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A Study on EMI Shielding Material Effectiveness for Building Construction

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Abstract. EMI shielding materials are often used to limit the penetration of electromagnetic field into space. These shielding materials block electromagnetic radiations with barrier made of conductive materials. Thus, with effective shielding in room or building, external electromagnetic field are not able to penetrate into the shielded space for security purposes. This paper presents the initial investigation on the shielding effectiveness of various shielding materials and also its apertures size in order to get optimum protection for building from EMI. Experimental works on taking measurement of the signal penetration level is conducted in anechoic chamber in STRIDE.

Keywords: electromagnetic interference (EMI), shielding effectiveness (SE), skin effect, antenna, concrete.

1. Introduction

Electromagnetic interference may exixts significantly to intefere the operation of certain devices or equipments such as radar system used in military or computer control room. It can be any form of disturbances caused in radio receiver or any electrical circuit by electromagnetic radiation emitted by external force like antenna. Thus it is vital to develop an effective EMI shielding material to be used in the bulding contruction for placing military and scientific electronic devices and communication instruments for high security level. [1, 2]

The shielding effectiveness is the amount of attenuation of incident radiation by a particular material and is expressed in decibel (dB). An electromagnetic wave can be attenuated by absorption inside the materials, by multiple internal reflections inside the materials and also by reflection from the outer surface. Shielding effectiveness is correlated with factors such as the material's diameter, variable-density and structures and etc. Tab. 1 below shows the conductivity, permeability and relative permeability of various materials which provides different levels of shielding effectiveness.

Carbon materials have gained popularity in polymer composites of shielding materials[3-5], owing to their light weight properties and electrical conductivity, chemical resistance and low density. However, high conducting materials are always claimed to be most suited for EMI shielding purposes [6- 8]. For conductor, ferromagnetic material such as iron and steel are used for to protect sensitive electrical devices from interference of external electromagnetic field.

Table. 1: Shielding Material and its properties

Material	Conductivity (σ)Sm^{-1}	Permeability(μ)$\frac{H}{m}$	Relative permeability
copper	$5.82x10^{7}$	$1.256\ x10^{-6}$	0.99994
aluminium	$3.55x10^{7}$	$1.25\ x10^{-6}$	1.00022
nickel	$6.11x10^{7}$	$1.25\ x10^{-4}$	100
Mu-metal	$1.33x10^{7}$	$2.5\ x10^{-2}$	20000

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This paper presents the initial investigation on the shielding effectiveness of various shielding materials and also its apertures size in order to get optimum protection for building from EMI. Experimental works on taking measurement of the signal penetration level is conducted in anechoic chamber.

2. Experimental Setup

The shielding material, Mu- metal is to be placed inside the concrete block. There will be four concrete to be casted by placing Mu-metal with apertures size of 0.25 inch and 0.5 inch into concrete block is ca each block respectively. These concrete blocks are casted based on the standard wall building which has a cement mixture of grade 30. This material has been proven to be an effective EMI shielder as possessing high permeability.

In order to measure the shielding effectiveness of the material that will be placed into concrete block, signal is transmitted and penetrate into the casted concrete block and measurement of received signal is taken using vector analyzer in anechoic chamber as these measurement on th elevel of penetration of the material must be done in a shielded room whose walls have been covered with a material that scatters or absorbs so much of the incident energy that it can simulate free space from any unwanted signal that exists at surrounding [9].

3. Results & Analysis

Based on the experimental measurements as shown in Fig. 1 that were taken in anechoic chamber, the shielding material of 0.5 inch aparrture able to reduce signal penetration up to 20% at frequency of 0.7GHz when compared to the unshielded concrete blocks. The resultant proves that the 0.5 inch Mu-metal able to block signal from passing through the concrete block.

