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Experimental Study on Automatic Cleaning Roads using Water and Air

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Abstract: *The cleaning and maintenance of the pavement is the need of the town and urban communities now a day. Assuming individuals stand with the ongoing maintenance process, it will just extend and develop the crisis. Any numerous unsafe substances which influence human as well as climate and makes road frightful. It gives bad impact on the lower part of vehicles, for example, vehicles motors, and plastic wastage can be the reasons for major and minor accidents. The durability of the pavement is extensively relied upon the temperature variation. The change in temperature creates undesirable stresses in the pavement, which leads to the development of cracks. Eliminating and controlling of this kind of issues is the challenging task. The basic ideology of this paper is to achieve a smart road by cleaningthe pavements by using water and air pressure and prevention of distresses in concrete pavements due to temperature variation. This paper also highlights the solution for potholes in concrete pavements.*

Keywords: *Nozzles, Pavement distress, Potholes, Road stud, Sensors for operation,Smart Road.*

I.INTRODUCTION

In India there are numerous major roads and other minor roads which contributes to the aesthetics of India however these roads are covered with disgusting material and wastage. Which ruins the magnificence of the roadway and these wastages has negative impact on the human heath as well as affects the environment. Sometime these materials may cause accidents and spread disease in the environment. These sorts of issues primarily get started in high populated urban areas like Delhi, Mumbai, Hyderabad,Chennai, and so on. The filthy materials in the pavements can be eliminated by flashing out water in the road surface at regular intervals and by this process the temperature variations in the pavement can also be balanced. In general, the water used in the cleaning process is a residential waste water which is recycled and reused for further process. The residential waste water is collected in trucks and poured into the drainage system which works as a storage tank as well as a sedimentation tank. So, the recycled waterthrough pipelines reaches the nozzles of the road stud from where the water flashes out to execute the cleaning process. The cleaningprocess is executed in regular intervals and it is operated through sensors. The cleaning process has a dual advantage, it removes the filthy materials in the pavement and also balances the temperature variation. Once the cleaning process is done the water gets drainedoff in the drainage and the debris gets collected in the gratings which is provided in two layers and finally this water is reused againfor the cleaning process. While the sediments in the drainage is 2 used a fertilizer for plants. Now the debris in the gratings are removed by providing a suction, which is operated through sensors. The major aim of this study is to achieve a clean pavement by removing all the filthy materials, to prevent distresses in the concrete pavement by balancing temperature variations and importantly to improve aesthetics of Indian roads.

II.LITERATURE REVIEW

Dileep Singh, Sandeep Kumar, Subhendu Mishra, Pawan Kumar, Himanshu Yadav, Raj Kumar Gupta, 2022 The study givessolution for road washing problems. This technique is used in South Korea, but this can also be used in India. This study explains the advantages of this technique. Road washing is a good for its aesthetic and durability. So, to maintain road washing works the road stud can be very useful at dividers preventing it from breaking from vehicles due to its advantages of using it. The Automatic Cleaning and Treatment of road pavement process is capable to reduce the road cracking effect and it also helpful to clean the Roads,Highways which is the beauty of Indian.

Shubham Upadhyay, Amit Kumar Soni, Aasutosh Gupta, Rananjay Pratap Singh, Sachin Kumar Yadav, 2017 This experimental study describes that the Automatic Cleaning and Treatment of road pavement process is capable of reducing the road cracking effect and it also helpful to clean the Roads, Highways which is the beauty of India. And all substances which gives a harmful effect on environment and also human health, can be easily removed from the road surface and dumped safely and Automaticwater wash and dry system gives a broad impact of cleaning and maintenance process of roads.

Rajeshwari Madli, Santosh Hebbar, Praveenraj Pattar, and Varaprasad Golla, 2015 The model proposed in this paper serves two important purposes; automatic detection of potholes and humps and alerting vehicle drivers to evade potential accidents. The proposed approach is an economic solution for detection of dreadful potholes and uneven humps, as it uses low-cost ultrasonic sensors. The mobile application used in this system is an additional advantage as it provides timely alerts

about potholes and humps. The solution also works in rainy season when potholes are filled with muddy water as alerts are generated using the information stored in the database. The solution provided in this paper can save many lives and ailing patients who suffer from tragic accidents.

