JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EXPERIMENTAL INVESTIGATION ON MAGNETIC CONCRETE FOR WIRELESS CHARGING

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Abstract : *Electric transportation will assist in lowering emissions of greenhouse gases and mitigating the impact of rising petrol prices. To promote the widespread adoption of electric transportation, a diverse range of charging stations must be established in an atmosphere that is friendly to users. Wireless electric vehicle charging systems are a viable alternative technology that can charge electric vehicles (EVs) without any plug-in issues. Wireless power transfer (WPT), which involves the transmission of electricity via an electromagnetic field despite the presence of an intervening area, holds out the possibility of new prospects for EVs to increase environmentally responsible mobility. This review article examines the WPT technology and how it might be applied to electric vehicles from both a technical and safety standpoint. The prime aim of this review is (1) to illustrate the current state of the art in terms of technological advances as well as research limitations in the field of WPT development and use within the field of transportation; (2) to organise the experimental the deployment of WPT EV systems in the actual world; and (3) to analyse the results over a sustainable period and to identify limitations as well as chances for growth. From a technical point of view, the progress that has been made on the selection of material for designing coils, different types of coils with a specific focus on the overall performance of the system. As a result, this study aims to provide an extensive overview focusing on the magnetic materials and the architectures of the transmitter and receiver pads*.

I. INTRODUCTION

The production of magnetic concrete involves integrating soft magnetic components, such as crushed ferrite, iron oxide grains, or scraps of amorphous or nano-crystalline metallic magneticmaterials, into a typical cement slurry. This process results in the production of magnetic concrete. This leads to the production of magnetic concrete as a result (cement and water mixedtogether). In common parlance, this particularmixture is referred to as "magnetic cement mortar,"which is also one of its common names. A certain sort of concrete that exhibits certain magneticproperties can be obtained by first vibrating the mixture, then compacting it, and then allowing it to curefor the desired amount of time.

E-mobility encompasses all forms of automobile transportation, including privateautomobiles, commercial trucks, and most notably buses, and it has the potential to significantly cut down onair pollution in large urban areas. Electric vehicles are the ideal answer to lessen the impact thatinternal combustion engine vehicles (ICEVs) have on the environment because fuel resources are running out and there is concern for the environment. Charging stations that are able to assurethe charging of their batteries at home, in parking lots, while they are on the route, or at depots are required for all of them. The conventional way of conductive charging has several disadvantages, but the novel approach of wireless charging has many advantages.

II. LITERATURE SURVEY

A Comparative Assessment of Magnetic Concrete versus Ferrite for a High Power Inductive Coupler.(1) Author:- Andrei Marinescu Romanian Academy of Technical Sciences Craiova Branch, Romania, Tiberiu Tudorache Faculty of Electrical Engineering University Polyethnic of Bucharest Romania, Adrian Vintila INCD ICMET Craiova,Romania. (2021)

This paper assesses the possibility of replacing the brittle ferrites used in classical constructionswith Magnetic Concrete. The air pollution in large urban agglomerations can be drastically reduced by electrical mobility which covers all means of road transport: personal cars, freight cars and especially buses. All of them are dependent on the existence of charging stations that are able to ensure thecharging of their batteries at home, in parking lots, on the route or in depots. Compared to the classic, conductive charging, contactless charging (Wireless Power Transfer - WPT) is a disruptive technique with numerous advantages that allows static, semi-dynamic (opportunity charging) and dynamic charging of batteries. This paper refers to the WPT transfer via an inductive magnetic coupler that is embedded in the pavement and must withstand heavy car traffic without damage. This paperalso assesses the possibility of replacing the brittle ferrites used in classical constructions with Magnetic Concrete. It presents the choice of concrete mixture composition, the experimental determination of its magnetic properties and an analysis on the electromagnetic efficiency of the WPT system for different magnetic coupler structures, through Finite Element simulations the inductive magnetic coupler is an air-core transformer with independent windings consisting of a transmitter and a receiver operating in a magnetic near field. It is widely used in many practical applications of wireless power transfer with powers ranging from a few W to hundreds of kW. As with any application of the WPT technology, the main problems to solve relate to the power transmitted, the separation gap ground clearance of the electric vehicle EV, the transfer efficiency, the permissible offset ofthe coupler coils, the level of the leakage magnetic field, and last but not least, the cost of the equipment.

