Nondestructive testing of concrete by gamma backscattering method

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Introduction

Nondestructive testing (NDT) methods are used to examine objects without destroying it. In many situations like working industrial plants and fluid transportation system, inspection of huge or thick sized objects by destructive methods are not desirable. The Compton backscattering of gamma rays, one of NDT techniques could be used for material characterization and detection of defects in materials easily.

Concrete structures require testing after the concrete has hardened, to determine whether the structure is suitable for its designed use. There is a possibility of defects in the constructed buildings and structures, and therefore, defects like voids and cracks, if any, have to be evaluated for the purpose. Further, periodic testing of old buildings and structures to know their integrity has become a necessity. These types of testings can be conducted only by employing nondestructive techniques[1].

In the present study, Ordinary Portland Cement (OPC) of grade 43 from UltraTech Company was used in making the 100 mm × 100 mm × 10 mm concrete blocks. The concrete mix for the specimen comprised OPC, fine sand, and water in the proportion of 1:2:0.272. It was found that the weight of all the samples were almost the same and the density was about 2.42 g/cm^3

Method of Measurements

The experimental set-up to measure the backscattered photons is shown in Fig. 1. Gamma photons of 0.662 MeV are obtained using ^{137}Cs of strength 5.8 mCi from a suitable collimator. The gamma spectrometer kept at a backscattering angle of 120° with respect to the source, consists of 76 mm × 76 mm NaI (Tl) scintillation detector.Fig. 1 shows the experimental set-up for measurement of backscattered γ-rays. The entire experimental set-up was placed at a height of 340 mm on a stable platform. The experimental data were accumulated on a PC using Microsoft Windows-XP based spectroscopic application software *winTMCA32*, acted as a user interface for system set-up and display. A software program using *winTMCA32* was written for the present experimental set-up in order to evaluate parameters backscattering events.

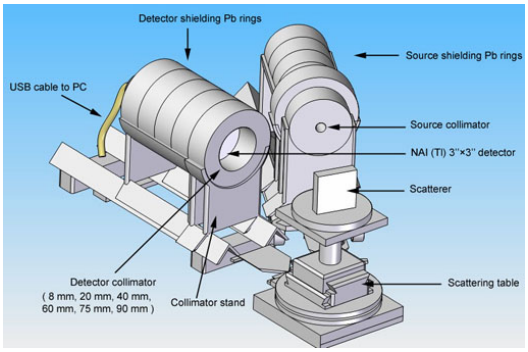

FIG. 1: Experimental setup

Results and conclusions

Backscattered spectrum is obtained by irradiating OPC concrete targets of thickness 10 mm to 160 mm.The dead time corrected acquisition time of 1000 seconds was used to acquire the data. The multiple scattered photons with respect to concrete target thickness are found and increases with increase in sample thickness and becomes almost a constant, noted as the saturation thickness [2, 3] of the

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concrete block. The saturation thickness of the concrete block made of OPC was found to be about 70 mm(Fig. 2). To study the density variation of the target material, the following study was carried out using concrete targets. Rectangular targets of aluminium, iron, copper, and composite materials such as high density polyethylene (HDPE), Polyvinyl chloride (PVC), Nylon, Polytetrafluoroethylene (Teflon), and OPC concrete were intruded (simulating inclusions) in between concrete blocks of the same dimension. It can be seen from (Fig. 3) that the backscattered photons also increases with increasing of their density.To evaluate the variation in the thickness of the materials inserted inside the concrete targets, experiments were conducted using iron plates of varying thicknesses (1 mm to 10 mm). Iron plates of the same dimension as that of the concrete blocks were inserted between them and the backscattered counts were obtained and presented in Fig. 4.

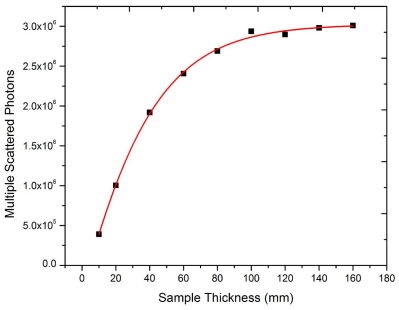

FIG. 2: Multiple scattered photons as a function of target thickness for concrete targets.

The intensity of the backscattered photons increases with increase in its thickness . This observation shows that any variation in thickness or density of the material inside the concrete blocks or structures can be easily identified. Using this method, a change in variation of steel reinforcement of known dimension in concrete due to corrosion can be easily identified, and the extent of corrosion can be accurately quantified during inspection or evaluation. Therefore, the NDT method using gamma backscattering technique can be employed as a useful method to identify corrosion and to estimate the extent of corrosion inside buildings and structures.

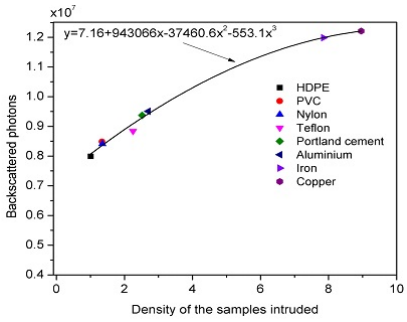

FIG. 3: Backscattered counts as a function of density of material intruded.

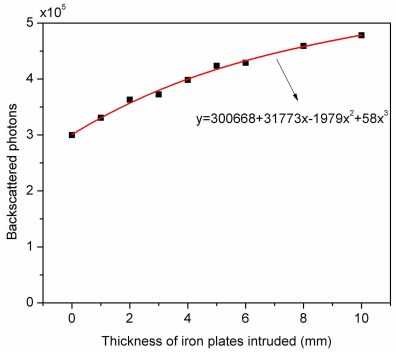

FIG. 4: Backscattered counts as a function of thickness of iron plates intruded.

Acknowledgements

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References

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