ANTI ELECTROMAGNETIC GREEN BUILDING MATERIALS FOR SUSTAINABLE FUTURE

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Abstract - *New era means most modern technologies. Nobody can think about a world without modern technologies. With the use of most modern electronic equipments, harmful electromagnetic radiations are rapidly increasing to a rate that we can't even imagine. These radiations are harmful to both human beings and environment. To protect our health and environment from these serious electromagnetic radiation, electromagnetic functional material become an inevitable requirement of the society. Electro Magnetic wave absorbing materials has great significant in present scenario. In this research paper ferrite is used as chief EM functional material along with different green material especially waste material. Absorption performance of different composition of materials with different thickness range is tested in 1-8GHz frequency range. To create a sustainable future and pollution free environment different green materials and their electromagnetic absorption capacity is analyzed*.

Key Words: **Electro Magnetic (EM) Radiation, Green Materials, Reflection Loss, Ferrite, Sustainability**

1. INTRODUCTION

Most modern world is filled with most modern electronic reequipments' are living in a digital era, highly anticipated electronic equipment are widely using everywhere. They become an inevitable part of our day-to-day life. Due to this widespread use of electronic equipment having heavy frequency range EM radiation is increasing to an unimaginable rate. These harmful radiations are affecting human health and environment. Living in a healthy pollution free environment is like a dream today. Building materials having the capacity to absorb this harmful EM radiation have great importance in current society.

In the present scenario green buildings become the Centre of attraction of the construction industry. People are showing more interest towards green buildings and green materials in order to achieve safe and sound living.

1.1 Electro Magnetic Interference (EMI)

The disruption caused by EMWs in another electronic device, causing the second device to malfunction is known as the electromagnetic interference (EMI) [7–12]

2. Electromagnetic functional materials

The EM functional materials with attenuation effect on EM waves are usually divided into EM wave absorbing materials and electromagnetic interference (EMI) shielding materials.[1]

2.1 EMI shielding materials

EMI shielding materials can separate the two regions and control the induction and radiation of electric fields, magnetic fields, and EM waves from one region to the other. Both reflection and absorption in EMI shielding materials will contribute greatly to excellent EMI shielding. However, based on the pursuit of the green shielding concept, the ideal EMI shielding requires low reflection and strong absorption.[1]

2.2 Electromagnetic wave absorbing material

EM wave absorbing material refers to a class of materials that can absorb EM waves energy projected onto its surface.[1]

3. DESIGN PRINCIPLE

An incident EM wave through EM absorbing material undergoes three processes: reflection, absorption and penetration, as shown in Fig. 1. EM wave absorption is a process, in which the EM energy will be transformed into other forms energy under the action of EM loss fillers, so that the incident wave cannot be reflected or permeated through the materials [2,4]

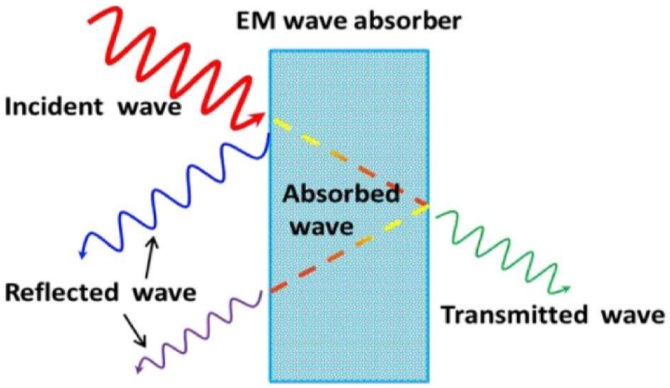

Fig – 1: The general processes of incident EM wave through an EM absorber.[5]

The EM absorbing property of an absorber was often indicated by the reflection loss (RL), which can be expressed as [6–9]:

$$RL = 20\lg|\Gamma| = 20\lg\left|\frac{Z_{in} - Z_0}{Z_{in} + Z_0}\right| \tag{1}$$

$$Z_{in} = Z_0\sqrt{\frac{\mu_0\mu_r}{\varepsilon_0\varepsilon_r}}\tanh\left(i\frac{2\pi fd}{c}\sqrt{\mu_0\mu_r\varepsilon_0\varepsilon_r}\right) \tag{2}$$

where, Z_0 ¼ μ_0/ε_0 is the input impedance of absorber, μ_r and ε_r are the relative permeability and relative permittivity of the absorber, respectively; Z_0, μ_0 and ε_0 are the wave impedance, permeability and permittivity of free space, respectively; f is the frequency; c is the propagation velocity of the wave in free space; and d is the thickness of absorber

