EXPERIMENTAL STUDY ON RADIATION SHIELDING CAPACITY CONCRETE USING GGBS WITH LATHE METAL WASTE

P.Rajeswari[#1] and Dr. M.Mariyappan [*2]

[#] *Department of Civil Engineering, Adhiparasakthi Engineering College,Tamilnadu, India*
[*] *Prof. and Head of Civil Engineering Department, Adhiparasakthi Engineering College, Tamilnadu, India*

Abstract— **The advanced construction techniques and equipments have made the construction work much easier. Although the strength and durability of the concrete structure largely depends on the properties of the concrete. The properties of the concrete can be improved by using various types of fibres. In today world there is an increase in population and industrial activities the quantity of waste fibre generated from various lathe metal industries will increase manifold in the coming years. These lathe metal waste fibres can be effectively used for making high strength low cost concrete. In this study an attempt has been made analysis the characteristics of the waste steel scrap material which is available from the lathe is used as a steel fibre in concrete. Using of wastes and industrial by-products as concrete aggregate to be used as structural and radiation shielded material has increased in the recent years. Concrete was mixed with different amounts of lathe metal scrap used as partial replacement of sand in the studied composites. The concrete composites obtained were characterized in terms of density, compressive strength and attenuation of γ-rays. The attenuation coefficient and the half value thickness of the different matrices were calculated and discussed. The characteristic of compressive strength, flexural strength, split tensile strength and Radiation shielding capacity of M25 cement concrete with various proportion adding 0% ,25%,50%,75%of GGBS in concrete in replacement of cement and also the 3% of lathe metal scrap is added in all mix proportion of GGBS. Finally test results are compared with conventional concrete.**

Index Terms— **Mix design of concrete, properties of lathe metal scrap, Compressive strength, split tensile strength, flexural strength test of concrete made with lathe metal scrap radiation shielding capacity of concrete.**

I. INTRODUCTION

The high performance concrete usually contains Portland cement. The use of different types of sub-products into the cement based materials has become a common practice in concrete industry. However the partial introduction of metal waste from industries are help to improve their strength properties. So the waste can be used economically into the concrete is advantageous. This project to study the concrete made with lathe metal scrap in normal concrete. It has been observed that the composites reinforced with the lathe metal scrap are more advantageous in terms of post-cracking behavior and load-carrying capacity. Since these lathe metal scrap are available locally, they can be easily used in to the concrete. Due to their coiled nature they may offer more resistance to loads. In these project the addition of GGBS into concrete mass can whither it increase the strength properties like compressive strength, tensile strength, and flexural strength and it is also tested in Radiation shielding capacity of concrete.

II. OBJECTIVES

• The objective of these research are adding 0% ,25%,50%,75%of GGBS in concrete in replacement of cement and also the 3% of lathe metal scrap is added in all mix proportion of GGBS, then the following test are to be conducted such as,

- Compressive strength
- Split tensile Strength
- Flexural strength of concrete
- Radiation shielding capacity of concrete(To determine the attenuation coefficient of concrete)
- The test results are compared with conventional concrete

III. MATERIALS

A. LATHE METAL SCRAP & GGBS

The use of steel products from the lathe workshop is enormous in day to day activities. Since 2009, India has consumed in total around 100 million tones of iron and steel scrap each year. The amount of lathe metal scrap produced from lathe workshops is very high. At present these scraps are recycled through recycling process. But these scraps are in fibres shaper it can be directly used is concrete. The performance of lathe metal scrap is improving the concrete properties. The direct use of lathe metal scrap also helps saving the recycling cost. The chemical composition of Ground Granulated Blast Furnace Slag(GGBFS)

