Experimental Studies on Concrete using SAW Flux Waste

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***Abstract* — *About 10000 tonnes of flux is being generated in India . Such a large quantity of flux that becomes slag after welding & it has to be disposed-off. Land-fill space is required to dump the slag waste. It is non bio-degradable and will not decay with time. Disposal cost will increase apart from environment pollution. This work deals with the recycling of fused submerged-arc welding (SAW) Flux Waste in the civil construction. It is used as a replacement of Coarse Aggregate in the production of Concrete. Fused SAW Flux Waste was mixed with Concrete by replacing coarse aggregate in 10%, 20%, 30% & 40%. The experimental study has been analysed and presented.*

Keywords — *Fused submerged-arc welding (SAW) Flux Waste, Compressive strength, Split Tensile strength, Flexural strength*

I. INTRODUCTION

Submerged arc welding is a versatile welding process in which coalescence is produced by heating the metal with an arc maintained between a bare metal electrode and the work piece. The arc is shielded by a blanket of granular fusible material known as flux placed over the welding area. Filler metal is obtained from the electrode and sometimes a supplementary welding rod or metallic addition. Flux contributes a major part towards welding cost in submerged arc welding. The Flux is converted into slag during welding which is treated as waste and discarded.

About 2500 tones of flux were consumed in India alone in year of 1982 which has risen to 10000 tons in the year of 2006. Such a large quantity of flux that becomes slag after welding & it has to be disposed-off. Land-fill space is required to dump the slag waste. It is non bio-degradable and will not decay with time. Disposal cost will increase apart from environment pollution. Non renewable resources may get exhausted due to continuous mining. It is not possible to stop the generation of slag because it is a by-product of the process but slag can be reused as a flux in the same submerged arc process again. The first attempt of recycling the slag was made by Alfred Beck in 1959. He used closed loop recycling process and started practicing this in 1963. After that the Paton electric welding institute of the national academy of science in Ukraine also reported the development of a technology for recycling of slag. Reuse of slag can not only minimize the above problems, but can also save non-renewable mineral resources.

The slag is normally reused after its processing & recycling so as to reclaim its original characteristics. However if this slag is reused as flux again only after crushing it to the normal particle size of the original slag without any new additions/processing, the cost of reuse of this slag will be quite low. However the quality of weld/clad metal obtained using this reused slag needs to be analyzed before recommending its reuse. The preset study aims at exploring the possibility of reused of the crushed slag as flux & effects of use this flux on the chemical composition and weld bead characteristics of the welds/clads obtained using this flux.

When making fused fluxes, the raw materials are dry mixed together, and then they are fused or melted into a liquid state by using a high temperature furnace. This may be accomplished by using a stream of water or with big chill blocks. Once the fluxes are cooled, they are crushed or ground into particles. A variety of particle sizes are made to ensure optimal performance for different applications. Advantages of fused fluxes are the non-hygroscopic flux particles do not absorb moisture and, therefore, any surface moisture can be eliminated merely by drying the particles at a low temperature oven setting of 300 degrees F, Low temperature drying of condensation on the fused flux particles provides better protection against hydrogen cracking, Flux particles create welds that are chemically consistent, Recycling of fused flux particles through the flux recovery systems can be achieved without losing sizing or composition.

II. RESEARCH ARTICLE

Viana, C. E., Dias, D. P., Holanda, J. N. F., Paranhos [1], has concluded that the SWF waste can be used as an alternative raw material for manufacturing of clay bricks. It was demonstrated that the technological properties of the bricks incorporated up to 10 % wt of SWF waste replacing clay are compatible with those specified for ceramic bricks.

Jatinder Garg, Baba Hira Singh, Dr. Kulwant[2] has concluded experimentally proved that the SAW slag after proper recycling/reclamation can be used & can produce the same results as are obtained by the use of fresh flux, then this technique can be adopted in practical field resulting in financial as well as ecological benefits.

Kulwant Singh1*, V. Sahni1, S. Pandey [3] has concluded that Submerged arc welding slag can be recycled. Recycled slag can produce weld metal having chemical composition within the acceptable range of American Welding Society specifications.

III. EXPERIMENTAL INVESTIGATION

A. Materials

Concrete was prepared by mixing various constituents like cement , fine aggregate, coarse aggregate, Saw flux and water.

