SELFHEALING ASPHALT USING ELECTROMAGNETIC INDUCTION

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ABSTRACT

Due to the rapid urbanization, most of the land masshave become impervious due to the constructionofbuildingsandroads.This paper focuses on providing a sustainable road development in urbanareaswhichhelpsthewatertopassthroughtheporousasphaltwithself-healingpropertyinsustainable pavement design. The results producedarebyreviewingvarious experimental contents.

Keywords: Porous asphalt, Self-healing, Inductionheating.

INTRODUCTION

The impervious nature of soil causes ground waterdepletionwhichiscreatingthewaterscarcityallover. During monsoon burst on floods large amountof water is being flooded over roads which mixeswith sewage. To reduce this flooding and to makewater to pass through porous asphalt is employed.These asphalt roads undergo potholes developmentwhichreducesthedesignlife,trafficflowandremainsreasonformostaccidents takingplaces.

This problem can be overcome by making asphalt troad with self-healing property.

POROUS ASPHALT ROADS

Asphalts are used for road surface which is easy toapply.i.e.,1.Warmthebitumen2.Mixtheaggregate3.Applyonsurface.Onceitcoolsitbecomes hard road surface with pores which allowswatertopassthrough.Thisporousasphaltroadshelp in managing storm runoff which drains waterthroughthesurfacepavementintostormwaterdischarge bed and into soil beneath the pavement.Thishelpsinrecharginggroundwatertableandreducesstrain in storm runoffsewage.

Buttheseasphaltroadssufferfromamajordisadvantageofpotholedevelopment.Thesepotholes remain major cause for accidents in Indiawhich claims 10 lives per day and 3597 death in2017.Potholes occurs when water percolates belowandweakensthesoilandcausestrafficfatiguewhichcausesravelingofaggregatesandsoilfromtheplacewhichaffectstheflowoftrafficandrequireshigher maintenancecost.

This disadvantage can be overcome by making theasphalt roads develop the self-healing nature by twomethodswhichhavetobedonebeforelayingasphaltroads.

PROCESSOFSELF HEALING

Therearethreeprimarystepstobefollowedforself-healingprocess;

1. Wettingthetwofacesof thecrack.
2. Diffusionofmolecules.
3. Randomizationofdiffusedmoleculestoattainoriginal strength.

Self-healingtakesplaceatmolecularlevel,whenbroken molecules are available to form links andchains via hydrogen bonds. So, this process canbetermedas Reversible Hydrogen Bonding.

INDUCTIONHEATING

To prevent raveling on porous asphalt pavement anraveling porous asphalt was developed. This

methodiscalledasinductionheatinginwhichsteelwoolwasaddedtoporousasphaltbeforelayingroads.Thissteelwoolgenerallyprovidestrength byincreasing ductility. It improves cohesive and tensilestrengthofmixture.Thus,fibrereinforcementasphalt mix would have good resistance to ageing,moisturedamageandcrackresistance.Undervarious test using carbon fibres, graphite, steel fibresandwoolandconductivepolymerpolyanilineresulted as carbon and steel wool as best conductivematerial.

Induction heating process operates by sending analternatingcurrentthroughthecoilandgeneratingan alternating electromagnetic field which inducescurrent flow along the loops formed by steel fibers.This fibre conducts the heat and melt the bitumenaround it which causes capillary flow and diffusionofbitumen.

Twokindsof steelwoolarebeenused:

Onewhich has been termed ‘‘coarse steel wool’’ (CSW),withwiresof0.10–0.12mmthick,andanothercalled‘‘mediumsteelwool’’(MSW),withathickness of 0.04–0.06 mm.