TABLE 1 CHEMICAL COMPOSITION OF GGBS

Composition of GGBS	%
SiO_2	35.34
Al_2O_3	11.59
Fe_2O_3	0.35
CaO	41.99
MgO	8.04

B. RADIATION SHIELDING MATERIALS

A variety of materials can be used for radiation shielding. To choose an appropriate type of shielding material, the type of radiation that is being shielded, the energy of the radiation, and the level of dose reduction are in need to be considered. In choosing a shielding material, the first consideration must be effectiveness. If dealing with external radiation protection, the most important consideration must be personnel protection. An effective shield will cause a large energy loss in a relatively small penetration distance without emission of more hazardous radiation. However, other factors may also influence the choice of shielding materials such as, cost of the material, weight of the material, and how much space is available for the material. The effectiveness of the shielding material is determined by the interactions between the incident radiation and the atoms of the absorbing medium. The interactions which take place depend mainly upon the type of radiation, the energy of the radiation, and the atomic number of the absorbing medium. The typical radiation shielding material are given in Figure

Fig 1 Typical radiation shielding material

C. MIX PROPORTIONS (M25)

Cement = 413.33 kg/m3
Water = 186 kg/m3
Fine aggregate = 648.85 kg/m3
Coarse aggregate = 1101 kg/m3
C : W : F.A : C.A 1: 0.45 : 1.57 : 2.66

D. SPECIMEN DETAILS

Chettinad brand Ordinary Portland Cement (OPC) 53 Grade confirming to IS: 4031-1988. Locally available river sand confirms to Zone II of IS: 383-1970 as fine aggregate, Crushed granite aggregate of maximum size 20 mm confirming to IS: 383 as coarse aggregate and Potable water are used. Steel Scraps of length 25 mm to 30 mm, width 1.5 to 2 mm and thickness 0.3 to 0.4 mm which is obtained from the lathe machines as waste or by product are used as

reinforcing material in the concrete. To increase concrete density, the lathe metal scrap was added to concrete. The rectangular concrete blocks made with different % of lathe metal scrap having cross section of 150×150 mm, and thicknesses varies from 30mm to 65 mm are used for radiation attenuation test. To do so, concrete specimens were irradiated by gamma beam of 60Co (Phoenix Theratron). A total of 24 specimens, 150mm size cubes, total of 24specimens of cylinder 150 mm diameter and 300 mm height total of specimens,100mmx100mm x500mm beams and a total of 24 specimens of cylinder 150 mm diameter and 60mm height were tested to study the above parameters. The addition of 0%,25%,50%,75%of GGBS in to the concrete is added , then the Compression strength, split tensile strength, Flexural Strength, Radiation shielding capacity of concrete test are to be conducted

E. TEST PROCEDURE OF RADIATION SHIELDING CAPACITY OF CONCRETE

The γ ray standard sources (60Co) were put at the source position. The γ radiations emitted from these sources were passed through air without putting any blocks which strike the detector and their γ rays energy spectrum was measured for 120 seconds. The intensity of the traveled γ rays was detected which considered equal to the incident γ ray intensity peak, Io.Then the concrete block was placed in its position at the holder, and the γ radiations were allowed to pass through each of the concrete blocks for 120 seconds, where its energy spectra were recorded. The intensity of the transmitted γ ray peak energies for each concrete block was detected as the net area under the corresponding peak energy and recorded as the intensity of the attenuated γ peak energy Ix. Applying the measured values of Io and Ix in the attenuation coefficient equation; $I_x = I_o e^{-\mu x}$, the linear attenuation coefficient (μ) of the concrete block is determined. The half value thickness (HVT), which is the thickness at which Io reduces to its half value, of the different concrete cubes for each energy can be calculated by the equation; HVT $(X_{1/2})$ =0.693/ μ.The results are tabulated in table4.The basic test procedure are shown in Figure
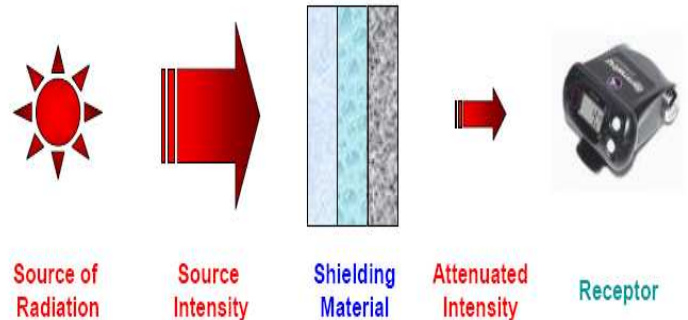

