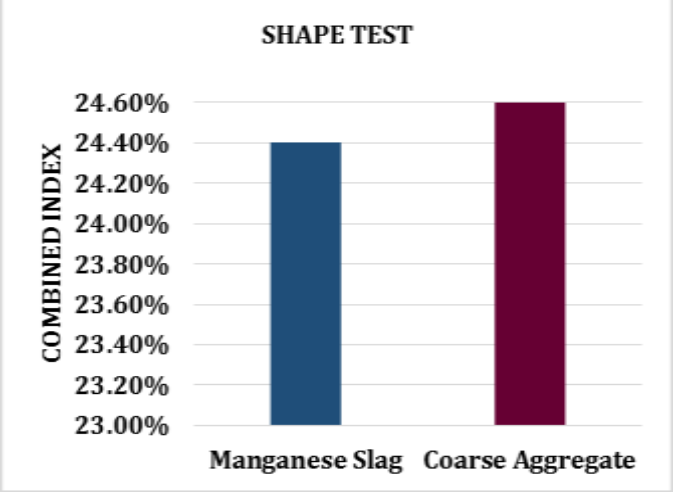

Chart -5: Comparison of Combined index values of Manganese slag vs Coarse aggregates

Table-1: Test results of Manganese slag

Sl. No.	TEST	OBTAINED RESULTS	PERMISSIBLE LIMIT (AS PER TABLE 500-14 of MoRT&H)
1	Specific Gravity	2.63	2.5-3
2	Water Absorption	0.78%	2%
3	Aggregate Impact Value	18.62%	24%
4	Abrasion Value	32.74%	35%
5	Combined Index	24.4%	35%

Table-2: Test results of Natural Coarse aggregates

Sl. No.	TEST	OBTAINED RESULTS	PERMISSIBLE LIMIT (AS PER TABLE 500-14 of MoRT&H)
1	Specific Gravity	2.62	2.5-3
2	Water Absorption	0.84%	2%
3	Aggregate Impact Value	18.2%	24%
4	Abrasion Value	31.4%	35%
5	Combined Index	24.6%	35%

Table-3: Cost Price Analysis

Material	Quantity	Rate	Cost (Rs.)
Natural coarse aggregates	$1m^3$	$1400/m^3$	1400
Manganese Slag	$1m^3$	$600/m^3$	600
Difference in Cost			800

5. CONCLUSIONS

The present experimental studies were carried out to find out the physical properties of manganese slag and natural coarse aggregates.

The conclusion is based on the best results obtained for manganese slag and coarse aggregates. The following conclusions have been drawn based on the laboratory investigations carried.

From **water absorption test**, slag has better resistant to moisture than natural aggregates.
From **Specific gravity test**, slag is more durable than natural aggregates.
From **Impact test**, Slag is 0.4% tougher than natural aggregates.

From **Abrasion test**, Slag is 1.3% harder than natural aggregates.
From **Shape test**, Combined Index of Slag is more or less equal compared to natural aggregates.
From **Cost Price Analysis,** Rs. 800/m^3 can be saved by using manganese slag.

The above test results shows that Manganese slag is more efficient and economical than natural coarse aggregates.
Hence Manganese slag is recommended to use as coarse aggregates in Highway Construction.

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BIOGRAPHY

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