"STUDY OF SNOW MELTING TECHNIQUE BY ELECTRIC HEATING IN PAVEMENT"

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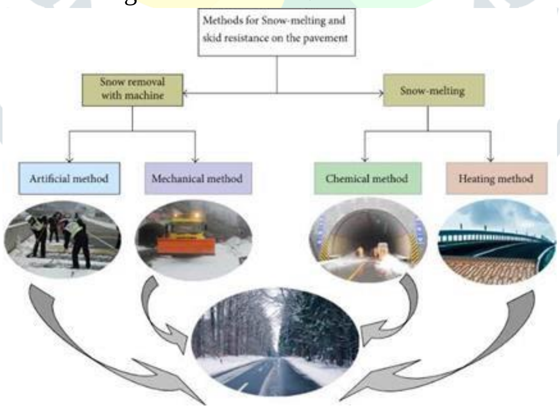
Abstract : In recent years, with the increase of economy and sharp rise of motorized vehicles, the pavement skid resistance has become vital in cold region. Because of snowstorm the skid resistance of pavement is decreases. However, the de-icing salt, snow removal with machines (scrappers), and different antiskid measures adopted by road maintenance division have several limitations. To enhance the treatment result, we are introducing a new snow-melting approach by employing electrical heat tracing within which heating cables are put in between the structural layer of road. Through the experiment, type of structure, heating power, and preheating time of the pavement, heating system in roads were consistently analysed and blessings of electrical heat tracing technology in rising the pavement skid resistance. Therefore, such new technology, which offers new snow melting strategies for Driveways, Parking yards even in bridge, mountainous space, and enormous longitudinal slope in cold region, has promising prospect for intensive application.

***IndexTerms* - Skid resistance, Electric tracing system, Rigid and flexible pavement, Positive temperature, Constant (PTC), Resistivity, VG30 Bitumen.**

I. INTRODUCTION

In recent years, with the rise of economy and sharp increase of automobiles, the pavement skid resistance has become vital in cold region. Because of snowstorm the skid resistance of pavement is decreases. However, the de-icing salt, snow removal with machines (scrappers), and alternative antiskid measures adopted by road maintenance division have several limitations. Heavy snows within the cold region cause the soil temperature reduction and greatly scale back the friction coefficient of pavement, which frequently end in automobile accidents and endanger the drivers and passengers. To beat this, several snow-melting systems have been developed; but, in apply, their application is restricted, because of Economic reasons, Environmental pollution, and price related issues in construction technology. With relation to the treatment of the snow and ice on the pavement, researchers have conducted many studies and projected many ways for snow-melting and skid resistance of the pavement like currently, there are two major ways for ice and snow removal with machine and snow-melting. With high potency snow removing machines are applicable for removing snow in greater areas. The snow-removing machine alone cannot accomplish satisfactory snow removal result and cannot completely takeaway the snow on the pavement. Generally, the snow- melting technique can be divided into two types specifically chemical technique and heating technique. In several countries where chemical reagents were used have adverse effect on road and its ends in huge economic loss.



Therefore, so as to enhance the skid resistance of pavement in cold region and guarantee the safe operation of road, it is of nice significance to develop the new snow- melting and antiskid technology. To improve the treatment result, we are introducing snow-melting approach using electric heat tracing within which heating cables are put within the structural layer of road. Through the experiment and numerical investigation, pavement sort, heating power, and preheating time of the pavement heat are going to be consistently analysed. Benefits of electric heat tracing technology in up the pavement skid resistance for pavement were also given. Therefore, such new technology, that offers new snow- melting ways for Walkway, Driveway, Parking yards even in tunnel portal, bridge, mountainous space, and large longitudinal slope in cold region, has promising prospect for intensive application. To avoid regular use of scrappers, hands and chemicals we have a tendency to projected snow melting by electrical heating tracing provided within the pavement. The electrical heat tracing system commences as a replacement technique for the pavement snow-melting in tunnel portal, bridge, mountainous space, and huge longitudinal slope in cold region, which might additionally function references for effective style and construction of comes in urban roads. Moreover, with the benefits of wonderful performance in environmental protection renewable energy source, straightforward structure, convenient usage, and low producing price, the electrical heating tracing technology promising prospect for intensive application.