Yi Bao, Fujian Tang, Yizheng Chen, Weina Meng1, Ying Huang and Genda Chen, 2016 In this study, the PPP-BOTDA technology has been successfully implemented to measure distributed strains and detect multiple cracks in full-scale concrete panelsusing commercial single mode optical fibers as distributed sensors, providing a cost-effective sensing technology for pavement monitoring. Based on various experiments and analyses.

Hassene Hasni, Amir H. Alavi, Pengcheng Jiao, Nizar Lajnef, Karim Chatti , Kenji Aono Shantanu Chakrabartty, 2017 Thisstudy presented a new method for detecting bottom-up cracking in asphalt concrete pavements based on the data recorded by the SWS. The whole methodology is based on detecting the deviation of the voltage/strain amplitude caused by the damage or cracking events. The prototypes of the SWS can have floating-gates with constant and variable electron injection rates. The injection rate controls the injection of the electrons into the gate and therefore the voltage droppage across it. The sensor records the cumulative time at specific voltage threshold which is proportional to this droppage.

III.OBJECTIVES OF SMART ROADS

It reduces the vehicle maintenance by remove the dust and junk which affect the lower part of vehicles.It maintains the pavement temperature, which is the cause of pavement cracking.
It removes the toxic and waste material from road.
It also helps to make Indian clean and follow the SWACHA BHARAT ABHIYANIt reduces the average rate of accidents by road wastage.

IV.RESEARCH BACKGROUND

Impact of Wastages And Temperature Variations

Deformations in pavement is the mind-boggling phenomena that can be brought about by the temperature variations and load of vehicle. Temperature variations cause curling and thermal-expansion stresses inside the concrete. Rigid pavements are intended to give safe and durable road surfaces. However, fatigue and distress from repeated vehicular loading, temperature changes and dampness changes over the long haul are the most noticed failure mechanism. Thus, a good understanding of pavement deteriorationis crucial for the design and operation of road infrastructure.

Slab Curling

Curling deformation, leads to thermal-expansion stresses in the concrete slab, such distress might lead to void development becauseof the plastic deformation and resulting in withdrawal of the base course from the substantial. Bending of the slab due to both upwardand downward curling happens individually when the top surface of the section is cooler than the base course and furthermore when there is a higher temperature on the top surface.

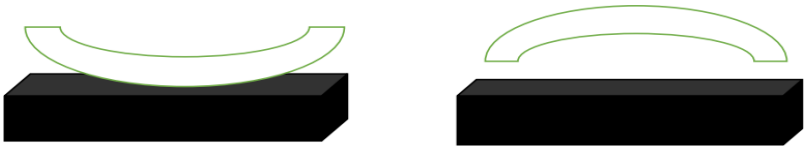

Fig.1 Slab curling

Expansion and Contraction

Pavements, will expand as the temperature rises and contacts as the temperature decreases. Extreme temperature variation may lead to catastrophic failures. Rigid pavement will experience huge transverse cracks because of great contraction in cold period. Rigid pavements are also prone to slab buckling due to great expansion in hot period. Not only the temperature variation has negative impact on the pavement but also wastage give a terrible effect on human wellbeing like plastic packs, jars, bottles and unsafe meds gives an expansive influence on humanity and these 4 substances are extremely toxic also, after some time it tends to react with the environmental agents and releases the destructive gases into the atmosphere.

V.DESIGN OF AUTOMATIC CLEANING ROADS

Description of Works On Road

The scope of works shall be broadly categorized as follows:

- Excavation for roadways
- Embankment construction of roads and all tracks
- Subbase Course comprising of GSB and WMM of all roads
- Base Course comprising of bituminous layers for all roads
- Culverts, Protective Works
- Cross drainage and side drains
- Miscellaneous works such as Traffic Appurtenances works etc
- Environmental protection.
- Traffic control during construction.

Calculation For 1 Km Of Pavement (Two Lane)

1. No of edge lane marking = 2
2. Road stud requirement @ 6mc/c for one edge = 167 no's
3. For both the edges = 374 No's
4. Pipeline requirement 40mm diameter = 1000 X 2 = 2000 m
5. For 1 road stud 2 nozzles are provided

Design of Drainage System

Drainage system provided in this project acts as a storage tank and as well as a sedimentation tank. The drainage system works as asedimentation tank because of more detention period. The drainage system in this project is designed as per the design procedure of sedimentation tank.

