Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env.Pharmacol. Life Sci., Vol 4 [Spl issue 1] 2015: 14-19

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

FULL LENGTH ARTICLE **OPEN ACCESS**

The use of Conductive Cement in data Centers as Building Material

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ABSTRACT
The purpose of this study is to investigate the use of conductive cement instead ordinary cement in construction of external walls and the building floor of data center and its internal configuration and finally, connection of this integrated structure in terms of electrical conductivity to the suitable earth system.The results of this paper can be used in the stable design of data centers buildings. Data centers are the dedicated environments that protect are the most valuable facilities and equipment and information of companies and organizations. These services centers offer services such as storage, maintenance and retrieval services and all services related to the information and data.
Key words: *Data centers, electrical conductivity, conductive cement, building stability*

INTRODUCTION

Data centers are the dedicated environments that protect the most valuable facilities and equipment and information of companies and organizations. A data center that has been properly made will not conform only to the future innovations and developments, but it will act as a catalyst for them. Companies that know their data center is powerful, flexible and profitable, can introduce new products with self-advanced commercial goals and react towards changes of commercial needs.

The purpose of implementing project

First, types of methods, their advantages and disadvantages were extracted to achieve a method for protecting against electromagnetic threats in this study and the existing necessity degree of each indicators as well as methods in form of a nine point Likert scale (the equivalent of one to nine) obtained through the use of collective decision-making method based on pair wise comparisons and finally this conclusion was achieved by the implementation of this method of research that is appropriate the use of conductive cement instead of conventional cement in construction of external walls and the data center building floor and its internal configuration and finally, connecting this integrated structure in terms of the electrical conductivity to earth system.

Dividing the internal space of data center

Building of data center has several sections in terms of the application. in this data center, according to its sensitivity degree, in addition to the equipment that the main goal of data center is their installation and exploitation in the center, equipment and other supplies also have been installed to facilitate and or supply the performance of systems including:
For cooling, cooling and cooler equipment
For power supply used, power generator devices
To provide uninterrupted input power, UPS devices
For firefighting, firefighting equipment including sensors and specific gas tanks
For monitoring and controlling network, monitoring and control equipment
A place for establishment of personnel
A place for unloading equipment
A place for present in-service trainings for staff

Electromagnetic waves

Figure 1A variety of existing interfering electromagnetic sources in the environment

It is seen production of electromagnetic waves from different systems (radio, telecommunications, radar, missiles, UAV etc.) at the above figure. The crisis of electromagnetic pulse (NEMP) is a kind of big shock waves which is produced by electromagnetic weapons and or nuclear explosions that is clearly seen in the above figure.

Contrast of electromagnetic pulse with systems can be divided to 2 sections of systems effectiveness, due to long lines and local effects.

Effects induced of electromagnetic pulse are the induction of voltages and flowing on power long lines, telecommunication cables links or even other conductors such as pipelines. Effects can happen in very far distances and be guided by the conductor to inside the equipment.

Local effects are voltages and currents that are induced directly on the structure of the building, wiring, cabinets containing equipment, etc. Analysis of these local effects to assess is very difficult. Anyway, an appropriate assessment can be presented largely by analysis, simulation and testing from condition of equipment. Contrast of electromagnetic pulse with long lines must be estimated analytically and simulated as a source of external stimulation in port of long lines. Pulse shape and its characteristics have been shown for different types of crises in Figure 1 and Table 1. Frequency range of these sources has been shown in Figure 2.