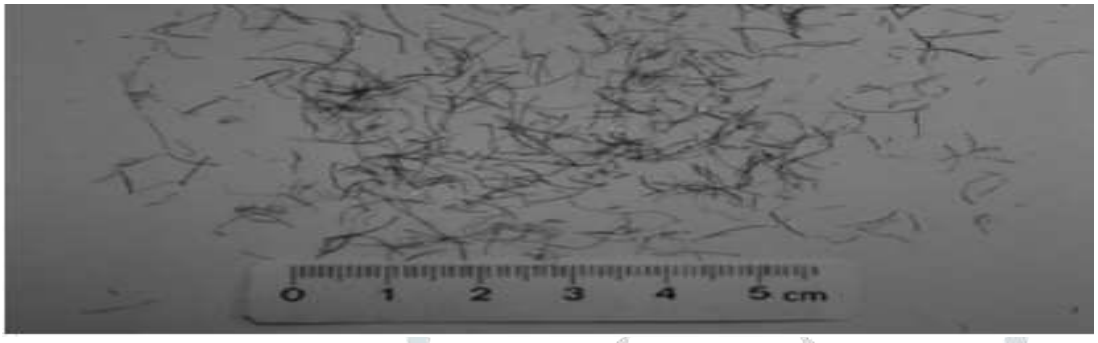

Fig1:Steelwoolusedforhealingofcracks

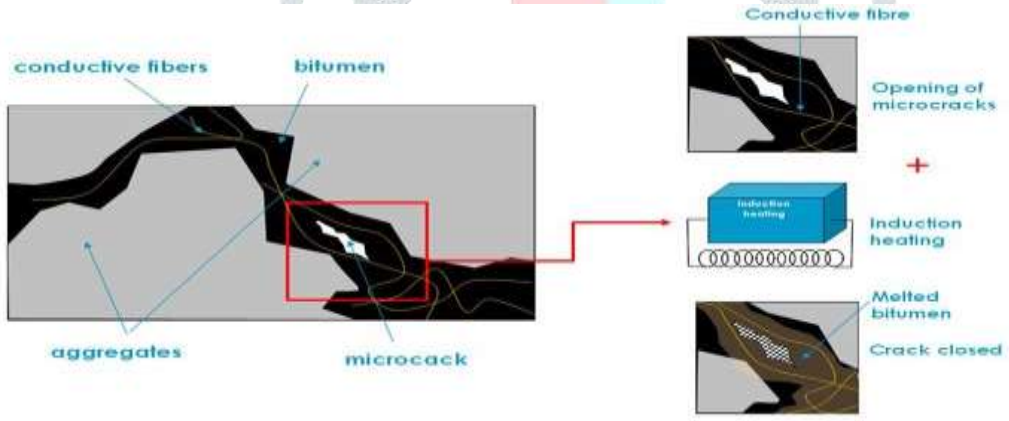

Fig2: Healingofcrackusing inductionheating

Various steel wool of long, short and medium werecomparedbyvarioustestwhichprovedmediumsteel wool of 1cm with 0.157mm diameter as beststeelwool forinductionheating process.

One adverse effect is that overheating of asphalt mixwouldcausebitumenswellinganddrainagefromaggregate which is a severe problem. Thus, optimumheating of mix is 85°C. The heating should not bedone tooearly ortoolate. Whenapplied tooearlythe stiffness of bitumen gets loosened when appliedtoolate thehealing process would be less.

Theheatingofasphaltwithinductionenergytoincreaseitshealingrate.Thefirstprerequisiteofinduction heating is that the heated material must beconductive.Inmanypreviousstudiesithasbeendemonstratedhowitispossibletomakeasphaltorconcreteconductivebyaddingelectricallyconductive fillers and fibers. The second prerequisiteisthatthesefillersandfibersareconnectedinclosed-loopcircuits.InFigure8aschematicrepresentationisgivenofthesysteminwhichinductive energy is used for the healing of asphaltconcrete. First a microcrack appears in the bitumen.If enough volume of conductive fibers or fillers isaddedthey willformclosed-loopscircuitsallaroundthemicrocrack.Then,ifthismagneticallysusceptibleandelectricallyconductivematerialisplacedinthevi-cinity of a coil, eddy currents are induced in theclosed-

loopscircuits,withthesamefrequencyofthemagneticfield.Heatisgeneratedthroughtheenergylostwheneddycurrentsmeetwiththeresistance ofthematerialand,finally,bitumenismeltedandthecrackisclosed.When fibers are added to the mixture, the thicknessfilm of mastic around the aggregates is reduced. Thiscanhaveanegativeeffectonthemechanicalpropertiesofasphaltconcretepavementsso,toensure the durability of this porous asphalt, bitumencontentneeds to beincreased.

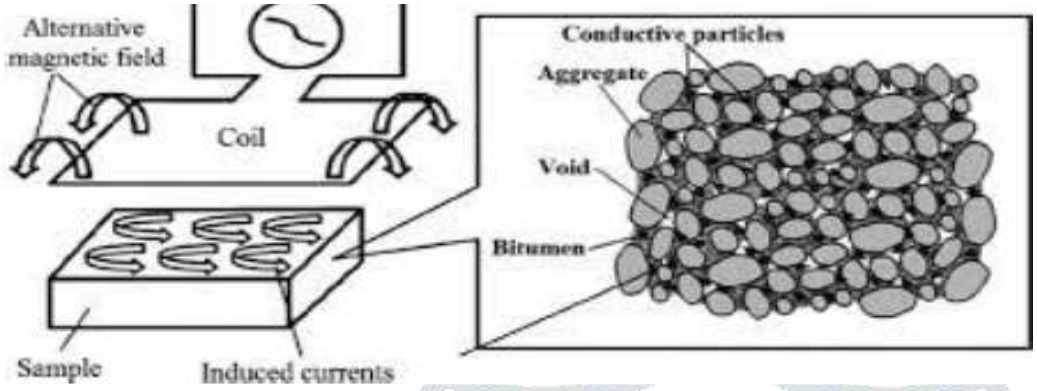

Fig 3: Magnetising the steel wool using inductionheating

CONCLUSION

Thus,byemployingporousasphaltwecanreducethe runoff and recharge the ground water table. Theraveling of stone from porous asphalt can also bepreventedbyInductionheatingprocess.Thisincreasesthelifetimeoftheroadandcausesreductioninbudgetsegregatedforroadmaintenance.

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