Effect of Discarded Iron and Plastic as Partial Replacement of Sand in Concrete

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Abstract— **The increasing demand for sand and due to it's high cost and depletion of natural resource it is necessary to find replacement of sand in concrete. Reuse of solid waste as partial replacement of aggregate in construction activities results in reducing the demand for extraction of natural raw materials. In view of the fact that iron and plastic wastes are widespread types of non biodegradable solid wastes derived as discarded materials form several industrial processes, the knowledge of their combined influence on the strength properties of concrete is worth to be considered. The purpose of this project is to evaluate the possibility of using mixed iron filings and shredded PVC plastic simultaneously to partially sub statute the fine aggregate in concrete composites.**

Index Terms— **eco-friendly concrete, plastics, Galvanized Iron.**

I. INTRODUCTION

One of the main goals of sustainable solid waste management is to maximize the ability of its recycling and reusing. Metal and plastic are the most common of these materials. Both these materials play a major role in the day to day life and hence their production is more. When once plastics are broken or if it becomes too weak to carry enough load that it must carry then it is thrown as waste. On the other hand certain metals are melted and reused while certain metals cannot be reused. Metal iron filings from the foundries are generally dumped in land. With increasing environmental pressure to reduce waste pollution, the concrete industry has begun adopting a number of methods to achieve these goals. Preserving natural aggregate is a matter of sustainable development to ensure sufficient resources for future generation. Reuse of solid waste as partial replacement of aggregate in construction activities results in reducing the demand for extraction of natural raw materials as well as saving landfill space. Since landfill sites, in general, are becoming overcrowded and expensive for waste disposal, efforts must be made to minimize the quantities of materials that are delivered to landfills. If the production of waste cannot be prevented, then it is attractive to create an alternative use in another process instead of disposal. The benefits of this recycling can be economically advantageous, due lower costs of removing the waste and the reduction of pollution and contamination.

Considering the relevance of some types of solid wastes as recyclable materials that can be reused in concrete industry, much research effort has been focused on reusing waste materials from steel and plastic industries to partially replace the aggregate in concrete mixes. The quality of aggregate is highly important since approximately three-quarters of concrete volume are occupied by aggregate; it greatly affects the strength, durability and the structural performance of concrete. In view of the fact that iron and plastic wastes are widespread types of non-biodegradable solid wastes derived as discarded materials from several industrial processes, the knowledge of their combined influence on the strength properties of concrete is worth to be considered. The current study describes the impact of utilizing mixed iron filings and plastic waste to partially replace sand on the mechanical properties of the waste modified-concrete mixes.

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II. MATERIAL INVESTIGATION

An OPC 53 Grade cement was used in this investigation. The quantity required for this work was assessed and the entire quantity was purchased and stored properly in casting yard. The river sand is used as fine aggregate similarly when compare to the coarse aggregates passing through 20mm and retained on 12.5mm sieve was used in this investigation

A. Galvanized iron fillings

The galvanized iron fillings used were collected from lathe workshops .The iron filings are foundry waste. Iron filings are very small pieces of iron that look like a light powder and it is shown below in figure 1

Fig.1 Galvanized iron fillings

B. SHREDDED PVC

In the present investigation, PVC shredded plastic was used. PVC stands for Poly Vinyl Cholride. It is a polymer made by catalytic polymerization of vinyl chloride. PVC also includes co polymers that contain at least 50% vinyl chloride. It is hard, brittle and difficult to process but becomes flexible when plasticized and it is shown below in figure 2

Fig.2 shredded PVC

The basic test results will tabulated below as table 1

TABLE 1: MATERIAL PROPERTIES

PROPERTIES	CEMENT	COARSE AGGREGATE	FINE AGGREGATE	GALVANIZED IRON FILLINGS	SHREDED PVC
SPECIFIC GRAVITY	3.15	2.7	2.68	3.84	1.63
INITIAL SETTING TIME	35 min	--	--	--	--
FINENESS MODULUS	--	6.81	3.34	2.78	2.89
GRADE	--	--	ZONE II	--	--
CRUSHING VALUE	--	28.3	--	--	--

III. MIX DESIGN AND SPECIMEN

A. *Mix Design*

The grade of concrete used in this investigation is M-25 grade.The mix design for M-25 is calculated as per IS 10262:2009 "Recommended Guidelines for concrete mix design" and the cement: fine aggregate: coarse aggregate ratio is obtained as 1: 1:2 and the water to cement ratio is selected as 0.40.

B. *Workability*

The behavior of green or fresh from remixing up to compaction depends mainly on the property called "workability of concrete". Slump test is used to determine the workability of fresh concrete. Slump test as per IS:1199 – 1959 is followed. The apparatus used for doing slump test are slump cone and tamping rod.

C. *Specimen*

For this research 4 batches of mixes are prepared and its details are as follows. For each batch 6 cubes and 3 cylinders are casted.