Fig 2 Basic test procedure

Lambat's Law
$I = I_o e^{-\mu x}$
Where,

I – Transmitted intensity of radiation in(mSv/hr) millisievert Per hour

Io- incident intensity of radiation in millisievert per hour

μ-absorption coefficient per cm of material at a particular radiation energy.

X – Thickness of concrete made with lathe metal scrap.

Fig 3 Intensity of radiation measured from Phoenix Theratron with concrete block
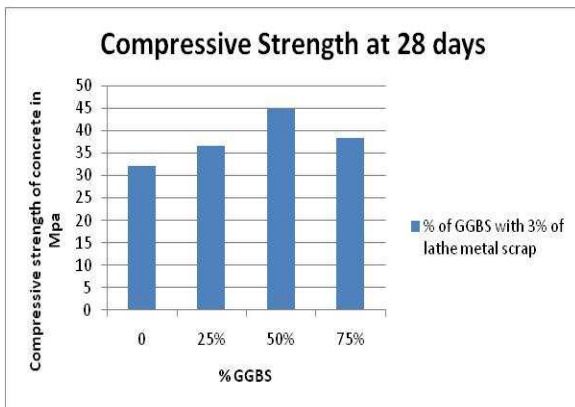
IV. TEST RESULTS

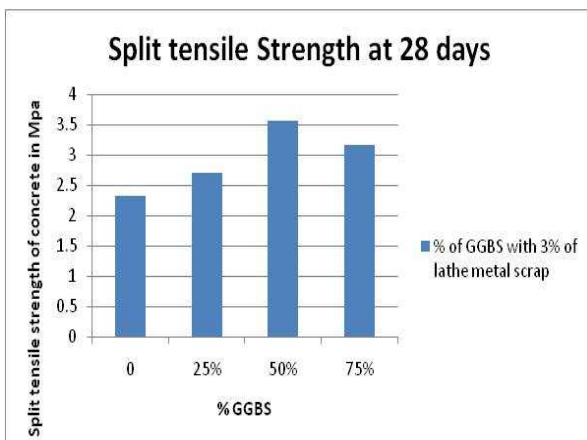Fig 4 compressive strength of concrete at 28 days
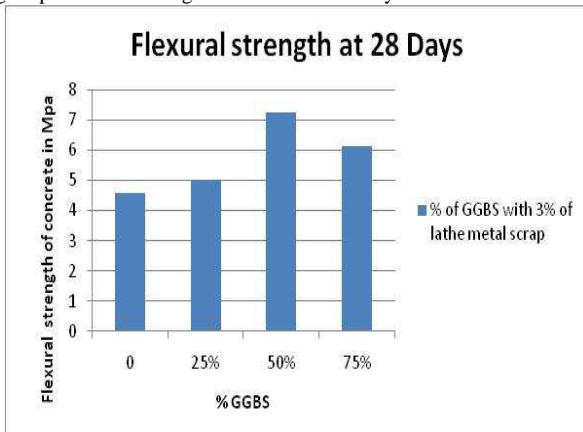

Fig 5 Split tensile strength of concrete at 28 days

Fig 6 Flexural strength of concrete at 28 days

TABLE 2 TEST RESULTS OF ATTENUATION COEFFICIENT OF CONCRETE

Sl. No	% GGBS with 3% of lathe metal scrap	Thickness of concrete specimen(cm)	Transmitted intensity of radiation(mSv/hr)	% of passing intensity	Attenuation coefficient(1/cm)
1.	0	3.0	290	80.55	0.052
2.	0	4.5	270	75.00	0.039
3.	0	6.0	266	73.88	0.030
4.	25	3.0	250	69.44	0.067
5.	25	4.5	232	64.44	0.050
6.	25	6.0	228	63.33	0.038
7.	50	3.0	150	41.67	0.128
8.	50	4.5	112	31.11	0.108
9.	50	6.0	103	28.61	0.086
10.	75	3.0	195	54.17	0.095
11.	75	4.5	176	48.89	0.072
12.	75	6.0	161	44.72	0.059

V. CONCLUSION

The following conclusions are arrived based on experimental investigation.