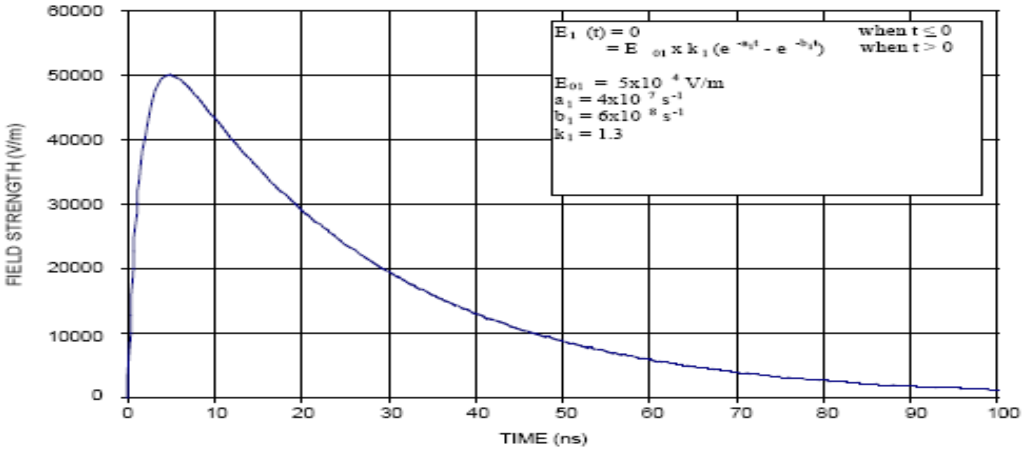

Figure 1 Electromagnetic pulse

Table 1 Characteristic of electromagnetic pulse parameters

Pulse	Rise time t_1	t_{fwhm}
UWB	100 ps	2.5 ns
EMP (fast)	1.5 ns	80 ns
EMP (med.)	5 ns	300 ns
UWB (slow)	500 ps	2.5 ns – 1600 ns
EMP	10 ns	2.5 ns – 1600 ns
EMP (slow)	>10 ns	500 ns

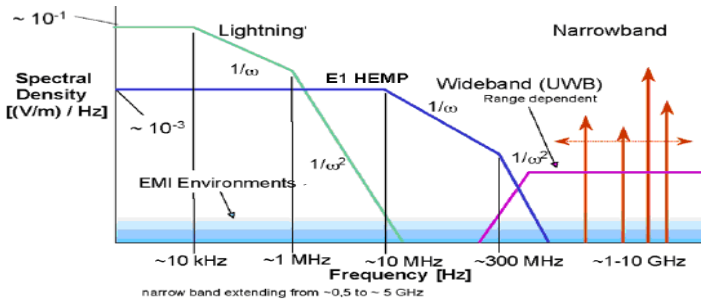

Figure 2 The frequency range of electromagnetic crisis source

Electromagnetic weapons

Electromagnetic waves are generated by either of the following methods:

Missile (during the war)

Fixed and mobile stations (defense and subversive operations)

These weapons in few Hz to several GHz frequencies can produce powerful pulses of a few tens kilovolts per meter and or few gigawatt.

