A Guide for Analysis and Comparative Study on Conductive Concrete

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Abstract

This paper represents the comparative study on the behavioral properties & strength of conductive concrete.The purpose of this research was to conduct a thorough review of the literature and summarize the numerous mix ratios of conductive concrete that helped in achieving deicing.

Keywords — *De-icing, Conductivity, Conductive Concrete, Composites.*

I. INTRODUCTION

Concrete is the most extensively used construction material. In a developing country like India at some places like Jammu Kashmir, Himachal Pradesh, Shimla etc., during the snowfall it is challenging for the people to access the roadways for day to day transportation and commuting. The range of extreme weather events, low temperatures, heavy blowing snows have significant impacts on military operation also. This problem is a major concern to transportation of vehicles in those regions and it's also affecting the runway of the airports in that particular region. This study deals with alternative solution for improved deicing methods has been a research focus for quite some time. The use of other technical methods involving tubes and heating pipes but were ineffective due to economical and various other reasons.

Over the past 10 years, an innovative material called "conductive concrete" has been developed and evaluated for bridge-deck deicing. Conductive concrete is said to be a compendiousblendwhich contains components with electrical conduction assets to enable free flow of electrons thus achieving electrical conductance. Owing to its impedance and natural electrical resistivity, a shrill concrete cover or coat when coupled with a substantial power source is able to generate the required amount of heat to avert ice accumulation on the surface of a bridge deck.

A. Problem Statement

Bridge decks are susceptible to accumulation of ice and snow. The deck being made out of concrete freezes before the tarmac approaches do, making travel on roadways and highways during winter hazardous. Conservatively, eliminating ice from a pavement can be accomplished by a mish mash of several techniques, for instancehand plowing, normal melting, and chemical treatment. Plowing alone appears to be fruitlessdue to the fact that the strength of the bond between the ice and the concrete or tarmac is greater than mechanical force exhibited by hand plowing. This bond is cut down with the aid of chemical treatment. Most highway winter maintenance across the world depend on using chemicals as a primary treatment method for deicing and anti-icing. Although the usage of chemicals have been proven to be useful, it has been observed to causes damage to concrete and corrosion of reinforcing steel in concrete bridge decks. Freeze-thaw cycles (frost action) causes damage to concrete pavements, bridge decks and railings which is one of the major problems for state and local governments at various western nations. Such a concern raises huge expenses for repair and replacement of existing concrete pavements and bridge decks. Frost damage in concrete comes in various types, the most common being spalling and cracking. Many studies have been proposed to describe the deterioration and impairment of concrete exposed to freezing and thawing. The two popular conjectures are:

1. The occurrence of hydraulic pressure caused by frozen water inside of large cavities.
2. The osmotic pressure resulting from incomplete freezing of water in capillaries.

B. Background Information

As mentioned earlier in the introduction to concrete that it is said to be a compendious blend which contains components with electrical conduction assets to enable free flow of electrons thus achieving relatively higher electrical conductance than conventional concrete.Owing to its impedance and natural electrical resistivity, a shrill concrete cover or coat when coupled with a substantial power source is able to generate the required amount of heat to avert ice accumulation on the surface of a bridge deck.

It has the probable capacity to address a wide array of applications with respect to de-icing in concrete

structures and open pavements such as garages, aircraft Unfortunately, its solicitations have been limited due to the fact that the existing mix ratios pertaining to conductive concrete didn't satisfy strength necessities required for construction and/or were too costly to be mass produced on a commercial scale.

For over a decade, numerous futile research attempts were made to design a type of concrete that could conglomerate excellent conductive properties with the engineering developments of present day conventional concrete proportions and mixes. From a recent research study based on IRC, researchers have managed in achieving this uphill task, with electrically conductive concrete offering convincing potential for landing strips and bridge decks. use in a diversity of applications in the field of highway maintenance and constriction. Further advancements and experimentation research is now fixated on enhancing formulations of the mixes used for conductive concrete for the finest amalgamation of physical strength parameters, electrical properties related to reduced resistivity and increased conductivity, all within the spectrum of ideal economy focused on production methods in very minimal monetary assets, which could possibly pave the way for its standardization and developments on a commercial scale.

