

# Design of Self-Healing Flexible Pavement by Helianthus

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**Abstract**— Self-healing technology is a new field within material technology. It represents a revolution in materials engineering and is changing the way that materials behave. Incorporating self-healing technology into the road design process has the potential to transform road construction and maintenance processes by increasing the lifespan of roads and eliminating the need for road maintenance. There are various healing agents such as steel fibres, glass fibres, Nano rubber, Nano clay, etc. these materials are not economically available. Helianthus possesses a mending property that alters the viscosity of the asphalt-based products. Hence this property of Helianthus can be used in the construction of pavements which will have self-healing capabilities. As the asphalt also has the viscoelastic properties, helianthus can accelerate the healing process. The study focuses on various techniques adopted for the suitability of pavement healing. The study also reflects on suggesting a suitable material which can help in achieving the self-healing capabilities within the economy.

**Keywords:** Self-healing Asphalt, Viscoelastic Properties, Helianthus

## I. INTRODUCTION

Pavements play an important role in the development of any nation. The road network is spread through different cities, towns, villages and to many different parts which results in communication between them and make way for development. The pavements are of two types i.e. Rigid and Flexible from which flexible pavements are used widely for highways. These flexible pavements are made up of asphalt as the binder material Asphalt is a sticky, black and highly viscous liquid or semi-solid form of petroleum. This asphalt is of two types i.e. natural asphalt and artificial asphalt. Asphalt in the natural deposit is found as rock asphalt and lake asphalt whereas artificial asphalt is obtained by distillation of crude oil. The asphalt has good binding property also it is used for waterproofing purposes. These pavements are subjected to heavy vehicular load which may result in fatigue cracking, resulting in potholes and many other defects. Also, different conditions may lead to defects in pavements such as low temperature, oxidation of asphalt and faulty materials. In this, fatigue and thermal cracking are dominant. restoration of pavement. To achieve the self-healing mechanism simply, helianthus can be used as the self-healing agent. This may prove economical and easier than other self-healing techniques. So a self-healing approach by using helianthus is carried out the technique tends to recuperate the damage or defects that happened to pavement. The asphalt has the viscoelastic nature which is an advantage for the intrinsic healing that gives a 10% increase pavement lifetime. By techniques such as Rejuvenators, heating. The rejuvenators are glass fibre is heated to achieve restoration of pavement. To achieve the self-healing mechanism simply, helianthus can be used as

the self-healing agent. This may prove economical and easier than other self-healing techniques. So a self-healing approach by using helianthus is carried out.

## II. LITERATURE REVIEW

Self-healing has great potential to extend the service life of asphalt pavement and it is regarded as an important strategy when designing sustainable infrastructure. The self-healing concept is a natural phenomenon that helps to recover, repair cracks and extend the life span and it can be divided into two types in a liquid-based and solid base. Asphalt has intrinsic healing capacity but it may need to be modified to enhance its healing capacity. Adding a binder can help in improving the optimized pavement design. Also Fundamental Understanding of chemo-mechanical properties of asphalt can lead to a significant impact on the sustainability of highways and impact on the environment. Various techniques and materials are used for it used glass fibres from which he concluded that Glass fibre Modification of Asphalt Mix at low temperatures of 25o C has indicated increased flexure stiffness, increased resilient modulus and higher fatigue lifecycles which indicated improvement in viscoelastic behaviour. used steel wool fibres in their research which also proved in improvement in a healing capacity. Fibres offer excellent mechanical properties and these fibre pavement restoration processes are done by induction heating. Mix Asphalt to utilize plastic waste efficiently and contribute to the wellbeing of the environment. Also, economy and sustainability are achieved by using polythene in the mix. Rejuvenators in the form of embedded capsules restore the original properties of binder and increase the self-healing rate by closing the crack or limiting its growth. developed two encapsulation methods; polymeric shell and porous aggregate. These microcapsules can release their active agent in both ways i.e. in response to stimulus and by diffusion.

## III. MATERIALS USED FOR SELF HEALING PAVEMENT

### A. Asphalt:

Asphalt is a black sticky highly viscous material obtained in natural deposits and by distillation of crude oil. It is soluble in carbon disulfide. The use of asphalt is 70% in road construction, where it is used as binding material. It is also used as a waterproofing product. The composition of asphalt include floor main classes of compound, they are naphthene aromatics, polar aromatics, saturated tests on asphalt.

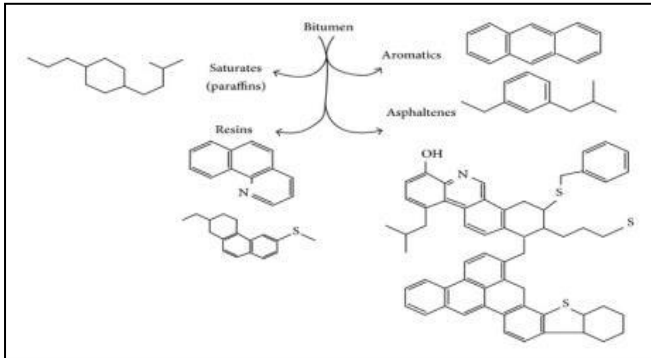


Fig. 1: Molecular structure of Asphalt (researchgate.net)

Laboratory Tests conducted on Asphalt:

Penetration test – 30/40 grade

60/70 grade

80/100 grade

Ductility test – Should not be less than 350 C

Softening point test - 350C to 700C

#### B. Aggregate:

Aggregate is a collective term for the mineral materials such as sand, gravel and crushed stone that are used with a binding medium to form compound materials. In pavements, aggregates are used for base and sub-base courses for both flexible and rigid. Aggregate can either be natural or manufactured.