2. LITERATURE REVIEW

1. Raman Analysis and Experimental Investigation of Nichrome and Aluminium Nitride Micro tubular Coil Heaters: (2d Approach) 2 April 2013 - The material characterization was performed using Ramanspectrometer. The geometric optimization for the micro tubular coil heater was performed by simulating a wide range of possible geometries using COMSOL metaphysics commercial Finite Element Analysis (FEA) package.

2. Study on Induction Heating Coil for Uniform Mould Cavity Surface Heating 12 Jan 2014. - Identical direction current in the proximity coil had better heating rates. The case of opposite adjacent current directions had better temperature uniformities. Heating power had no significant effects on temperature uniformity. The average temperature was increased due to an increase in heating power.

3. New Technology and Experimental Study on Snow Melting Heated Pavement System in Tunnel Portal 29 June 2015 - While rapid increase in vehicles need of snow free pavement. This requirement is fulfilled by providing pavement with heaters. Different methods of snow melting are not as convenient as electric heater. Design of electric circuit with insulation for shockproofing and short-circuit of electric circuit. Using pavement is implemented in the tunnel and it working well.

4. Research of snowmelt process on a heated platform 2016. - Cleaning and removal of snow from road and streets consumes 40% of yearly maintenance of roads. Conducted process on the horizontal plane stand heated by electric circuit. Concluded that electric heating snow melting is efficient method than other methods.

5. Polyurethane carbon microfiber composite coating for electrical heating of concrete pavement surfaces August 2019. - Electrically-heated pavements have attracted attention as alternatives to the traditional ice/snow removal practices. Based on the concept of joule heating, the conductive composite can be utilized as a resistor that generates heat by electric current and increases the surface temperature to melt the ice and snow on the pavement surface.

3. PROBLEM STATEMENT

Snow removal with machine and other antiskid measured adopted by highway maintenance division have many limitations. To improve the treatment effect, we proposed a new snow-melting approach employing electric heat tracing, in which heating cables are installed in the structural layer of road.

4. OBJECTIVES

1. To understand and design Electric Tracing System for snow heating.
2. Pavement design and implementation of electric tracing system in pavement.
3. Observe pre-heating and post-heating effect on the road.
4. To check working ability of pavement for adverse conditions.
5. Comparison between suitability of rigid and flexible pavement.

5. WORKING PRINCIPLE OF ELECTRIC HEAT TRACING SYSTEM

Electric heat tracing system, utilizing wire as heating medium, transforms electrical energy into thermal energy by thrilling or stimulating the heating cable so transfers the thermal energy to pavement that is the radiant heating. With further protection of the outer wall of warmth insulation material. Many effects of heat insulation and snow-melting are often received. The heating cable, as shown in Figure below, is mainly composed of many components, that are unit heating thread, insulation layer, metal shielding layer, water proof and anticorrosion layer, and then forth. The self-limiting temperature heating belt, which is generally utilized in this, has the electrical phenomenon with high positive temperature constant (PTC).The PTC material can rework electrical energy into thermal energy; that's, the temperature of the heating unit is rising, once in associate energized state. Besides, the electrical phenomenon that is resistivity will increase step by step with the effect of PTC. With the benefits of high thermal potency, very little impact on structure, excellent performance in energy conservation, convenient installation, zero pollution, long service life, and remoteautomatic management, the electrical heat tracing system has been with success applied in engineering science, oil engineering, chemical engineering, and so on. The early Nineties, the electrical heat tracing technology was firstly introduced in China. After that, alongside the advance of fabric technology and electronic technology, this technology was experiencing a really fast growth in varied fields of engineering construction.