TABLE II: SPECIMEN DETAILS

MIX NUMBER	PERCENTAGE OF IRON	PERCENTAGE OF PLASTIC	SLUMP VALUE
M1	0	0	98
M2	25	10	80
M3	50	10	67
M4	75	10	54

IV. EXPERIMENTAL PROCEDURE.

A. *Compressive strength test*

The size of mould used in this test is 100mm x 100mm x 100mm.The mould is cleaned well and oiled with the help of a waste cloth. Then the concrete is mixed according to the mix proportion given in the batching chapter. The concrete mix is then filled in the moulds in 3 layers and each layer is tamped not less than 25 times with the help of a tamping rod of diameter 16mm. The top surface is leveled and smoothened with the help of a trowel. The cube is then demoulded after 24hours and the specimens are cured in water. The specimen is then removed from water after specified curing time and the excess water is wiped out from the surface. The specimen is then dried for sometime till the wetness is completely dried. Then the specimen is then aligned centrally on the base plate of the machine. The movable portion is rotated gently by hand so that it touches the top surface of the specimen. The machine is then locked and the load is gradually and continuously applied till the specimen fails and the maximum load is recorded. The machine is stopped when the first crack is noticed, also the pointer in the dial gauge moves back. After that the movable portion is rotated so that the cube is free to remove from the machine. The reading is noted and the cracked cube is thrown away in a safe manner. This procedure is repeated for all the other mixes. The final results of compressive strength as tabulated in table 3 and figure 1.

TABLE III: COMPRESSIVE STRENGTH FOR GALVANIZED IRON AND PLASTIC

BATCH	COMPRESSIVE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
M1	17.33	29
M2	25.33	41.67
M3	20.67	32.33
M4	12	21

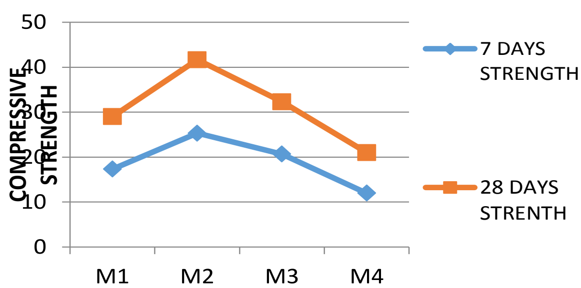

Fig.1 Graph showing the compressive strength for 7days and 28 days.

B. *Ultimate flexural strength test*

The rectangular mould of size 50cm x 10cm x 10cm is used for this test. The mould is cleaned and oiled first. The concrete mix is prepared according to the batch discussed in the later chapters. Then the concrete is filled in the moulds in 3 layers and each layer is tamped for not less than 25 times with a tamping rod of diameter 16mm. Then the top surface of the mould having the final layer is smoothened with the help of a trowel. The mould is de-moulded after 24hours and the specimens are cured in water for a specific amount of curing time. Then the specimen is removed from water and it is dried till the wetness is dried and then the specimen is prepared for testing after the excess water is wiped from the surface, if any. Centre point of the specimen is marked with the help of a marker or a chalk piece and the ends of the beam are rested on the supports present in the machine. Now the movable portion of the machine is rotated gently so that the specimen is completely locked inside the machine. The load is applied gradually on the specimen. The load where the specimen develops a crack and fails is noted. After that the movable part is rotated so that the specimen is removed and thrown away. The reading in the machine is then noted. This is the load at which the specimen fails. From this load with the formula given below the ultimate flexural strength of the specimen is calculated. The final results of compressive strength as tabulated in table 4 and figure 2.

Table IV: FLEXURAL STRENGTH FOR GALVANIZED IRON AND PLASTIC

BATCH	FLEXURAL STRENGTH (N/mm^2) 28 days
M1	8.57
M2	9.77
M3	8.27
M4	7.53

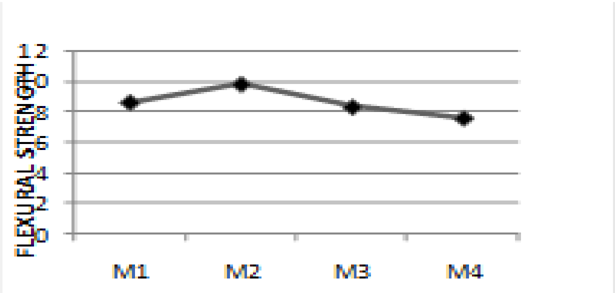

Fig.2 Graph showing the flexural strength for 7days and 28 days

V. CONCLUSIONS

- The workability of the concrete decreases approximately by 17.51% for each mix.
- The compressive strength of the mix M2 which is the replacement of sand by 25% iron filings and 10% plastic is high.
- The compressive strength obtained was 41.67 N/mm^2 .Almost 40% increase in strength when compared to the target strength is seen.
- The ultimate flexural strength of the concrete is seen high for the mix M2. The flexural strength obtained was 9.77 N/mm^2.
- Thus it can be concluded that the galvanized iron and shredded PVC plastic used in this project in the percentages 25 and 10 respectively (M2 mix proportion) was found to be optimum as it produced a higher compressive and flexural strength when compared to the other mixes used in this experiment. Overall, the use of iron and plastic waste materials is, indeed, a viable solution to recycling such waste materials in concrete mixes.

REFERENCES

[1] "Code Of Practice For Plain And Reinforced Concrete IS 456:2000", Bureau of Indian Standards, New Delhi.
[2] "Concrete Mix Proportioning – Guidelines IS 10262 - 2009", Bureau of Indian Standards, New Delhi.
[3] A.Bhogayata, K.D. Shah. IJRET Journal, " Performance of concrete by using Non recyclable plastic wastes as concrete constituent"
[4] M.S Shetty. "Concrete Technology", Chand Publications, New Delhi.
[5] P.Suganthy, Dinesh Chandrasekar. IJRET Journal, " Utilization of pulverized plastic in cement concrete as fine aggregate"
[6] Zainab Z. Ismail, Al-Hashmi, " Validation of using mixed iron and plastic wastes in concrete"