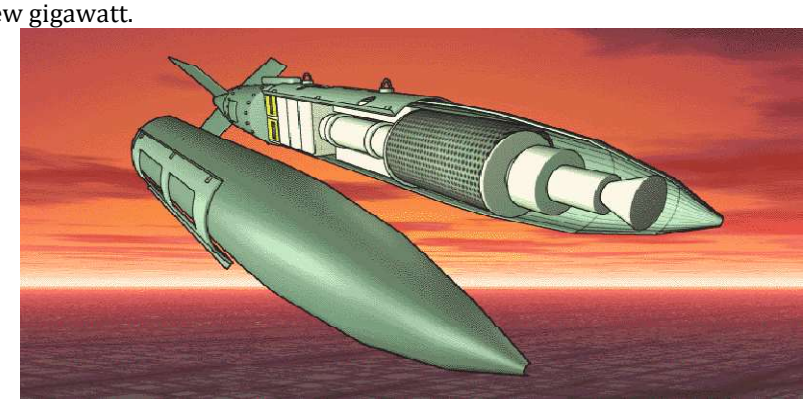

Figure 2 The electromagnetic weapons as missile

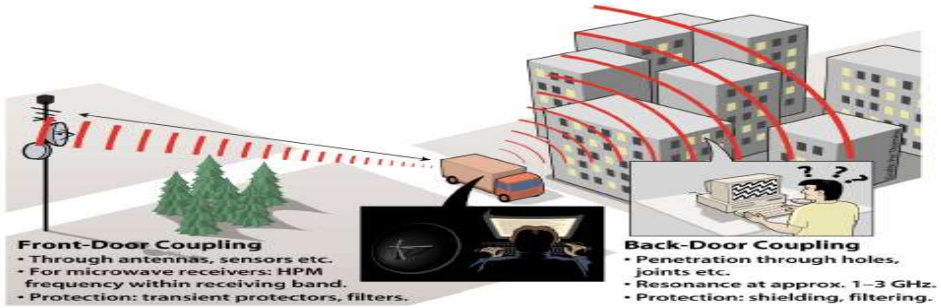

Figure 3 The electromagnetic weapons as mobile station

The vulnerability caused by electromagnetic crisis

Generally, electrical and electronic equipment are damaged by two types of damages caused by electromagnetic crisis.

1- Transient damage
2- permanent damage

Transient damage:

This damage occurs in digital systems and is called bit error when sending or processing information. Transient damage causes to announce the error message, the wrong performance and restart of the systems is in the worst conditions.

Permanent damage:

This damage includes the crash and burn of processing and control elements and parts (analog and digital).

Lack of shielding Electromagnetic and or inadequacy of protecting electronic equipment transform them system vulnerable points.Influence of the pulse to this equipment can be through the body or wall, openings or slots and input / output cable. The overall model of the influencing pulse electromagnetic into equipment has been shown in Figure 6.

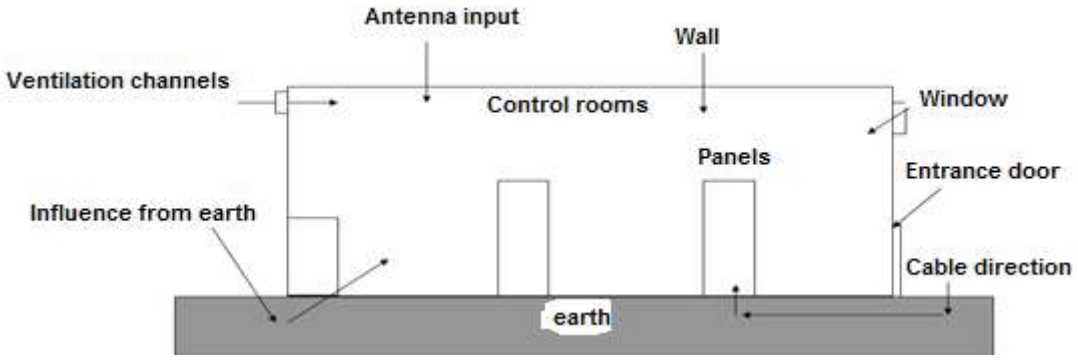

Figure 4 The overall model of the influencing pulse electromagnetic (indoor)

Conductive cement

The methods were mentioned to protect against the electromagnetic waves y coating which each were advantages and disadvantages and was conducted researches on each and is ongoing but attempts have been made to find newer ways and these methods have been based on using the ferromagnetic metallic nano-materials.

These materials are groups that have both the benefits of carbon nano-tubes and conductive polymers as well as haven't disadvantages of metallic materials. These materials are already the newest materials that research is conducted on them and have alternative potential of previous methods.

According to the cited subjects, we should construct building of data center and especially the data control center while construction which is as resistant integrated against influence of electromagnetic waves so that these waves when entering are trapped inside the protected area and then these waves are transmitted to the appropriate earth well through a suitable path. (Figure 5)