Electric Heating Cable

6. RESEARCH METHODOLOGY

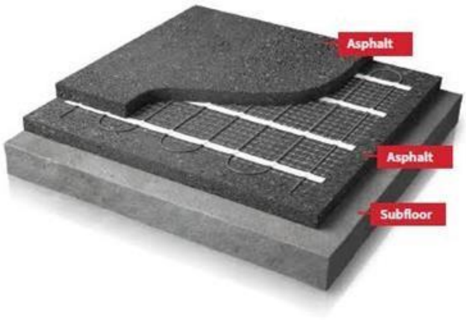
1.To spot the potential of ways will use for ice melting.
Interacting with electrical engineer for style of heating tracing. Grouping knowledge of temperature, snowfall depth. Studies of worst conditions which can be occur. To check the electrical tracing system use for pavement heating. Analyse the heating energy created by electrical coil. Estimate the heating capability needed for the pavement style and configure the electrical circuit as per the need
2. Analyse the pavement construction. Knowledge assortment for construction of pavement at extreme cold (snow fall) region. Study the quality technique of pavement construction and is code. Decide the planning of pavement by proving drainage system.
3.Confirm the planning of pavement with electrical tracing system. Style of pavement containing profile of electrical tracing system style of instrument panel for operation of pavement
4. Design of Model and testing Model of 1 m x 0.6 m for versatile pavement.
Model of 1 m x 0.6 m for rigid pavement.
With depth of 0.1 m depth
Note the expenses for model creating so calculate cost accounting for actual site. Testing the models. Adopt appropriate from rigid and flexible.
5.Calculate operating expense for model and predict the construction cost and operation cost of actual site.

7. MIX DESIGN CALCULATIONS

Design of Bitumen Pavement:

Volume required = 0.06m³
= 60,000 cm³
Bitumen material - used VG30 Bitumen
Specification of VG30:
As per MORTH section 500 and Table 500 and
Table 500-16
And 500-17 (5th revision)
Conclusion:
(5.5% for optimum at 120°C)
(2 % filler that is lime Powder)

Material	Quantity
Coarse Aggregate(12mm)	24kg
Fine aggregate (6mm)	28.8kg
Sand	41kg
Filler (lime powder)	1.74kg
Total quantity	95.54kg



Coarse aggregate

$0.06X0.25 = 0.015m^3$
=24kg

Fine aggregate

$0.06x0.3 = 0.018m^3$
=28.8kg

Crushed sand

$0.06 \times 0.43 = 0.0258\ m^3$
=41kg

Filler

$0.06\ X\ 0.02= 0.0012m^3$
=1.74kg

By assuming density of materials as follows
Aggregate density 1600 kg/m³
Lime powder density 1450 kg/m³

Total weight =95.54 kg

Quantity for model= 95.54 + (4% of quantity for extra or wastage)
= 100 kg
Bitumen required = 5.5% by weight

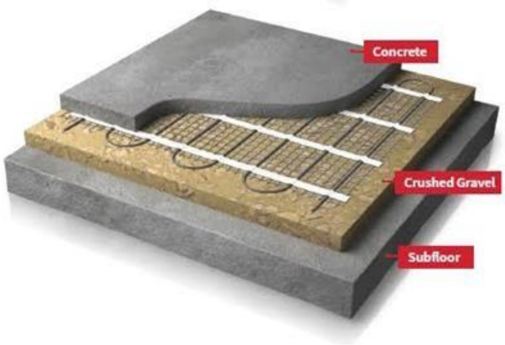
=5.5 kg of VG30 Bitumen

Coarse aggregate (12mm)	Fine aggregate (6mm)	Crushed sand	Filler (Lime powder)
25	30	43	2

<u>Design of Concrete Pavement:</u>

Data required for Mix Design:
Type of Cement: OPC 53
Standard Deviation: 5 MPa
Maximum Nominal size of Aggregate: 20mm
Grade of Designation: M40
Minimum Cement Content: 300 kg/ m^3
Exposure Condition: Moderate
Workability: 100 mm
Maximum W/C: 0.5
Zone of Sand assumed: Zone I

Slump	Water content
25-50	186 lit
100	?



