IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 3, Issue 3, March 2016

Use of $MnSo_4$ Sludge as a Partial Replacement for Cement in Concrete

Golhar Ankush[1], Jogdand Mohini[2], Malvi Ketan[3], Salunke Swanand[4], Gorade Swapnil[5]

UG Students, Department of Civil Engineering, Pimpri Chinchwad College of Engineering, Pune, India[1,2,3,4]

Asst. Professor, Department of Civil Engineering, Pimpri Chinchwad College of Engineering, Pune, India [5]

Abstract: Cement is the main and costly ingredient of concrete. Study says that during manufacturing process of cement the global cement industry contributes large quantity of CO_2 emission to the atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to minimize the use of cement. Extensive research is ongoing into the use of partial cement replacements using many waste materials. Keeping this in mind the work was planned to use the Manganese Sulphate Sludge (MSS) as a partial replacement for cement and strength was compare with ordinary concrete of same mix design. $MnSo_4$ sludge is the waste generated from Manganese Sulphate solution manufacturing companies which is not hazardous. The results obtained are quite encouraging indicating the use of 15% MSS replacement for cement gives same compressive strength compare to ordinary concrete without MSS.

Keywords: Manganese Sulphate Sludge, Cement replacement, Concrete, Compressive strength.

I. INTRODUCTION

In view of energy saving and economical considerations, a number of waste materials has been investigated as possible blending components. During manufacturing of the cement it emits large quantity of CO_2 and sulphur in atmosphere which is harmful for the environment. Over the last decade considerable work has been done in the utilization of fly ash, slag, and silica fume due to their pozzolanic nature and different industrial waste making concrete economical and sustainable.

Studies say that fly ash and silica fume shows the pozzolanic properties and when added 15 to 30% for cement as a partial replacement shows improvement in compressive as well as flexural strength of concrete [1, 2]. Some researchers also use quarry dust and metakaolin as partial replacement for cement in concrete and found up to 25% of quarry dust and 10% of metakaolin shows improvements in compressive and tensile strength [3].Possibility of partial replacement for cement was also checked by using Indian rice husk ash and red mud (waste generated in aluminium industry) and investigation says that 10-20% replacement improves long term strength of concrete [4, 5]. MnSo4 Sludge is the waste material and obtained from the Manganese Sulphate solution manufacturing companies in Maharashtra which is not harmful to environment. Hence use of such waste is essential considering green and durable concrete.

II. MATERIALS USED

A. Cement

Cement used is an Ordinary Portland Cement (OPC) of 53 grade confirming to IS 12269

B. Aggregates

1. Coarse aggregates (CA): Coarse aggregates used which are obtained from local quarry. Retailed on 4.75mm IS sieve having size 10mm and 20mm.Table I shows the properties of coarse aggregates confirming to IS 383.

TABLE I PROPERTIES OF COURSE AGGREGATE

Sr. No	Name of test	20mm	10mm
1	Flakiness Index (%)	6.2	2.8
2	Specific gravity	2.91	2.89
3	Water absorption (%)	1	1
4	Bulk density (dry)gm/cm^3	1.53	1.47
5	Crushing value (%)	16	19

2. Fine aggregates (FA):

100% crush sand is used as a fine aggregate and specific gravity, water absorption & moisture content were carried out as per IS 2386 before mix design. Table II shows the properties of fine aggregates confirming to IS 383.

TABLE III PROPERTIES OF FINE AGGREGATE

Sr.No	Name of test	Result (crushed sand)
1	Specific gravity	2.73
2	Water absorption (%)	2
3	Dry bulk density	1.76
4	Free moisture	Nil

C. Manganese Sulphate Sludge (MSS)

Manganese Sulphate Sludge is the by-product obtained while manufacturing of Manganese Sulphate Solution. Table III shows the properties of MSS.

TABLE III MSS PROPERTIES

Form and colour	Solid (Cake) Black
CaO	5.8%
SiO_2	23.30%
$Al2O_3$	15.83%
Fe_2O_3	14.17%
Combined oxide	30%
LOI	14.8%
Water holding capacity	69.05%
PH	7.34

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 3, Issue 3, March 2016

D. Water

Potable water is used for mixing as well as curing of concrete. Quality and quantity water is required to check carefully. Water to cement ratio adopted 0.45.