The RL of EM absorbing building materials in 1–40 GHz frequency range is usually evaluated by arch reflection method, and the test system is shown in Fig. 2. The

value of -10 dB for RL represents that 90% EM waves can be absorbed, which has been commonly used as effective absorption performance index.[5]

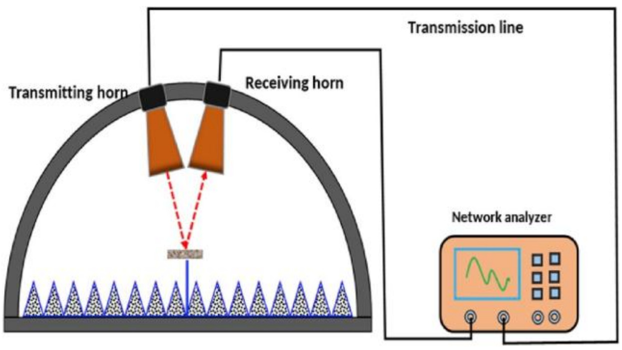

Fig – 2: Sketch map of Arch Reflection Method of System [5]

4. METHODOLOGY

This thesis is regarding the identification of green materials capable of absorbing EM radiation, preparing specimen with various thickness and doping amount. And to determine the EM radiation absorption capacity of every material.

The methodology adopted for the present analytical investigations is summarised as follows

1.Collecting various green materials such as ferrite, strawbale powder, carbonized cork powder, Bamboo fibre, Carbonized bamboo powder, Hemp fibre, coconut husk ash, Carbonized wood powder, carbonized peanut shell powder, cellulose powder, Glass powder, Slate powder, Tyre waste

2.Adding ferrite with one of the other green materials to cement in different proportion as filling materials. (Composition used are 85% cement(c) + 5% ferrite(f) + 10%othergreenmaterial(g),70%(c)+10%(f)+20%(g),55%(c)+15%(f)+30%(g),40%(c)+25%(f)+40%(g)

3.Specimen with different thickness are prepared (For every combination of mixtures, specimen of thickness 10mm,20mm,30mm,40mm are prepared)

4.Absorption performance analysis done using Arch Reflection Method (Vector Network Analyser (VNA) capable of measuring 1-8GHz frequency range is used)

5.ELECTRO MAGNETIC FUNCTIONAL MATERIAL – FERRITE

Ferrite is considered as chief EM functional material due to its unique properties. It is a complex compound of iron oxide with certain metallic elements. Ferrite usually possess high magnetic property and certain dielectric property making it an efficient EM wave absorbing material. It is very cheaply available.

6.ELECTRO MAGNETIC WAVE ABSORPTION ANALYSIS OF GREEN MATERIALS

Collected green materials in combination with ferrite is added to cement ass filling material in different proportion. specimen is prepared with different thickness and analysis is done to determine the EM wave absorption rate.

6.1 Straw Bale Powder

Mostly used green building material made from the waste of agricultural industry. A strawbale is approximately 40% carbon by weight. The material has good insulation property. These are reasonable and readily available material.

Of all combinations tested, 40% cement + 20 % ferrite + 40% straw bale powder specimen with 20mm thickness shows maximum RL of -26.88 dB in 2-4 GHz frequency range.

6.2 Carbonized Cork Powder

Cork is a natural cellular material with unique combination of properties. It has low density, buoyancy, low thermal coefficient and elasticity. Carbonized cork consists of honeycomb of microscopic cells filled with air-like gas and created mainly with chemical such as suberin and lignin.

Of all combination tested 55% cement + 15 % ferrite +30% carbonized cork powder specimen with 20mm thickness shows maximum RL of -34.85 dB in 4-8 GHz frequency range.

6.3 Bamboo

Bamboo is one of the incredible sustainable material available today. It is one of the most rapidly growing plant on this planet.

Bamboo Fibre: Bamboo fibre has various micro gaps making it softer than any other natural fibre. They are elastic, environment friendly and biodegradable.