Concrete Placing: By Hand
Water Absorption: Coarse Aggregate = 0.5 %
Fine Aggregate = 1 %
Specific Gravity of Coarse Aggregate: 2.74
Specific Gravity of Fine Aggregate: 2.74
Specific Gravity of Cement: 3.15
Specific Gravity of Admixture: 1.145

STEP I: Target Mean Strength of Concrete:

$F_K = F_{CK} + K.S.$
For M40, S = 5 MPa
K = 1.65 (As per IS 456-2000)
$F_K = 40 + (1.65 X 5)$

F_k = 48.25 MPa

STEP II: Selection of Water-Cement Ratio:

It depends on:
- Exposure condition: Moderate
- Type of Cement: OPC
- Nominal Aggregate Size: 20 mm

From IS 456 (Table No.9.7.3)
W/c = 0.45 < 0.5

Workability = 100

For 20 mm nominal size of Aggregate and Slump
25-50 mm
Maximum Water Content = 186 lit

W/C	Volume of Coarse Aggregate
0.5	0.6
0.45	0.61

Required Water Content = 186 + 6% of 186
=197.16 lit
Based on trial with Super plasticizer, we can reduce quantity of water by 29 %
Reduction in Water Content = 197.16 - (29% × 197.16)

Water Content =140 kg / m^3

STEP III: Calculation of Cement Content:

Water/cement = 139.98 / Cement

Cement content =311.07 kg /m^3

STEP IV: Proportion of Volume of Coarse and Fine Aggregate:
Zone of Sand = zone I
According to zone I,
Volume of CA and FA for 20 mm size aggregate = 0.6 for 0.5 w/c
But w/c is 0.45 so needs to change volume of CA by ± 0.01
Volume of Fine Aggregate = 1 – 0.61

= 0.39

Corrected volume of CA and FA for 0.45 W/C = 0.61 and 0.39

STEP V: Mix Design Calculation:

Volume of Concrete = 1 m^3

Volume of Cement = Mass of Cement /

(Specific Gravity of Cement × 1000)

= 311.07 / (3.15 × 1000)

Volume of Cement = 0.1 m^3

Volume of Water = Mass of Water / (Specific Gravity of Water × 1000)

=140 / (1 × 1000)

Volume of Water = 0.14 m^3

Volume of Admixture = Mass of Super plasticizer / (S.G. of Admixture × 1000)

Mass of Admixture = 2% of Cementitious Material

= 2% × 311.07

= 8.8 kg

Volume of Admixture = 8.8 / (1.145 × 1000)

Volume of Admixture = 0.01 m^3

– Volume of Cement – Volume of Water

= 1 - 0.1 – 0.14

Volume in all Aggregate = 0.76 m^3

Mass of Coarse Aggregate = S.G. of CA × 1000 × Volume of CA × Volume in all Agg

= 2.74 × 1000 × 0.61 × 0.76

Mass of Coarse Aggregate = 1270.26 kg / m^3

Mass of Fine Aggregate = S.G. of FA × 1000 × Volume in all Aggregate

= 2.74 × 1000 × 0.39 ×0.76

Mass of Fine Aggregate = 812.14 kg /m^3

STEP VI: Water Correction:

Extra quantity of water to be added,

In Coarse Aggregate = 6.32 kg

In Fine Aggregate = 8.08 kg

Total Water Content = 140 + 6.32 + 8.08

Total Water Content = 154.4 kg / m

STEP VII: Mix Proportion for Trial:

By Weight,

Material	For Concrete Volume = 1 m^3	**For Concrete Volume = 0.06 m^3**
Cement	311.07 kg / m^3	**18.664 kg / m3**
Water	154.4 kg / m^3	**9.264 kg / m3**
Admixture	6.22 kg / m^3	**0.373 kg / m3**
Coarse Aggregate	1270.26 kg / m^3	**76.216 kg / m3**
Fine Aggregate	812.14 kg / m^3	**48.728 kg / m3**

8. CONCLUSION

Design of snow melting pavement by electric heating having low construction cost, low operating cost and maintenance cost.

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