Sedimentation Tank Design

In this project, an economical rectangular primary sedimentation tank is adopted. Considering 1km of the rigid pavement asedimentation tank is designed. Let the initial water supply be 200litres/km

Losses

Evaporation and Percolation loss =10%
Sewage produced =80%
The maximum water supply
=400 l/kmLet the detention
period be 12hours
Capacity of the tank required (Q) = 400 X 12 /24
Therefore, Capacity of the tank required (Q) is 200
m3 /km
Let the velocity of flow through the tank is maintained at 0.3
m/secLength of the tank considered is 1km
Cross-sectional area of the tank required = capacity of the tank /length of the tank
= 200m3/ km /1000mTherefore, Cross-sectional area of
the tank is 0.2m2 /km
Let the depth of the tank be 6m
Width of the tank = Cross−sectional area /Depth
= 0.2m2/ km /6m = 0.03m/kmAdopt,
Width of the tank as 0.1m/km
Overall depth = Free board+ Depth
=0.5m+6mOverall depth be 6.5m/km
Therefore, Dimensions of the tank be 1000m X 0.1m X 6.5m /km

Check

Q =1000 X 0.1 X 6.5
Q =650m3 /km > 200m3 /km T
herefore, the sedimentation tank of above dimensions can be adopted.

Baffles

These are required to prevent the movement of organic matter and its escape along with the effluent and to distribute the sewageuniformly through the cross section of the tank, and thus to avoid short circuiting.
Adopt, Submerged Baffle wall of size 1000m X 0.03m X 2m/km 19

Inlet and Outlet Arrangement

- In order to short circuiting and to distribute the flow uniformly proper arrangement must be made for smooth entry of water.
- A most suitable type of an inlet for a rectangular settling tank is in the form of a channel extending to full width of the tank, withthe submerged weir type baffle wall.
- A similar type of outlet arrangement is also provided.

Design of ConduitPipes And Losses

Pipes And Losses

HEAD LOSS	1 inch PIPE	¾ inch PIPE
Major Head Loss	0.019m	0.027m
Minor Head Loss	0.0082177m	0.0082177m
Total Head Loss	0.027m	0.035m

Fig.2 Pipes and losses

Potholes

A pothole is a type of failure in an asphalt pavement caused by the presence of water in the underlying soil structure and the presence of traffic passing over the affected area. This failure is seen as irregularities or voids in the roads. As to avoid any furtherdamage to the road and to make comfort for drivers who pass by and also to avoid major accidents to occur We going to place a full layer of pipers below the pavements, a layer of pipes will be laid along the road side below the pavement . where ever potholesare created then the resin which are laid down the pavement will likely to break and potholes will be filled with resin automatically without any assistance while it is on process the indication will be shown to drivers who pass by. through sensors the whole process will take place and here we are using MMA resin i.e.., Methyl methacrylate resin to cover potholes and this resin will quickly dry and fix to it faster than other resin so it is readily usable after the process been done

Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The input can be light, heat, motion, moisture, pressure or any number of other environmental phenomena. Here we are using it for detecting motion of vehicle,heat or temperature of pavement, etc. For our project we are going to place sensors within traffic signals post and in street lights to indicate drivers or vehicles for the process of resin, creation of potholes As our main moto is to make roads clean and to avoid pavement damages due to climatic variations.

The process will go on like this:

- First the water starts to spray from nozzle to clean pavement thoroughly and air pressure blows to make flow dust like strawsrice husk etc.,
- Then the water flows to the drain pipes which are laid along the sides of roads
- Each and every 12 hours once this process will take place
- While it is on the process if the vehicles try to pass by then the drivers will be indicated to stop at a particular before the placewhere it IS clean.
- These all done automatically with the help of solar sensors.
- These are for cleaning purposes and for potholes sensors act similar to the above mentioned but each and every part sensor willdetect and glow light while the process is been done like a reflector light.