Wireless Power Transmission to Sensors Embedded in Concrete via Magnetic Resonance(4)
Author:- By Olutola Jonah and Stavros V. Georgakopoulos of the Department of Electrical and Computer Engineering Department of Electrical and Computer Engineering at Florida International University, Miami, Florida (2012)

The feasibility of efficient wireless power transfer through Strongly Coupled Magnetic Resonance (SCMR) in non-homogenous interface such as air-concrete is studied here. The feasibility of efficient wireless power transfer through Strongly Coupled Magnetic Resonance (SCMR) in non-homogenous interface such as air- concrete is studied here. Specifically, the efficiency of wireless power transmission from a source in air to a sensor embedded in concrete via strongly coupled magnetic resonance is analyzed. The concrete material is modeled for various humidity levels using the extended Debye's model. The efficiency of the SCMR is also analyzed for various depths inside the concrete.

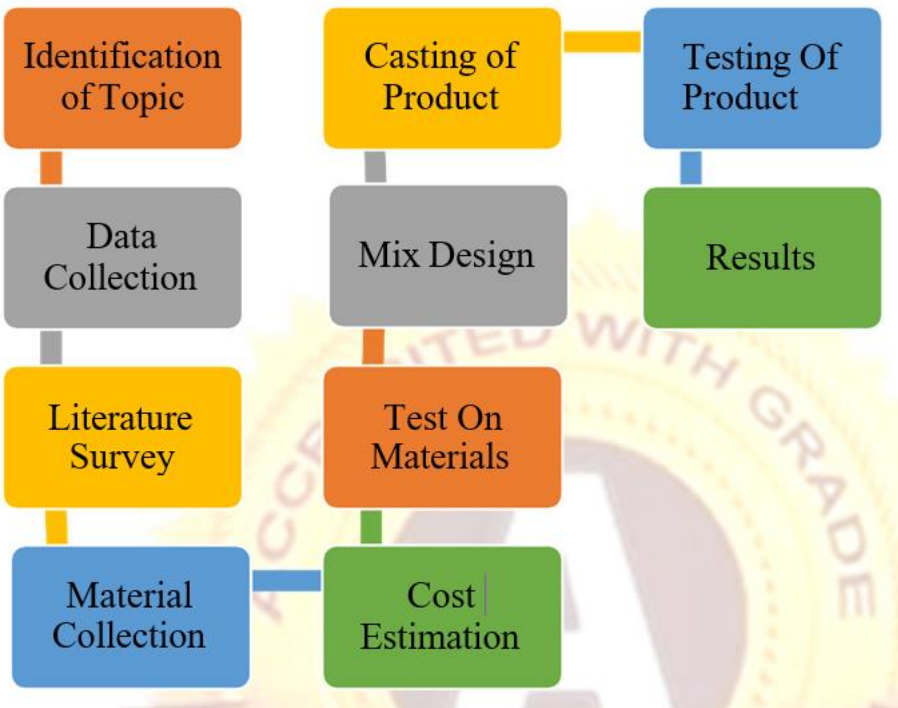
Challenges in the Electromagnetic Modeling of Road Embedded Wireless Power Transfer. (5)
Author:- Vincenzo Cirimele, Riccardo Torchio, Antonio Virgillito, Fabio Freschi, Piergiorgio Alotto. Department of Energy ―G. Ferraris‖, Politecnico di Torino, Corso Duca degli Abruzzi,24, 10129 Torino, Italy. Department of Industrial Engineering, University of Padova, Via Gradenigo, 6/a, 35131 Padova, Italy.(2019)