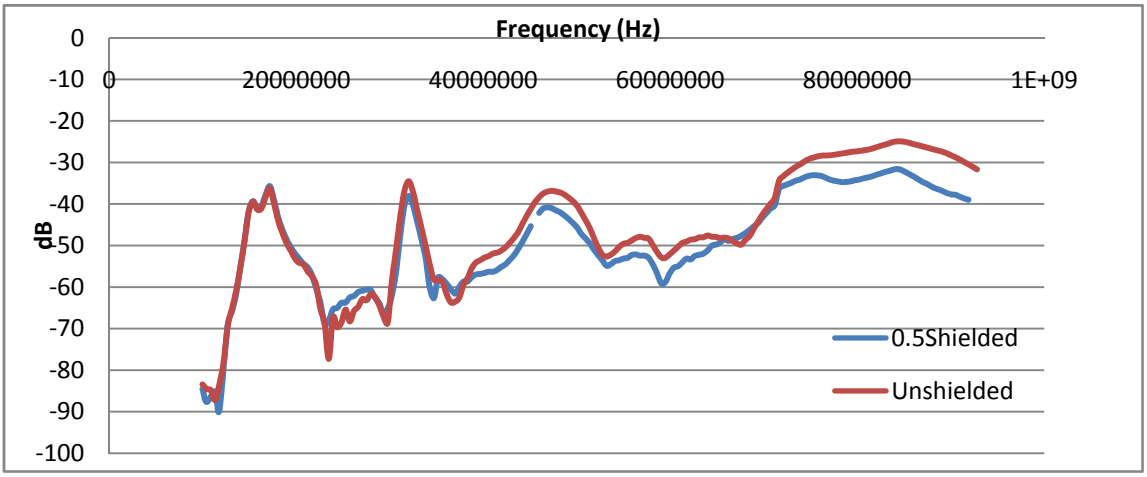

Fig. 1: Measurement of shielding effectiveness of 0.5 inch Mu-Metal.

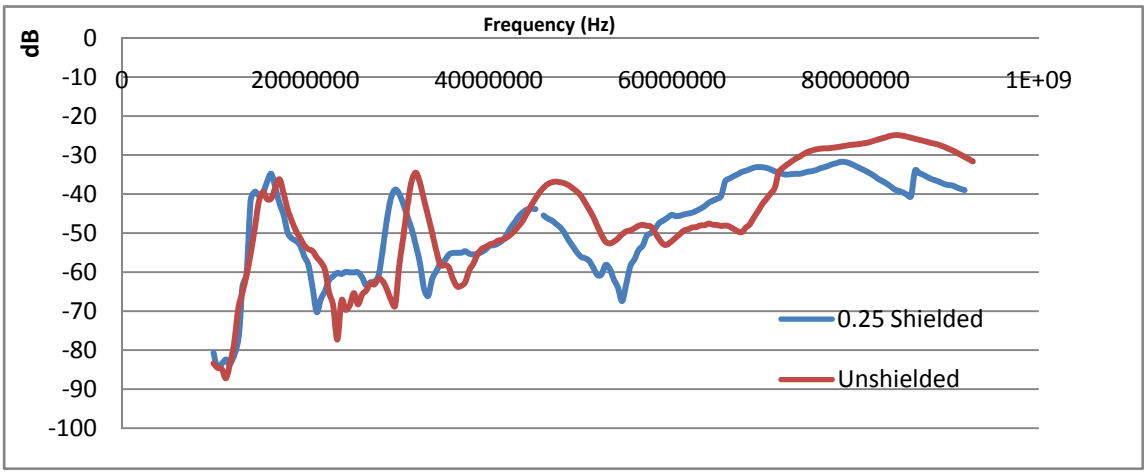

Fig. 2: Measurement of shielding effectiveness of 0.25 inch Mu-Metal.

Meanwhile the shielding material of 0.25 inch aperature reduces signal penetration up to 60% at frequency of 0.85GHz when compared to the unshielded concrete blocks. However, level of penetration seems to be increased in the range of frequency of 0.6GHz. This two graphs above show initial result of measuerement of shielding effectiveness from material placed in the concrete of wall building. Thus, the shielding material, the wider the size of apertures, the shielding effectiveness will decrease.

4. Summary

This paper presents the shieding effectiveness testing on Mu-metal with two different apertures sizes. The shielding effectiveness is an important parameter to determine whether the material is suitable to consider as shielding material for electromagnetic. In this paper we have investigate the effect of size of apertures on shielding material. The research need to be continued from aspect variety type of shielding materials.

5. Acknowledgements

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