Of all combinations tested 40% cement + 20 % ferrite + 40% bamboo fibre specimen with 20mm thickness shows maximum RL of -26.12 dB in 4-8 GHz frequency range.

Carbonized Bamboo Powder: Carbonized bamboo powder is considered as porous charcoal. This is manufactured by means of pyrolysis.

Of all combinations tested 40% cement + 20% ferrite + 40% carbonized bamboo powder specimen with 20mm thickness shows maximum RL of -28.45 dB in 2-4 GHz frequency range.

6.4 Hemp Fibre

Hemp is a fastest growing natural renewable resource. It has a lot of application in construction field. Its best quality is it is carbon dioxide negative.

Of all combinations tested 40% cement + 20% ferrite + 40% hemp fibre specimen with 20mm thickness shows maximum RL of -19.84 dB in 1-2 GHz frequency range.

6.5 Coconut Husk Ash

They are mostly considered as unused agricultural waste which is a major source of environmental pollution. It also used as partial replacement for cement in current construction industry.

Of all combinations tested 40% cement + 20% ferrite + 40% coconut husk ash specimen with 20mm thickness shows maximum RL of -32.24 dB in 4-8 GHz frequency range.

6.6 Carbonized Wood Powder

Wood powder is one of the major wastes in environment. Carbonized wood powder is porous. It is very cheap and light in weight. Wood powder contain more than 60.8% of carbon. It is biodegradable and compostable.

Of all combinations tested 55% cement + 15% ferrite + 30% carbonized wood powder specimen with 10mm thickness shows maximum RL of -32.21 dB in 2-4 GHz frequency range.

6.7 Carbonized Peanut Shell Powder

Peanut shells are considered as agricultural waste without any further use causing severe environmental pollution. Peanut shells are highly porous. They are lignocellulosic material containing carbon, oxygen and hydrogen.

Of all combinations tested 55% cement + 15% ferrite + 30% carbonized peanut shell powder specimen with 20mm thickness shows maximum RL of -30.24 dB in 4-8 GHz frequency range.

6.8 Cellulose

Cellulose is a recycled product of paper waste. Nowadays it is widely used in construction industry.

Of all combinations tested 70% cement + 10% ferrite + 20% cellulose specimen with 20mm thickness shows maximum RL of -19.98 dB in 2-4 GHz frequency range.

6.9 Glass Powder

Waste glass is one of the most common waste materials nowadays. This material can be ground into fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete.

Of all combinations tested 70% cement + 10% ferrite + 20% glass powder specimen with 20mm thickness shows maximum RL of -22.24 dB in 4-8 GHz frequency range.

6.10 Slate Powder

Slate is a common stone that is abundant in nature. They have a very fine-grained crystal. Slate composed of clay minerals, mica, quartz, feldspar, calcite, pyrite, hematite and other minerals.

Of all combinations tested 70% cement + 10% ferrite + 20% slate powder specimen with 20mm thickness shows maximum RL of -18.98 dB in 4-8 GHz frequency range.

6.11 Tyre Powder

Waste tyres have great influence in contributing to environmental pollution. Wate tyres used in production of cement mixture, road construction and geotechnical works. Tyre consists of about 22% carbon black in it.

Of all combinations tested 40% cement + 20% ferrite + 40% Tyre powder specimen with thickness 20mm shows maximum RL of -30.26 dB in 4-8 GHz frequency range.

7. CONCLUSIONS

1.All green material studied in this paper shows EM wave absorption above 90% in all frequency range with different thickness.

2.100 % EM wave absorption cannot be achieved by any of these materials.

3.Carbonized materials with ferrite shows efficient EM wave absorption

4.Fibrous and Porous material with ferrite also shows efficient EM wave absorption.

5.Thickness is one of the important factors that affecting the EM wave absorption.

6.Different composition of material with different thickness shows different EM wave absorption

7.In most of the cases EM wave absorption decreases beyond 20mm thickness.

8.Conversion of materials to the required form is one of the difficulties faced during the research, if possible, methods are available to eliminate this problem, then these materials can efficiently be used.

9.Ordinary Portland cement is used in this entire work if other superior quality cement like High Strength Cement is used, may achieve more EM wave absorption.

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