In this paper, starting from the experimental experience of the road embedment of a transmittingcoil for wireless power transfer, a numerical model of such device is constructed. The model isthen used to perform several parametric analyses which aim at investigating the influence of the main electromagnetic parameters of the concrete and the geometrical parameters of the wireless power transfer on the overall behavior of the device. The results of such study allow for providing guidelines for the design of the coil and the choice of the materials for the embedment. Moreover,as a secondary result of the adopted methodology, the electromagneticcharacterization of the concrete adopted for the road embedment is obtained

Power efficiency improvement of wireless power transfer using magnetic material.(6)
Author:- Shigefumi Morita, Takuya Hirata, Eko Setiawan, Ichijo Hodaka University of Miyazaki Miyazaki, Japan.(2017)

In this paper Efficiency improvement of wireless power transfer system is studied using ferritebars with keeping distance of electric power transmission is studied. Experiments are performedto decide better installation of ferrite bars for improving efficiency; there are many possibilitieshow and where to install them. We conductedseveral experiments and devised a method of installing ferrite bar with high effect on WPT. Each result is compared with the case of no ferrite bar system. The result of experiments shows using ferrite bars is practical and cost effective. Some suggestion is given to drive wireless power transfer system with lowerfrequency, which is also noteworthy about the limitation of available power source. In this paper proposed the method of adding ferrite bars to improve the efficiency and power of WPTsystem. We have tried several numbers of bars and the cases when adding bars either transmitting coils or receiving coils, or the both, and shown experimental results which describethe effect of bars. Although the effect cannot be regarded drastic, it offers extra choices of driving frequency without losing efficiency and power. Putting a relay coil between transmitting and receiving coils is a popular method to improve WPT system but it does not keep the space between the transmitter and receiver open. Our method does not affect the spaceand improve the efficiency of system.

III. METHODOLOGY



3.1 Tests on Material:

3.1.1 Test on cement:

Fineness Test on Cement:(IS code 269)

The Fineness modulus of cement is determined empirically by adding the total percentage of an aggregatesample retained on each sieve in a specified series and dividing by 100.

Sr. No.	Description	1	2
1.	Weight of cement	100 gm	100 gm
2.	Weight of cement retained on 90 micron IS sieve	8.8	6.7
3.	Wight of cement passed through 90 micron IS sieve.	91.3	93.3
4.	Percentage weight retained on the sieve	8.8 %	6.7%
5.	Average	7.75%	

Results:

According to IS code 269, the weight of cement remaining on the sieving shall not exceed 10% of the total weight. The percentage of the cement sample retained on the sieve is 7.75 on average. Thus, the obtained cement fineness is within the acceptable range.

3.1.2 Setting time of Cement:(IS:4031(Part 5):1988)

The setting time of cement paste, mortar, or concrete will affect cement or concrete handling. There are two parts to the setting time:

- The initial setting time and the ultimate setting time. Initial setting time is the amount of time between when water is introduced to the cement and when the paste begins to lose its plasticity.
- The final setting time is the elapsed time between the addition of water to the cement and the time when the paste has completely lost its plasticity and achieved adequate firmness to withstand a predetermined pressure.

Initial setting time of cement:

Observations:

Weight of cement:300gm.

% of water added:32%.

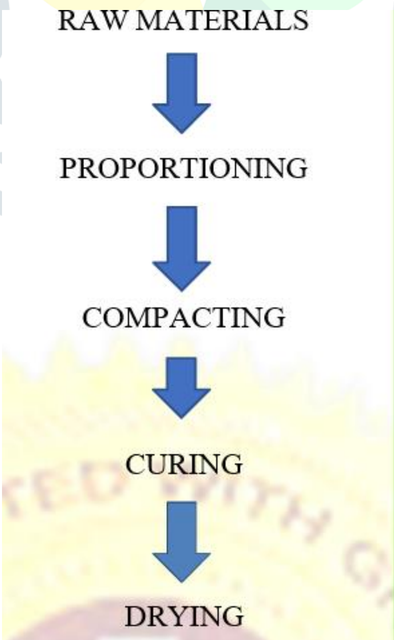
Quantity of water added: 81.6 ml.