VI.INSTALLATION

1. Construction of roads: The process to construct the road is by the removal of earth and rock by digging or blasting, construction of embankments, bridges and tunnels, and removal of vegetation (this may involve deforestation) and followed by the laying of pavement material. A variety of road building equipment is employed in this construction such as asphalt paver, road roller machine, excavator, wheel loader, etc.
2. Laying and fittings of pipe: The steel pipes are laid under the surface of the roads which is connected to chamber to supply the required amount of water to clean the roads. The pipes are also laid for drainage purpose and for sediments discharge Pipe fittings helps in changing the direction of water supply from main pipes to secondary pipes. Proper fitting also helps in checking leakage inthe plumbing lines. Pipe fittings are an important component of the plumbing system.
3. Nozzle placement: Generally, the road studs are provided to improve the visibility at night and prevent the cars from running offthe roads or lanes by making roads safer. In this project nozzles plays a dual role. It helps in cleaning the road as well as prevents the accidents. The number 50 of studs placed in the road are 167 for one side of the carriage way and the spacing provided for the road stud is 6000mm c/c.
4. Air Suction Pipe: The pipes are laid on the transverse direction on the road which is used to rip off the large dust particles on topof mesh like chips packets, plastic covers, etc.
5. Road Sensors: The sensors are used to detect the presence of the vehicle by ultrasonic waves transmitted from ultrasonicreceivers installed directly above the road. They are also used to carry out the cleaning process from sensors.
6. Road Mesh: Two layers of mesh is laid along the road sides on top of the drain collector pipe which helps in filtering the largeand fine waste particles.
7. Curing of Potholes: Potholes is a depression in road surface which are caused when water penetrates through tiny cracks in the road. The solution for repairing the potholes is by using Methyl Methacrylate resin.

Fig.3 Top View of The Pavement

Fig.4 Pipe Fittings

VII.WORKING

i. Source Of Water

During rainy season, the rainwater is directly used to carry out the cleaning process. In other seasons, the waste water from the residential apartments is directly discharged into the sedimentation tank (Drainage system) which gets purified and used for the cleaning process.

ii. Pre-Cleaning

Now with the help of motor of designed efficiency the supernatant water from the sedimentation tank is carried to the nozzles placed in the road studs through the conduits of various diameter.

iii. During Cleaning

The water is flashed out of the nozzles placed in road studs to clean the entire pavement. The nozzles are placed on roads for adesired interval and the water from the nozzles are flashed for about 120 degree which covers the entire pavement. Through sensors the indications are sent for about 12 hours once to carry out the cleaning process.

iv. Post Cleaning

Now the waste water is drained off from the pavement and gets collected on the side drains which runs through the entire pavement length. The larger dust particles from the waste water are collected on the top mesh and the particles of smaller size are collected on the second mesh which is of very small diameter. Further the water gets purified in the sedimentation tank through sedimentation process provided along the length of the pavement and again it is reused to clean the pavement. And activated carbon is added to enhance the sedimentation process. The air suction pipes provided on the roads are used to rip off the dust particles on top of the mesh. The suction pipes are operated for different intervals. By this action the mesh gets cleaned.

v. Discharge Of Sediments

The sediments which get settled in the sedimentation tank can be used as fertilizers for plants on the road sides. The sediments from the sedimentation tank are carried to the plants on road sides through separate pipe connections. These sediments serve forplants growth.

vi. Healing Of Potholes

The pipes filled with Methyl Methacrylate resin are laid underneath the pavement. Once the potholes get formed the resin in the pipe bursts out and fills the potholes, which serves as a temporary solution for potholes. Through sensors the indications regardingpotholes are intimated to the driver to be caution at that particular zone.

vii. Miscellaneous

Solar energy can be used for lighting the streets and even for sensor operations. The solar panels are installed on top of the street lights as well as on top of the sensors. These panels tend to absorb the solar radiation from the sun and converts it into electricity,so ultimately it can be used for lighting and sensor operation.

VIII.CONCLUSION

In the above experimental study, the road is designed for one kilometer by providing road studs at equal spacing to clean the roads using water pressure. Road washing is good for its aesthetic and durability. The Automatic Cleaning and Treatment of road pavement process is capable to reduce the cracking effect and the health risk caused by outdoor air pollution.

Some advantages of this project mention below –

- It reduces the vehicle maintenance by remove the dust and junk which affect the lower part of vehicles.
- It reduces the air pollution
- It removes the toxic and waste material from road.
- It helps in preventing the health risks of the civilians
- It also helps to make Indian clean and follow the SWACHA BHARAT ABHIYAN
- It reduces the average rate of accidents by road wastage.

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