E. Chemical Admixtures

High performance super plasticizers having specific gravity 1.1 and in liquid form.

III. METHODOLOGY

The chemical composition of MSS is quite similar to cement but variation in range. Partial replacement for cement by MSS in concrete is done with 5%,10%,15%,20%,25% & 30% and the results obtained for various tests are compared with 0% replacement i.e., with ordinary concrete. The workability of fresh concrete was measured by slump cone test and compressive strength of hardened concrete was tested after 7 and 28 days.

A mix M25 was designed as per IS 10262:2009 and the same was used for various design mixes for partial replacement for cement. The mix design proportions are shown in table IV.

TABLE IV MIX PROPORTIONS WITH VARIOUS % OF MSS REPLACEMENT

MSS %	Cement Kg	MSS Kg	CA 20 mm Kg	CA 10 mm Kg	FA in Kg	Water Litres
0	370.32	0	822.8	350.5	842.1	195.2
5	351.80	18.52	822.8	350.5	842.1	195.2
10	333.28	37.03	822.8	350.5	842.1	195.2
15	314.77	55.55	822.8	350.5	842.1	195.2
20	296.26	74.06	822.8	350.5	842.1	195.2
25	277.74	92.58	822.8	350.5	842.1	195.2
30	259.22	111.1	822.8	350.5	842.1	195.2

Plasticizers as admixture are added 3.36kg (1%) in all mixes. Total 42 concrete cubes are casted and tested for compressive strength test and finally average compressive strength is calculated for all design mixes.

IV. RESULTS AND DISCUSSIONS

A. Workability Test

To check workability of the fresh concrete slump cone is used for all design mixes and results obtained are shown in table V.

TABLE V WORKABILITY TEST IN TERMS OF SLUMP VALUE

Sr. No	Concrete Mixes	Slump in mm with Plasticizers
1.	M25 grade concrete with 0% MSS	140
2.	M25 grade concrete with 5% MSS	130
3.	M25 grade concrete with 10% MSS	100
4.	M25 grade concrete with 15% MSS	85
5.	M25 grade concrete with 20% MSS	60
6.	M25 grade concrete with 25% MSS	45
7.	M25 grade concrete with 30% MSS	25

In the mix design of M25 grade concrete the slump value is consider is 75-100 mm. After checking slump of all concrete mixes, it was observed that as MSS replacement % increases in concrete the slump value decreases.

Thought 1% plasticizer was used to maintain the workability of concrete, still it becomes stiffer as MSS % increases. Finally it was observed that at 15% MSS replacement for cement, slump value is 85 mm which was between design slump values (75mm-100mm).

B. Compressive Strength Test Results

The cubes specimens (150mm x 150mm x 150mm) were casted and tested for compressive strength of concrete for the various mixes given in table IV, as per IS 516:1959 and IS 5816:1999.The final compressive strength results are presented in table VI as well as shown Fig.1. A marginal increase in compressive strength at 15% MSS replacement mix is observed which was closed to compressive strength of ordinary mix strength. Observation shows better performance results compare to ordinary concrete. Addition of the MSS decrease the workability as the water demand is more hence in future more focus is required on % of admixtures.

TABLE VI COMPRESSIVE STRENGTH TEST RESULTS

Sr. No	Concrete Mix	Compressive Strength at 7days (MPa)	Compressive strength at 28 days(MPa)
1.	M25 grade concrete with 0% MSS	29.07	41.42
2.	M25 grade concrete with 5% MSS	27.93	39.90
3.	M25 grade concrete with 10% MSS	37.86	40.75
4.	M25 grade concrete with 15% MSS	37.80	41.08
5.	M25 grade concrete with 20% MSS	27.26	37.10
6.	M25 grade concrete with 25% MSS	26.23	32.24
7.	M25 grade concrete with 30% MSS	25.06	28.73

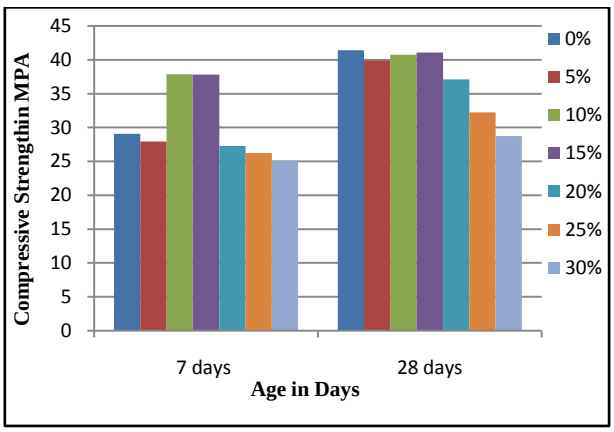

Fig.1 Variation of compressive strength of concrete at different % replacement levels

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 3, Issue 3, March 2016

V. CONCLUSION

From the above results following conclusions are drawn.