Sr. No.	Time (min)	Penetration (mm)
1.	5	0
2.	10	0
3.	15	0
4.	20	1
5.	25	2
6.	30	3
7.	35	4
8.	40	4
9.	45	5

Results:

Initial cement setting time (OPC) is greater than 30 minutes. The provided sample of cement has an initialsetting time of 45 minutes. Hence it is in range.

3.2 Process of manufacturing Concrete Tiles:



The production of cement concrete pavement tiles involves a number of steps, including administration, mixing, compression, and drying at the end of the process. For cement concrete paving stones with a water-cement ratio of 0.62, a concrete mixture with a volume of 1:3:6 (cement :sand :aggregate) can be used. This ratio is for the cement: sand :aggregate component of the mixture. The concrete mixture should not be any thicker than 1:6 with respect to the combined aggregate before it is mixed. This ratio is determined based on the volume of cement. The combinedaggregate fineness module ought to be between 3.6 and 4.0. Put all of the materials into a concretemixer, and let themixer turn for about 15 minutes. Take the created mixture out of the mixer and besure toeat it within the following half an hour. It is possible to compress the concrete mixture into the necessary size and shape by making use of a vibrating table. After the tiles have been compressed, take them from the mould and shield them for the next 24 hours from direct sunlight and wind. This process is used to cure the tiles. Following the curing process, the tiles are allowedto naturally dry before being distributed for use.

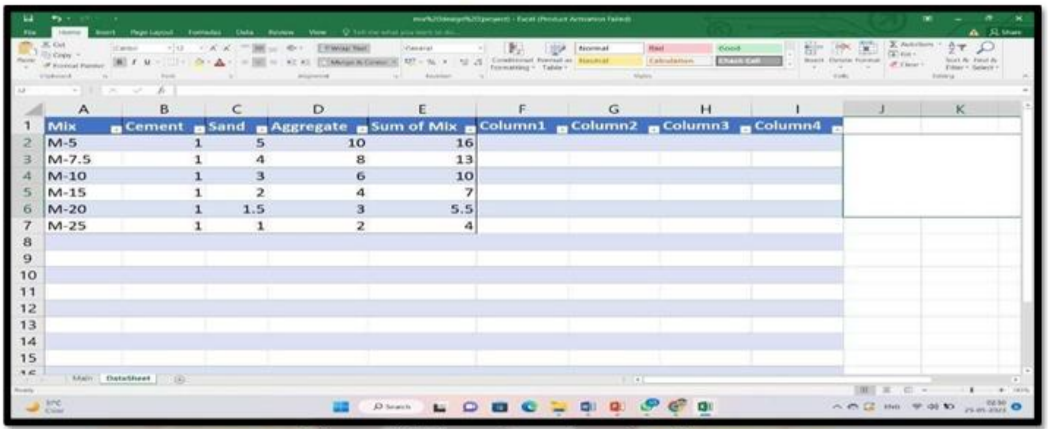
Paving stones made of concrete gain a significantamount of strength within the first three days of the hardening process, and this increase is assuredto reach its full value within the first ten to fifteen days. After the curing process, the tiles are allowed to cure in the shadeuntil the initial shrinking is complete.

3.3 Quantity Estimation:

The International Standard 10262-2009 is used for quantity estimation while designing the concrete mix. For this project, we decided to use concrete of grade M10. Moreover, we are going to replace ferrite for either cement or aggregates in the ratio of 40 to 50.