*1) **Cement:*** Ordinary Portland cement of 53 grade conforming to IS12269-1987 was used throughout the work.

*2) **Fine aggregate:*** The fine aggregate used in this investigation was clean river sand of maximum size 4.75mm confirming to grading zone II of IS 383-1970.

*3) **Coarse aggregate:*** The coarse aggregate used was soaked in water for 24hoursand then air dried. The maximum size of coarse aggregate used is 20mm.

*4) **SAW Flux waste:*** The fused submerged-arc welding flux waste is generated in the submerged arc welding process. The maximum size of flux used is 20mm.

Fig. 1 Fused submerged arc welding flux waste

TABLE1
PHYSICAL PROPERTIES OF SAW FLUX & COARSE AGGREGATE

S.No	Physical Properties	Coarse Aggregate	Saw Flux
1.	Specific Gravity	2.54	2.75
2.	Water Absorption	1.00 %	0.5 %
3.	Bulk Density kg/ m^3 1)Loose Density	1392.45	1294.33
	2)Dry Rodd Density	1549.05	1443.96
4.	Crushing Strength	22.70 %	20.94 %

B. Concrete Mixes

Mix design is the process of selecting suitable ingredients of concrete and determining their relative proportion with the object of producing concrete of certain minimum strength and durability as economically as possible. The mix design is arrived as per Indian standard code 10262-1982 for M25 grade concrete.

TABLE 2
MIX RATIO FOR M25 GRADE CONCRETE

Grade of Concrete	W/C ratio	Concrete Mix Proportion		
		Cement	FA	CA
M25	0.52	1	1.66	3.44

C. Casting Of Cubes

Control Mix concrete and concrete modified with SAW flux was prepared. The Mix was prepared for M25Grade Concrete and the various proportions of SAW flux is tabulated below.

TABLE 3
MIX PROPORTION

Mix Specification	Control Mix	E1	E2	E3	E4
Proportion of SAW flux	0%	10%	20%	30%	40%

D. Tests

Cube specimens of size 150mm were casted for conducting compressive strength test at the age of 7 and 28 days for each proportion of SAW flux. The compressive strength of any mix was taken as the average of three cubes. Cylindrical specimens of size 300mm length and 150mm and flexural beams of size 500x150x150mm were also cast for finding the tensile strength of specimens and flexural strength on 7 and 28 days for each mix specification respectively.

TABLE 4
COMPRESSIVE STRENGTH TEST RESULTS

Sl. No.	Concrete Mix Type	Compressive Strength (N/mm^2)	
		7 Days	28 Days
1	0%	27.64	37.74
2	10 %	25.03	36.35
3	20%	23.69	34.69
4	30%	21.38	32.89
5	40%	18.30	29.44

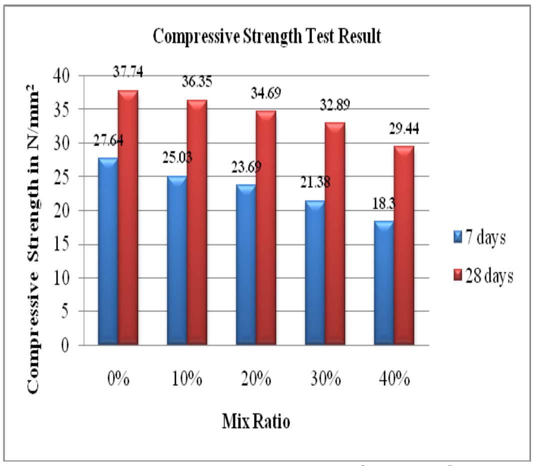

Fig. 2 Compressive strength test result

TABLE 5
SPLIT TENSILE STRENGTH TEST

Sl. No.	Concrete Mix Type	Split Tensile Strength (N/mm^2)	
		7 Days	28 Days
1	0%	2.84	3.85
2	10 %	2.61	3.71
3	20%	2.40	3.52
4	30%	2.15	3.34
5	40%	1.80	3.00