1. Addition of admixture is necessary for all the mixes to restrict the water cement ratio. Workability was affected effectively as increase in replacement of MSS from 5% to 30%.This may be due to water absorption property of MMS.
2. It is observed from table VI that for 7 days compressive test, at 5% to 15% replacement of MMS mix shows increase in compressive strength and after 15% it goes on decreasing. Similarly for 28 days strength results shows increase in compressive strength of concrete from 5% to 15% replacement and then decreases. The 28 days compressive strength obtained at 15% replacement for cement is close to ordinary concrete of same grade.
3. The increase in strength of concrete after partial replacement of MSS may be due to higher % of silica. Further studies are required to access the performance of concrete with replacement of MSS for cement based on durability point, workability point by using different admixtures. Detailed cost analysis should be carried out to check the level of savings from the use of MSS as partial replacement for cement.

ACKNOWLEDGMENT

The authors are thankful to Kemtech solutions Pvt. Ltd. and Ajwani Infrastructures Pvt. Ltd. for providing the material required for whole the concrete work. The authors would like to thank the civil department and especially our project guide **Prof. Mr. Gorade** sir for taking keen interest and giving valuable guidance at every stage of this work.

REFERENCES

[1] M. Velumani and K. Nirmalkumar, "Durability and Characteristics of Copper Slag as Fine Aggregates and Fly Ash as Cement in Concrete", IEEE Conference Number-33344 on Current Trends in Engineering and Technology, Coimbatore, India, pp. 222–227, July. 2014.

[2] Faseyemi Victor Ajileye , "Investigations on Micro silica (Silica Fume) as Partial Cement Replacement in Concrete " Global Journal of Researches in Engineering vol.12, issue 1, January 2012.

[3] A.V.S.Sai, "A Study on Strength of Concrete with Partial Replacement of Cement with Quarry Dust and Metakaolin" International Journal of Innovative Research in Science, Engineering and Technology, vol. 3, issue 3, March 2014.

[4] A.N.Swaminathen, "Indian Rice Husk Ash-Improving strength and Durability of concrete: A Review", IEEE Conference Number-32107 on Current Trends in Engineering and Technology, Coimbatore, India, pp. 16–17, July 2013.

[5] M.Vijaya S.Reddy and M.C.Natraja, "Red mud as Partial Replacement for cement in M50 standard concrete-an experimental study on Pozzolanicity and Strength Properties", Indian Concrete Institute Journal, pp.14-18, Oct-Dec.2014.

BIOGRAPHIES

Mr. Golhar Ankush is at present final year student of Civil Engineering from Pimpri Chinchwad College of Engg., Nigdi, Savitribai Phule Pune University. His area of interest is design of concrete.

Miss. Jogdand Mohini is at present final year student of Civil Engineering from Pimpri Chinchwad College of Engg., Nigdi, Savitribai Phule Pune University. Her area of interest is green concrete.

Mr. Malvi Ketan is at present final year student of Civil Engineering from Pimpri Chinchwad College of Engg., Nigdi, Savitribai Phule Pune University. His key interest in reuse of materials in concrete.
.

Mr. Salunkhe Swanand is at present final year student of Civil Engineering from Pimpri Chinchwad College of Engg., Nigdi, Savitribai Phule Pune University. He is interested in Concrete Mixes.

Prof. Mr. Gorade Swapnil received his B.E. Civil degree from Govt. College of Engg., Karad, Shivaji University in 2001.He received his Master's degree in Construction Management from Savitribai Phule Pune University. He joined Pimpri Chinchwad College of Engineering as a faculty where he is Assistant Professor in Civil Department with a total experience of 15 years in the field of construction & planning, structural design and in education. His area of interest is new construction materials and advances in construction management. He is a life member of Indian Concrete Institute.