C. Properties

Conductive concrete is a mixture of conventional ingredients such as cement, aggregate, water and additional constituents such as conductive materials, admixtures, and plasticizers. Supplementary cementitious materials such as fly ash and silica fume, and chemical admixtures for accelerating set time, air entrainment, retarding set time, and water reduction are often used in a concrete mix. In a conductive concrete mix design, electrically conductive materials are utilized for partial replacement of aportion of the fine and coarse aggregates. Preferably, the conductive materials are both metal fibers and metal particles and make up 1-4% and 6-30% respectively of the total volume of the mixture (subjected to change).

The electric property of conductive concrete is related to the property and proportion of the conductive materials mixed into the concrete and the mixing parameters and process of concrete. The conductive concrete belongs to a class of functional concrete in addition to the property of the structural concrete.

Conventional concrete is undoubtedly an insulator in the dry condition, and has shaky and deliberately superior resistive features than conductive concrete, even in a wet condition. Comparison of Electrically Conductive concrete by various researches listed in table.1

Table. I Comparison of Electrically Conductive concrete by various researches

S.No	Author Name	Title of the Paper	Journal Name	Strength of the specimen			
				Days	Percentage (%)	Cube (N/mm^2)	Cylinder (N/mm^2)
1.	Abid Ahmad Sofi, Sheikh Mohammad Iqbal,Suhail Ahmad Mir	Electrically Conductive concrete formed by waste coke	IOSR Journal of Mechanical & Civil Engineering (IOSR- JMCE)	7days	0% 5% 10% 15% 20%	28.34 27.85 21.8 17.4 14.9	-
				28day	0% 5% 10% 15% 20%	41.2 39.85 29.6 24.8 22.7	-
2.	Jeena Matthew & Amudhavalli	Effects of silica fume on strength and durability parameters of concrete	International Journal of Engineering Sciences & Emerging Technologies	7 day	0% 5% 10% 15% 20%	25.21 29.33 34.12 38.3 35.9	3.11 3.65 4.10 3.83 3.65
				28day	0%	38.30	4.67

					5% 10% 15% 20%	41.29 46.76 47.3 44.27	4.802 4.95 4.63 3.98
3.	R.SriRavindra rajah & Tam	Properties of concrete with crushing strength on aggregates	Magazine of Concrete Research	7day	0% 5% 10% 15% 20%	25.0 23.5 19.5 22.5 20.5	-
				28day	0% 5% 10% 15% 20%	37.5 29.5 30.0 28.5 24.5	2.30 2.15 2.40 2.20 1.85
4.	SnehalP. Abhyankar&S hekar D.Bhole	Electrical Properties and compressive strength of concrete	International Journal of Advanced Technology in Civil Engineering	7day	0% 5% 10% 15% 20%	21.33 19.0 16.44 17.78 16.5	-
				28day	0% 5% 10% 15% 20%	35.55 27.02 25.33 29.77 28.81	-
5.	Wu,RanHuang, Maochieh chi, &TsailungWen	A Study on electrical and Thermal Properties of Conductive concrete	Computers & Concrete.	7 day	0% 5% 10% 15% 20%	38.81 36.87 34.92 32.99 31.05	-
				28day	0% 5% 10% 15% 20%	43.4 41.23 39.06 36.81 34.72	-
6.	Christopher Y. TUAN	Conductive concrete for bridge deck de-icing and anti-Icing	ACI Materials & Journal	7 day	0% 5% 10% 15% 20%	32.13 30.87 29.0 25.0 24.23	-
				28day	0% 5% 10% 15% 20%	43.9 44.8 44.1 42.1 35.9	-

CONCLUSION

This paper specializes with the comparative study among the physical properties such as mechanical strength, durability and thereby predict its deicing capabilities, used to effective utilization of steel scraps, admixtures are replacement with various in the conventional concrete of various grades.
This paper is the collective compilation of various published papers and results regarding to the strength and properties of electrically conductive concrete. This paper aids in quick comparison of results which can be effectively used if need arises in practically implementing deicing through conductive concrete.

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