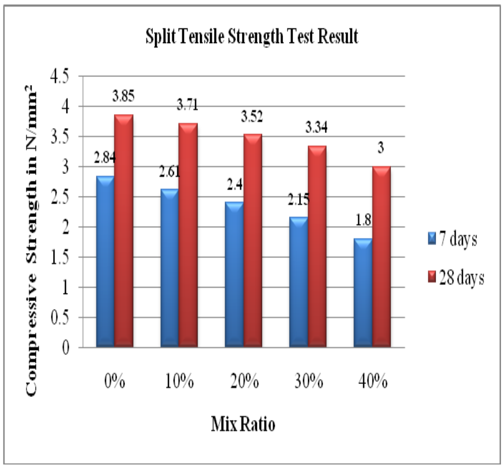

Fig. 3 Split Tensile strength test result

TABLE 6
FLEXURAL STRENGTH TEST RESULT

Sl. No.	Concrete Mix Type	Flexural Strength (N/mm^2)	
		7 Days	28 Days
1	0%	6.23	11.97
2	10 %	6.07	10.85
3	20%	5.43	10.02
4	30%	4.90	9.34
5	40%	3.74	8.26

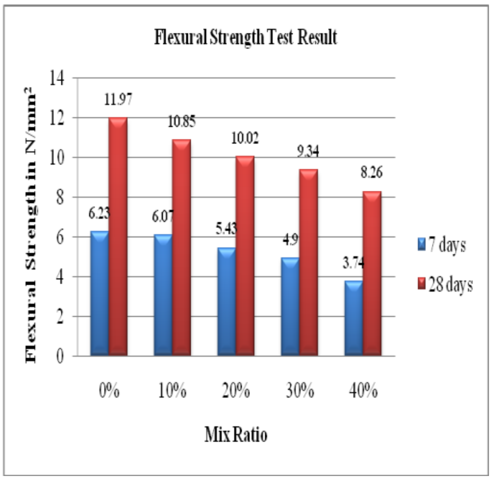

Fig. 4 Flexural strength test result

IV. DISCUSSION

By comparing the above result with the conventional concrete for compressive strength at 28 days ,it is observed that on addition of SAW flux waste up to 30% ,the compressive strength is reduced by 12.85%.This proves that when Coarse aggregate is replaced by SAW flux waste ,the compressive strength is reduced. And the split tensile strength and flexural strength also get reduced.

V. CONCLUSION

It is identified that Fused Submerged-Arc Welding Flux Waste can be recycled by using them as construction materials. Introduction of Fused Submerged-Arc Welding Flux Waste in concrete tends to make concrete ductile, hence increasing the ability to significantly deform before failure.

The results revealed that up to 30% replacement of Fused Submerged-Arc Welding Flux Waste concrete is giving an average compressive strength of 32.89 N/mm^2 for M25 Grade Concrete. The compressive strength of concrete cube decreases with the inclusion of Fused Submerged-Arc Welding Flux Waste but for 30% proportion of Fused Submerged-Arc Welding Flux Waste, it maintains the concrete compressive strength. On addition of 40% of Fused Submerged-Arc Welding Flex Waste, compressive strength of concrete decreases.

REFERENCES

[1] Viana, C. E., Dias, D. P., Holanda, J. N. F., Paranhos, R. P. R - Soldagem Insp. Sao Paulo, Vol. 14, No. 3, p.257-262, Jul/Set 2009
[2] Jasvinder Singh, Kulwant Singh, Sant Longowal - International Journal of Surface Engineering and Materials Technology, Vol.1 No.1 July-Dec.2011
[3] Jatinder Garg, Baba Hira Singh -National Conference On Advancements And Futuristic Trends In Mechanical And Materials Engineering (February 19-20, 2010)
[4] Kulwant Singh1*, V. Sahni1, and S. Pandey, Asian Journal .of Chemistry Vol. 21, No. 10 (2009), S047-051.
[5] www. en.wikipedia.org.
[6] http://www.keenovens.com/products/flux-details.html.
[7] “Concrete Technology” by M.S.Shetty
[8] “Concrete Technology” by A.R.Santha Kumar.
[9] Indian standard code 10262-2009 ,Concrete mix proportioning -Guidelines
[10] Indian standard code 4031-1968, Methods of physical tests in hydraulic cement
[11] Indian standard code 516-1979, Method of test for strength of concrete.
[12] Indian Standard code 12269-1987, Specification for 53 grade ordinary Portland cement, B.I.S., New Delhi.
[13] I.S.: 383 – 1970, Indian standard specification for coarse & fine aggregates from natural sources for concrete, B.I.S., New Delhi.
[14] Indian Standard Code 456 – 2000, Indian standard Specification for plain and reinforced concrete-code of practice.