The various test to be performed on aggregates include,

Abrasion test – permissible range 30% to 40% max abrasion allowed

Impact test – permissible range 30% to 35%

Shape test:

Flakiness index – value should be less than 15

Elongation index – value should be less than 15

Aggregate crushing test – permissible range is up to 45%

#### C. Helianthus Oil:

Helianthus oil is also known as sunflower oil prepared from the seeds of the sunflower. It is a mixture mainly of polyunsaturated fat, linoleic acid (59%), monounsaturated fat, oleic acid (30%) flavour and has a rich content of vitamin E.

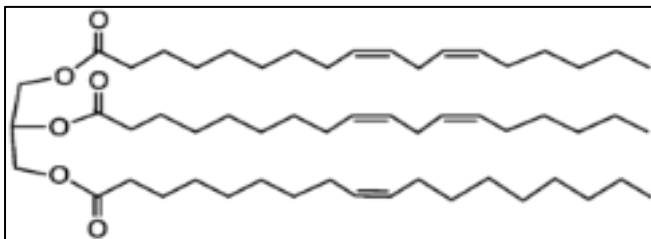


Fig. 2: Molecular structure of Helianthus oil  
(en.wikipedia.org)

#### IV. DATA COLLECTION

At first, we made us familiar with the procedure of Self-healing techniques using asphalt pavement. Various methods are being used in Self-healing techniques like induction heating, nanoparticles, rejuvenators. Among these three methods, we are going to study the rejuvenator method by using helianthus.

By referring and studying different research papers, we have collected the necessary data for the project. We have searched different sites which would be suitable for our project work and chose one of the sites which would fulfil the requirements of our project.

#### V. DATA ANALYSIS

After choosing the suitable site, we measured the 200-meter road and collected the sample which us will use further for performing different tests and finding an estimate for the project. The California Bearing Ratio test (CBR test) is performed on the collected sample which is a penetration test meant for the evaluation of subgrade strength of roads and pavements.

##### A. Performing the CBR test in the following procedure:-

Sieve the sample through 20mm IS sieve. Take 5 kg of the sample of soil specimen. Add water to the soil in the quantity such that optimum moisture content or field moisture content is reached

Then soil and water are mixed thoroughly. Spacer disc is placed over the base plate at the bottom of the mould and a coarse filter paper is placed over the spacer disc.

The prepared soil water mix is divided into five. The mould is cleaned and oil is applied. Then fill one-fifth of the mould with the prepared soil. That layer is compacted by giving 56 evenly distributed blows using a hammer of weight 4.89kg.

The top layer of the compacted soil is scratched. Again second layer is filled and the process is repeated. After the 3<sup>rd</sup> layer, the collar is also attached to the mould and the process is continued.

After the fifth layer collar is removed and excess soil is struck off. Remove base plate and invert the mould. Then it is clamped to the baseplate.

Surcharge weights of 5kg is placed on the top surface of the soil. Mould containing specimen is placed in position on the testing machine.

The penetration plunger is brought in contact with the soil and a load of 4kg(seating load) is applied so that contact between soil and plunger is established. Then dial readings are adjusted to zero.

Load is applied such that the penetration rate is 1.25mm per minute. Load at penetration of 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6,7,8, 10 and 12.2mm are noted.

##### B. Standard Load Values for CBR Test:-

Penetration(mm)	Standard Load(kg)	Unit Standard Load(kg/cm <sup>2</sup> )
2.5	1370	70
5	2055	105
7.5	2630	134
10.0	3180	162
12.5	3600	183

##### C. Observations during CBR Test

Weight of soil taken = 5kg

Weight of surcharge =5kg

Area of plunger, A = 50mm

Proving Ring Calibration Factor = 1.533kg/15.33N

Sl No.	Penetration(mm)	Proving dial reading
1	0.5	8
2	1	15.8
3	1.5	22.8
4	2	28.4
5	2.5	33.6
6	3	38.2
7	4	47.1
8	5	54.6
9	6	61

