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Radiation Sheilding Capacity Of Concrete Using Waste Steel Slag

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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 (2%,3%,4%,6%) of lathe metal scrap are experimentally found out. The experimental results shows that the property such as compressive strength, flexural strength, split tensile strength and the radiation shielding capacity of concrete are found to be increased by 24%,20%,21%,50% due to addition of lathe metal scrap fibre in the concrete.

1.Introduction

Concrete, the most widely used construction material, is always under development. Modern concrete is more than simply a mixture of cement, water and aggregates. Generally, it contains often mineral components, chemical admixtures, fibers, etc. Recently, the use of medium and high energy gamma rays has increased in Iran, and radiotherapy centers along with a variety of accelerators have been installed in some provinces. Hence, there is not sufficient skill in designing and installing radiotherapy treatment rooms. This study was conducted to evaluate the efficacy of different mixtures of concrete made with lathe metal scrap for shielding the radiotherapy rooms. This way, we have emphasized on determining the % lathe metal scrap to achieve the maximum radiation attenuation which leads to minimizing wall thickness in treatment room. The methods of radiation attenuation depend on the energy and the type of radiation. Selection of concrete γ-ray shielding usually depends on radiation energy and cost of shielding material. Using high density concrete in constructing the walls of cobalt and accelerator bunkers is more efficient than the conventional concrete The conventional concrete density is about 2.4g/cm3 which will increase by adding lathe metal scrap. Cameron et al. (5) were reported that the Half Value Layers (HVL) of the barite and conventional concrete for narrow beam of 60Co gamma are 4.06 and 5.08 cm respectively.

1.1 Objectives

- To study the compressive strength of concrete with lathe metal scrap.
- To study flexural strength, split tensile strength of concrete with lathe metal scrap.
- To compare the strength of conventional concrete with concrete made with lathe metal scrap

- To study radiation shielding capacity of concrete (To determine the attenuation coefficient of concrete and its values are compared with concrete made with lathe metal scrap)

2.Properties of Material and 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 lathe metal scrap with specimens incorporated 0%, 2% and 3% and 4% volume fraction were added to the concrete.

3.Results and Disscussion

3.1Compressive Strength

This test was carried out in accordance with IS 516 –1999.The cubes were casted to the size of 150mm.The specimens were prepared with varying proportions lathe metal scrap of 0%, 2%,3% and 4% were tested. The results are shown in Table 1.

Table 1 Compressive strength test results

SI.No.	% of lathe metal scrap	Compressive strength In MPa	
		7 days	28 days
1	0	21.60	30.50
2	2	23.45	32.56
3	3	25.85	33.40
4	4	22.87	30.80

It shows that addition of lathe metal scrap from 3% to 4% decreases the compressive strength by 7.21%.

3.2 split tensile strength

The split tensile test was conducted test as per IS516(1959) procedure. The specimens cured were tested after 7days and 28 days. The results are shown in Table2 . It shows that addition of lathe metal scrap from 3% to 4% decreases the split tensile strength by 10.95%.

Table 2 split tensile test results

SI.No.	% of lathe metal scrap	Split tensile strength In MPa	
		7 days	28 days
1	0	1.99	2.33
2	2	2.48	2.70
3	3	3.17	3.56
4	4	2.56	3.17

3.3 Flexural strength

The flexural strength was conducted as per IS516 (1959). Two points loading was applied to the specimens. The breaking load for the specimen were noted down. The flexural strength of the specimen is calculated using the formula fcr =(Pxℓ)/ (bxd2).The flexural strength are shown in table no 3.

Table 3 Flexural strength test result

SI.No.	% of lathe metal scrap	Flexural strength In MPa	
		7 days	28 days
1	0	2.8	3.52
2	2	4.17	5.01
3	3	5.68	7.26
4	4	4.69	6.11

Addition of lathe metal scrap from 3% to 4% decreases the flexural strength by 15.84%.

3.4 Radiation Shielding capacity of concrete test procedure

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; Ix =Io e-μx, 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 (X1/2) =0.693/ μ.The results are tabulated in table4.The basic test procedure are shown in Fig 1.

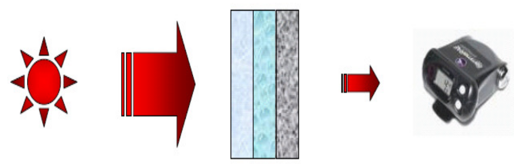

Fig 1 Radiation shielding test procedure

Table 4 Attenuation coefficient of concrete

SI. No.	% of lathe metal	μ cm^{-1}	HVT (cm)
1	0	0.039	17.76
2	2	0.050	13.86
3	3	0.108	6.42
4	4	0.072	9.62

The attenuation of coefficient of concrete is increase with increase in addition of lathe metal scrap upto 3% of lathe metal scrap and about 57.89% reduction in intensity of radiation as compared with plain cement concrete.

4. Conclusions

The following conclusions are arrived, based on the limited experimental investigation carried out.

- The compressive strength shows an increase of 6.34% and 8.68% with the addition of Lathe metal scrap into concrete by 2% and 3% respectively, when compared with the plain concrete after 28 days of curing.
- The addition of Lathe metal scrap into concrete by 2% and 3% results in an increase in the Split tensile strength by 13.70% and 34.55% respectively, when compared with the plain concrete.
- The addition of Lathe metal scrap into concrete by 2% and 3% volume fraction results in increase of 8.78 % and 30.99% respectively, in the Flexural strength when compared with the plain concrete.
- The attenuation coefficient of concrete made with 3% lathe metal scrap gives higher value when compared with the plain concrete
- About 57.89% of reduction in the intensity of radiation is achieved with 3% addition of lathe metal scrap into the concrete, as compared with the plain cement concrete.
- But with addition of Lathe metal scrap with the concrete about 4%, the Compressive strength, Split tensile strength and the Flexural strength are reduced by 7.21%, 7.93% and 15.84% respectively. Also the attenuation coefficient of the concrete is reduced.
- This reduction in the strength is attributed mainly due to the presence of the voids in the concrete.
- Hence it is evident that 3% lathe metal scrap added into the concrete gives the best result on all aspects. So, it can be concluded that the use of 3% of lathe metal scrap into the concrete will be optimum.

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