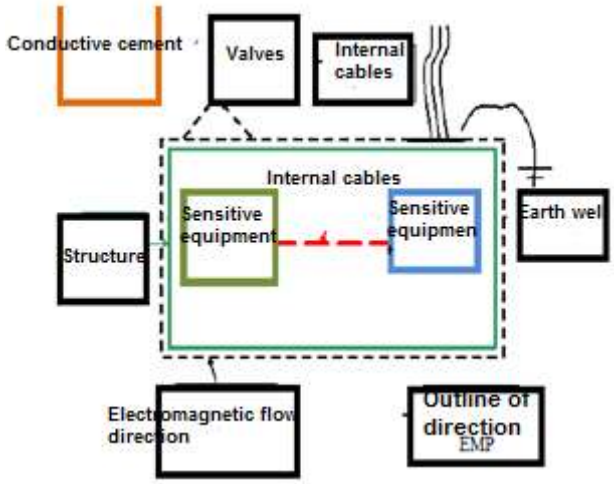

Figure 5 An outline of an area protected against electromagnetic pulse

Electricity conductive cement due to having electron transfer bridges has a special ability to protect structures against lightning, static electricity disposal, electromagnetic wave interference and the cathodic protection. This is due to the addition of a conductive polymer to the obtained cement and plaster that causes to provide new applications for cement usages. Hydrous calcium sulfate is the primary element of cement constituent is found in nature as $CaSO_4$, $2H_2O$ and is an insulator combination which is converted heat and to gypsum after water loss. Placing it in an autoclave under pressure and a temperature of 97 ℃, alpha gypsum and in vacuum with temperature of ℃, beta alpha are obtained.

A polymer type called polyaniline has been used in order to make conductivity of property in cement that due to environmental stability, change of color with changing relatively high electrical conductivity pH and low price, many usages cases users have found. The mechanism of its electrical conductivity is active as the main chain oxidation and protonation. Alpha and beta cement and chalks constitute polymer-mineral composite in laboratory special conditions that has the ability to electricity conduct and can be used in different chemical, military, elevated structures industries especially the electronics industries.

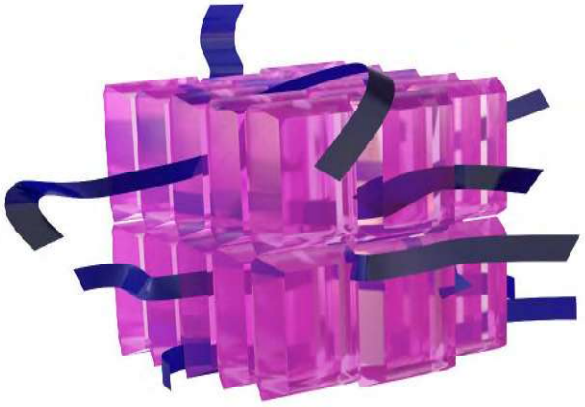

Figure 6polymer places in the crystal lattice of the mineral gypsum

Using conductive cement and appropriate solutions

There are three solutions for this purpose:

If the is approved in terms of strength, using conductive cement instead of conventional cement in constructing the external walls and data center building floor and its configuration and finally, being connected this integrated structure in terms of the electrical conductivity to the suitable earth system. Apparently, conductive cement due to having the carbon particles in the direction of its conductivity has less resistance than ordinary cement (at least in the case of conductive cement domestic made is it) and it cannot be replaced by the cement used in concrete of data center building structure (Fig. 7). Meanwhile, the discussion of additional cost imposed if the use of conductive cement is also that given that the area of this building is 2080 square meters and our concreting volume is about 500 cubic meters.

Additional cost for this change in design includes:

Ordinary cement price: A kilo, 120 Tomans

Conductive cement price: cement manufacturing company Gard Asia per kilo between 1400-2400 Tomans

In other words, our cost will be added between 10 to 20 times by the replacement of conductive cement.