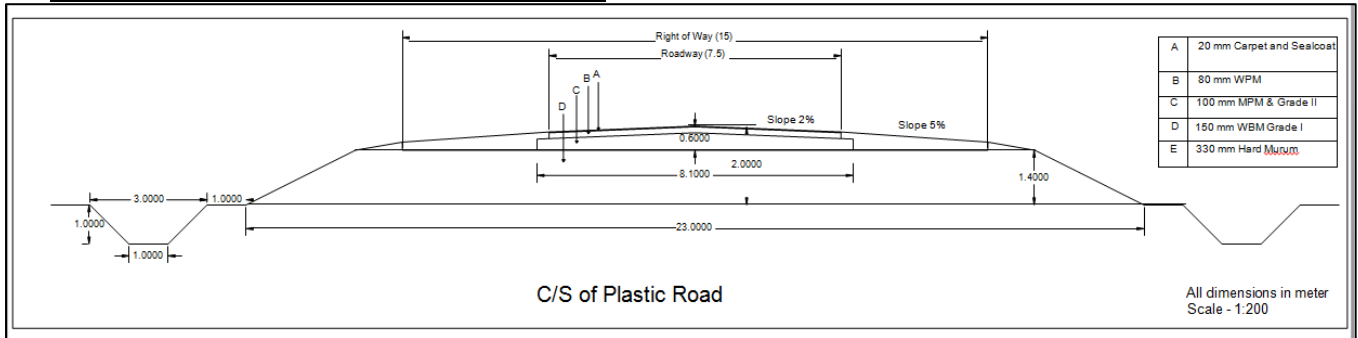
10	7	76.7
11	8	82
12	10	90.8
13	12.2	99.4

#### D. Result of California Bearing Ratio Test

California Bearing Ratio at 2.5mm penetration =3.75

California Bearing Ratio at 5.0mm penetration =4.07

California Bearing Ratio of subgrade soil =4.07



#### VI. SCOPE

The California Bearing Ration Test enabled us to find the estimate of road thickness. We are left with the two estimates naming the estimate of commercial Road and the Self-healing estimate of the road which would be studied further and get uploaded in the specified time.

#### VII. CONCLUSION

The above analysis carried out for the site used in this project gives us the estimate of road thickness which is being calculated using The California Bearing Ratio Test. Us will use this estimate for the further going analysis of the site.

Referred research papers and our project analysis helped us to understand that

- 1) The Helianthus oil was not used before as a Self-healing agent.
- 2) Helianthus oil possesses the property of altering the viscosity of asphalt hence help in accelerating the healing process.
- 3) From various studies, it is found that the Self-healing asphalt method is not economical. Also, most of the chemicals are not readily available. Hench similar properties can be obtained in the form of Helianthus oil which natural extract of sunflower.

#### REFERENCES

- [1] Ali Azhar Butt, Bjorn Birgisson, Nikki Kringos "Optimizing the highway lifetime by improving the self-healing capacity of asphalt. Transport report arena – Europe 2012". Procedia – Social and Behavioral Sciences 48 (2012) 2190 –2200
- [2] Jian Qiu, Martin Van De Ven, Shaopeng Wu, Andre Molenaar and Jianying Yu. "Self-Healing characteristics of Bituminous mastics using a modified direct tension test. Journal of Intelligence Material Systems and Structures, DOI: 1177/1045389X12467515
- [3] Q. Liu, E. Schlangen and G. Van Bochove. "The first engineered self-healing asphalt road. How is it performing? ICSHM 2013.
- [4] Raquel Casado Barrasa, Victor Blanco Lopez, Carlos Martin-Portugues Montoliu, Veronica Contreras Ibanez, Josefina Padrajas, Julio Santarem. "Addressing the durability of asphalt concrete by self- healing mechanism. Procedia – Social and Behavioral Sciences 162 (2014) 188 –197"
- [5] Dr Devesh Tiwari, Prof. Manoj Shukla, "Performance characteristics of fibre modified asphalt concrete mixes. The international journal of pavement engineering and asphalt technology (PEAT) ISSN 1464 – 8164 volume: 15, Issue: 1, May –2014"
- [6] Tariq Ali, Nouman Iqbal, dr. Mehboob Ali, Dr Khan Shahzada, "Sustainability Assessment of Bitumen with Polyethylene as Polymer. Journal of Mechanical and Civil Engineering (IQSR – JMCE) e – ISSN: 2278 - 1684, p- ISSN: 2320 – 334X, Volume 10, Issue 5 (Jan – 2014)"
- [7] Prof. Hassan Baaj, 278 – CHA "Crack healing of asphalt pavement materials international union in laboratories and experts in construction materials, systems andstructures"
- [8] THAO Dinh, Nguyen, LUU Xuan Le "Research of asphalt pavement rutting on national roads in Vietnam. Paper identification number – AYRF2016-012"
- [9] Daquan Sun, Guoqiang Sun, Xingyi Zhu, Alvaro Guarin Bin Li, Ziwei Dai, Jianming Ling. "A comprehensive review on self-healing of asphalt materials: Materials, Models, characterization and Enhancement. Key laboratory of road and traffic engineering of the ministry of education, Tongji University, Shanghai." CIS –01887.
- [10] Miss. Gauri R Mahajan, Dr Y.P Joshi, Prof S.S.Goliya "technologies for healing of asphalt pavements – A Review International Journal for Scientific Research and Development vol. 5, issue 01, 2017, ISSN (online):2321-0613