Potentiality of Steel Mill Scale as Raw Material for Concrete as Fine Aggregate

P.M.Rameswaram[1], M.Jothilingam[2],M.MohanaRam[3]
[1]*Assistant Professor/Senior Grade, SRM Institute of Science & Technology, Ramapuram Campus, Chennai.*
[3]*Structural Design Engineer, Raven Structural Designs, Virudhunagar.*

Abstract: *While in the process of making steel various waste products are resulted among that some of the products are reused by refining process by the steel industries itself. But the repeated action of refining some of the materials is resulted as unusable even after refining process due to its drastic change in chemical composition and physical properties. Steel Mill Scale is one of the unusable wastes of the steel industry. Steel mill scale has Iron as its major component and this can be used in the field of civil for various purposes. This waste is already used by many cement industries for making various types of Portland cement because of its iron content. So this material has potential properties of fine aggregate which is fined by some of the basictests which are done to identify the potential properties of the material. So with the reference to the test results, this material can be used as a partial replacement for the fine aggregate for making concrete.*

Index Term: Steel Mill Scale, Fine Aggregate, Sand Replacement, Green Concrete

1.INTRODUCTION

Steel Mill Scale – The main composition of this waste product is iron, the amount of iron present in this waste is ranges from 60 to 70 %. Mostly this material is used by the cement manufacturing industry as one of the compositions of the cement due to the high-level presence of iron content in it. Even though it is used by cement manufacturing industry, the waste is not fully utilized because the output of steel mill scale is in drastic level, but the usage of steel mill scale in cement industry is minor amount only. By dumping this waste product in land will leads to environmental hazards and soil pollution due to the presence of its high metal content. So alternative usage of steel mill scale is needed to find out. In this work, steel mill scale is used as fine aggregate partially.

I. Steel Mill Scale

This is a one of the waste material which is resulted in the process of making steel. The appearance of this material has bluish black in color. Mill scale is mainly composed of iron. Aluminum and Silicon are the minoritycomposition of the steel mill scale and traces of Chromium, Nickel and Manganese are found in steel mill scale.

Fig. 1 Filed Deposit of Steel Mill Scale in Steel Manufacturing industry.

II. The objective of the Work

The need of the work is to study the physical properties of the steel mill scale and to identify the optimize replacement of the sand with steel mill scale to attain a higher compressive strength of the concrete cube. To identify the various physical properties of the steel mill scale, some of the experiments are carried out, like sieve analysis, specific gravity test, and moisture absorption test.

III. Result and discussion

A. Physical Character of mill scale

B. Sieve analysis test was done in the lab, to identify the particle size distribution of the steel mill scale. To ensure the accuracy and standards, for the test, IS 2386 (Part-1) – 1963 (Method of Testing for Aggregates for Concrete) was considered. And the result values are verified with the Indian Standard 2116 – 1980, Specification for Sand, to check that the result values are in the permissible limit as per standards. The sieve analysis resultswere shown in the table – 1 with the permissible values accordance to the Indian Standard.

C. Table – 1: Steel Mill Scale - Sieve Analysis.

IS Sieve Size (mm & Micron)	Weight Retained (g)	Percentage of weight Retained (%)	Cumulative Percentage of Retained (%)	Cumulative Percentage of Passing (%)	Allowable Cumulative Percentage of Passing (%)
4.75	0	0	0	100	100
2.36	50	10	10	90	90-100
1.18	80	16	26	74	70-100
600	120	24	50	50	40-100
300	185	37	87	13	5-70
150	60	12	99	1	0-15
75	5	1	100	0	-

From the sieve analysis test result, the permissible limit in accordance with IS 2116 – 1980 is matching with steel mill scale so this material can be used as are placement material for fine aggregate. The important characteristic does not only depend upon the particle size distribution of the material, it also depends upon the specific gravity of the material.

A. Specific gravity

Specific gravity has anindirect relationship with the density of the material. If the density of the material is very low then the sand density then the compressive strength of the concrete will be reduced. And therefore thevery high density of the material will make concrete as denser and the weight of the concrete will be increased so that the dead load of the building will also increase. But the high-density material can be used for making high-density concrete that has various applications like pavement concrete, gravity dam and so.

Indian Standard 2386 (Part-III) – 1963, Methods of test for aggregate for concrete has stated the test procedure for testing of aggregates which is used in concrete. This test is also done with the accordance of the above-mentioned code.

By the test result, it is observed that the specific gravity of the steel mill scale is 5.904 and the water absorption (in percentage) is 0.806. When comparing the specific gravity of the steel mill scale (5.904) and sand (2.74), the specific gravity of the steel mill scale is higher than sand, so the density of the concrete will be high than the controlled concrete. The test results are given in Table – 2.

Table – 2: Specific gravity test - Pycnometer.

Key	Weight (g)
Surface Dry Sample	500 g
Water + Sample + Pycnometer	1963
Water + Pycnometer	1547
Oven Dry Sample	496

A. Compression Test

For experimentation purpose, Totally 24 cubes are cast in theM25 grade of concrete is used with partial replacement of steel mill scale in increment of 5 percent from 0% up to 35%. The specimens are cast for 150 X 150 X 150 mm^3. All 24 casted cubes are cured for 28 days and after curing of cubes, it is subjected to testing. The testing observations are tabulated in table -3.

Table – 3: Observation for Compression Test

S.No	Percentage of Mill Scale %	Strength on 28 days of Curing (N/mm2)	Mean Strength (N/mm2)
Cube No 1	0	26.2	26.5
Cube No 2		26.5	
Cube No 3		26.8	
Cube No 4	5	27.3	27.60
Cube No 5		27.7	
Cube No 6		27.8	
Cube No 7	10	29.6	29.53
Cube No 8		29.9	
Cube No 9		29.1	
Cube No 10	15	32.8	32.83
Cube No 11		32.9	
Cube No 12		32.8	
Cube No 13	20	34.9	34.4
Cube No 14		34.1	
Cube No 15		34.2	
Cube No 16	25	37.1	37.4
Cube No 17		37.5	
Cube No 18		37.6	
Cube No 19	30	35.1	35
Cube No 20		34.8	
Cube No 21		35.1	
Cube No 22	35	34.9	34.93
Cube No 23		34.8	
Cube No 24		35.1	

Conclusion

The compressive strength of the M20 grade concrete is increased by partially replacing sand with steel mill scale. Optimized strength is gained when 25% of sand is replaced with steel mill scale. And when steel mill scale is replaced with sand the strength of the concrete is increased to 1.5 times of controlled concrete. (The Strength of Controlled Concrete Cube is 25N/mm^2, 25% partially replaced steel mill scale concrete attains 37.4N/mm^2)

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