- The addition of GGBS in to concrete by 25% and 50% volume fraction results in increase of 13.5%, 25.56% in the compressive strength when compared to the plain concrete after 28 days curing. But addition of GGBS of 75% in to the concrete results in decrease in compressive strength by 14% as compared with the 25% addition of GGBS in to the concrete.

- The addition of GGBS in to concrete by 25% and 50% volume fraction results in increase of 13.70%, 34.55% in the Split tensile strength of concrete when compared to the plain concrete after 28 days curing. But addition of GGBS of 75% in to the concrete results in decrease in split tensile strength by7.93% as compared with the 25% addition of GGBS in to the concrete.

- The addition of GGBS in to concrete by 25% and

50% volume fraction results in increase of 8.78 % , 30.99% in the Flexural strength when compared to the plain concrete after 28 days curing. But addition of GGBS of 35% in to the concrete results in decrease in Flexural   strength by 15.84% as compared with the 75% addition of GGBS in to the concrete.

- The attenuation of coefficient in concrete made with 50% of GGBS as higher value compared with plain concrete and also 57.89% reduction in intensity of radiation as compared with plain cement concrete.

REFERENCES

[1] Sekar T. (1999), 'Role of Fibre in Concrete', Proceeding of the National Symposium on Recent Trends in Concrete Technology, Vol. 1, pp. 225-228

[2] Sangeetha P., and Sumathi R. (2010), 'Behaviour of Glass Fiber Wrapped Concrete Columns Under Uniaxial Compression', International Journal of Advanced Engineering Technology, Vol. 1, pp. 74-83.

[3] Chandramouli G. (2010), 'Study on Strength and Durability Characteristics of Glass Fibre Concrete', International Journal of Mechanics and Solids, Vol. 5, pp. 15-26.

[4] Demir D, Kele G (2006). 'Radiation transmission of concrete including boron waste for 59.54 and 80.99 keV gamma rays',Nucl Instrum Meth B, 245: 501-504.

[5] El-Sayed AA, Kansouh WA, 'Investigation of radiation attenuation properties for baryte concrete', Megahid RM (2002), J. Appl.Phys. 41.

[6] hitti Babu Kolangini (2010) "Durability Studies on High Performance Concrete", Mtech Thesis submitted at NIT Tiruchirappalli.

[7] IS 516 – 1959 Method of Test for Strength of Concrete.

[8] M.S.Shetty., Concrete Technology, Theory and Practice, 6th Edition, New Delhi, S.Chand & Company Ltd, 2005.

[9] ANSI/HPS N43.3-2008, American National Standard For General Radiation Safety - Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV

[10] F. Demir, G. Budak, R. Sahin, A. Karabulut, M. Oltulu, and A. Und, "Determination of radiation attenuation coefficients of heavy weight and normal-weight concretes containing colemanite and barite for 0.663 MeV γ-rays" Annals of Nuclear Energy, vol. 38, pp. 1274–1278,2011.

[11] E. Yılmaz, H. Baltas, E. Kırıs, I. Ustabas, U. Cevik, and A. M. El-Khayatt, "Gamma ray and neutron shielding properties of some concrete materials," Annals of Nuclear Energy, vol. 49, pp. 303-312, 2011.

[12] O. Gencel, A. Bozkurt, E. Kam, and T. Korkut, "Determination and calculation of gamma and neutron shielding characteristics of concretes containing different hematite proportions," Annals of Nuclear Energy, vol. 38, pp. 2719–2723, 2011.