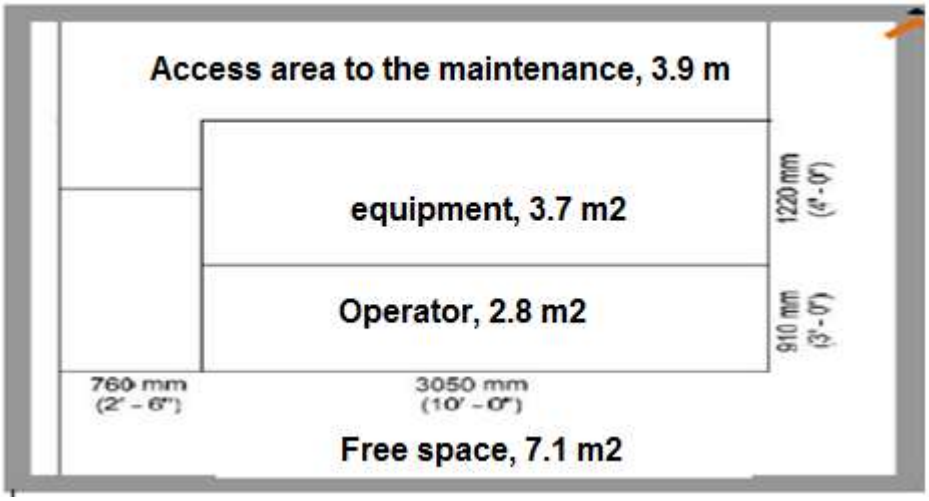

Figure 7 Building of control center equipped with conductive concrete

Thus, it is not possible to implement this plan. If the replacement of conductive cement instead of ordinary cement because of cost or technical not be allowed, at least one layer of conductive cement with a diameter of pre-calculated (which should be tested by penetration of electromagnetic waves due to the type of conductive cement purchased and determined the required diameter of conductive cement to prevent penetration electromagnetic waves) should be used on ordinary cement. (Fig. 8)

3. The use of steel sheets or metal meshes with fine texture among cement and implementing the integration for conductors with maximum accuracy. (Fig 8)

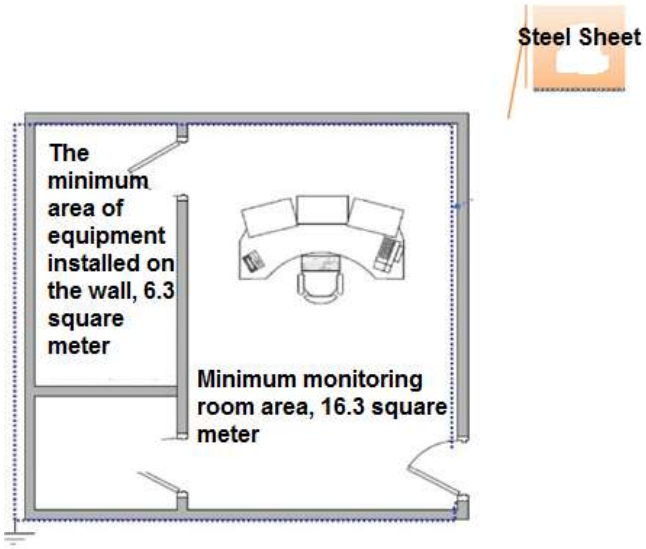

Figure 8 Building of control center with steel cover

CONCLUSION

Protection against electromagnetic waves interference today has become a critical issue. Increasing the frequency of devices and thus decreasing in wavelengths cause until waves penetrate even in small pores. Due to the protective effect influenced by factors such as frequency, geometry (geometric shape) of shielding, its location, the type of field and or waves weakened, and the direction of incoming waves and polarization differentiates.

Electromagnetic adsorbents can be used along with act of preventing incorporation in various areas which including camouflage the radar, stealth technology, microwave noise control, microwave antenna pattern, heating by microwaves can be noted.

Various techniques such as coating by metals, intrinsically conductive polymers, carbon and carbon nanotubes on textiles have been used to overcome the adverse effects of these waves and each has their advantages and disadvantages.

We used conductive cement in this study and finally, it is concluded that the use of conductive cement instead ordinary cement is suitable in construction of external walls and the building floor of data center and its internal configuration and finally, connection of this integrated structure in terms of electrical conductivity to the earth system. The results of this paper can be used in the stable design of data centers buildings.

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