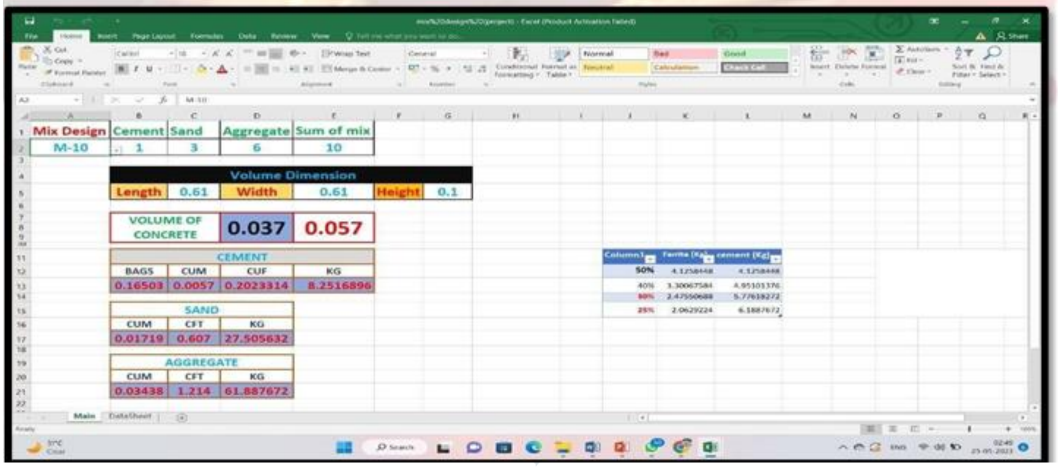
Following are the steps for determining the material quantities:

1. Create a spreadsheet in Excel that will allow you to determine thequantities by combining multiple formulas.
2. Select the required concrete grade initially.
3. Add the tile dimensions to the Excel sheet.
4. Then the volume of concrete is calculated in the Excel sheet.
5. After the calculation of the volume, the quantities of materials are formulated.



Mix	Cement	Sand	Aggregate	Sum of Mix	Column1	Column2	Column3	Column4
M-5	1	5	10	16				
M-7.5	1	4	8	13				
M-10	1	3	6	10				
M-15	1	2	4	7				
M-20	1	1.5	3	5.5				
M-25	1	1	2	4				

Figure 4.2:Quantity estimation sheet.



Execution And Construction: Trial no 1: For ferrite Powder

Step No:1 Batching of Materials:

- Ferrite - 252gm
- Cement- 252gm
- Crush sand- 1683gm
- Aggregate 10mm-3788gm
- Concrete additive-5ml
- Water - 700ml

Step No 2: Mixing of Materials

After batching the material is then properly mixed to ensure a consistent color and the absence of any streaks. The Hand Mixing procedures have to be carried out only for smallconcrete works.

Step No 3: Placing of material in the mould.

The next stage is to distribute the material throughout the mold in an even mannerusing shovels to properly pack the material into all of the corners of the mold.

Step No 4: Compacting the material

IV. RESULTS

4.1 Abrasion testing:

Tiles designation:	Initial thickness of specimen (mm)	Final thickness of specimen (mm)
T1.	26	25.3
T2.	26	25.6
T3.	26	25.65

Results: The abrasive wear of the specimen after 16 cycles of testing is less than 1 mm as per specified byIS15658.2006.

4.2 Compression testing:

Tiles designation:	% used ferrite	Apparent average compressive strength (N/mm^2)
T1.	25%	22.256
T2.	30%	23.682
T3.	35%	25.800

Results: The compressive strength of the tiles is 23.916 N/mm^2 which is within the limit specified by IS15658.2006.

4.3 Flexural strength test:

Tiles designation:	% used ferrite	Apparent average flexural strength (N/mm^2)
T1.	25%	1.567
T2.	30%	1.454
T3.	35%	1.686

Results: The flexural strength/breaking load of paver tiles is 1.569 N/mm^2.

4.4 Voltage check with multimeter:

Tiles designation	% used ferrite	Distance between transmitter and receiver(mm)	Voltage (v)
T1.	25%	20	5
T2.	30%	27	5
T3.	35%	30	5

V. Conclusion

To increase the effectiveness and power of the wireless charging transfer system, we have suggested a way, including the addition of ferrite magnets. We tested a variety of ratios and presented experimental findings that illustrate the impact of ferrite magnets in concrete tiles. The results of an experimental examination of magnetic concrete show that magnetic tiles can boost a wireless charger's efficiency by up to 25%.

Tiles designation	% used ferrite	Distance between transmitter and receiver(mm)	Voltage (v)
T1.	25%	20	5
T2.	30%	27	5
T3.	35%	30	5

The charger's usual operating distance was 2 to 10 mm, but the ferrite magnetic tiles allowed the distance to beexpanded to 20 to 30 mm.

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