

# Modified Effective Materials for Flexible Pavement Pothole Repair: A Review

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**Abstract** – One of the most important infrastructure in a progressing country are the communication routes. Since roads indirectly contribute the economic growth. Potholes are the biggest enemy for road users. Government is looking at all options to keep our roads in the best conditions but it is temporary solution for pothole repair. Due to this potholes claimed 30 lives every day in India. Therefore, this preference study need states that to fulfil the need of sustainable repair pothole structure by developing enhanced modified bitumen. There are different kinds of waste materials which satisfy all analysis and strength for pavement performance, significantly it improves asphalt mixture strength when mixed with modified material with bitumen. It contributes to reduce, reuse of waste materials to achieve, economy and develop environment friendly solution to improve pavement strength performance.

**Highlights**– Physical, mechanical properties of different waste materials are discussed, Bitumen modification by using different combination of material, Significantly improved asphalt mixture properties and performance, This preference of binder satisfied all the requirements of asphalt, New environment friendly, economical solution developed for pavement materials.

**Keywords**– Pothole, Bitumen, Pavement, Modified, Repair, Waste, Performance.

## I. INTRODUCTION

### 1. Background

A pothole is a depression in a road surface formed due to the water and load of traffic. Now days, Pothole is a one of the serious issues. Road construction is not a challenging task, but its maintenance is. It requires large maintenance cost of highways due to again and again pothole filling in monsoon season. Due to potholes, accidents may take place and also public required to face traffic congestion problem. The traditional pothole filling materials like aggregate, bitumen are not remain for a long time. It separates from the road after specific time due to action of water and heavy loads or due to improper bonding of the material. So there is need of modify a material which has great binding capacity and great stability.



Fig.1. Pothole due to heavy traffic



Fig.2. Pothole due to poor quality of material

### 2. Recycling waste in bitumen

Waste used in modified bitumen like cigarette butts, crumb rubber, waste motor oil, plaster of Paris are not degradable materials. These materials harm the environment.

- **Non-Newtonian fluid** - A Non-Newtonian fluid is a fluid that does not follow Newton's law of viscosity i.e., constant viscosity independent of stress. corn starch is one of the Non Newtonian fluid type. Corn starch is the starch derived from the corn grain. corn starch used as a binder and gaining strength by heating at a relatively low temperature ( $\leq 200^\circ\text{C}$ ).
- **Cigarette butts** - cigarette butts are noting but cigarette filters. It is most common type of waste found around us. In 2013, 5.7 trillion cigarettes butts were consumed worldwide and every year an estimated 4.5 trillion butts from the annual cigarettes consumptions are deposited in the environment [1]. It takes 2 months to year for decomposition of the butts. It is good absorbent and design to catch different types of toxic chemicals and tar [1].
- **Coconut Fibre** - It is a natural fibre extracted from the husk of coconut. coconut fibre is a waste material commonly seen around the world. Annually 3.18 million tonnes of coconut fibre is produced. It has good weather resistance. It contains 33.61%

cellulose, 36.51% lignin, 29.27% pentons and 0.61% ash.

- **Scrap Rubber tyre** - A tire consisting of a rubber ring around the rim of an automobile wheel. The crumb rubber is obtained blending the scrap tires. It contains 47% rubber, 21.5% carbon black, 16.5% steel, 5.5% fibre, 1% sulphur, 1% zinc oxide and 7.5% other additives[2]. It can give great binding and high strength. It has high cracking resistance [2]
- **Plaster of Paris** - It has good property of setting quickly. Plaster of Paris is prepared by heating calcium sulphate dehydrate, or gypsum, to 120–180 °C (248–356 °F). Plaster of Paris does not generally shrink or crack when dry. It is one of the non-degradable wastes.

## II. LITERATURE REVIEW

### 1. RFP Patch Using Non-Newtonian Fluid.

BY: Arpit Vyas, Rahul S Gupta, Rishabh Gupta, Saurav Valand, Shubham Rathod  
Publishing year : 2018

This paper state for new material implement for pothole repair. It is an environment friendly patch created from organic material and is of economic cost. It is acting on stress behavior of material property. Non- Newtonian material gave good results and bought us a step closer in achieving our objective.

### 2. Physico-mechanical properties of asphalt concrete incorporated with encapsulated cigarette butts.

BY: Abbas Mohajerani, Yasin Tanriverdi, Bao Thach Nguyen, Kee Kong Wong, Ahmad Rezaei  
Publishing year : 2017

This study investigate the possibility of encapsulating CBs with different classes of bitumen. It increase the porosity. Particularly when encapsulating in higher grade bitumen which in turn, lowers its thermal conductivity. This helps reduce the Urban Heat Island effect in urban environments. Manufacturing Asphalt sample using higher class bitumen to encapsulate the CBs gave better result for the physical & mechanical properties.

### 3. Effect of crumb rubber production technology on performance of modified bitumen.

BY: C. Loderer, M.N. Partl, L.D. Poulikakos  
Publishing year : 2018

This paper investigated fracture, rheological, thermo mechanical behavior of crumb rubber. Crumb rubber modified bitumen produced with CR production technologies and use as a recycled pavement materials. It acts as a geotechnical and mechanical properties of asphalt as a binder.

### 4. Pulverized coconut fiber as an additive in asphaltic concrete.

BY: Adebayo, V.B Mohammed  
Publishing year : 2016

In this paper it is concluded that effect of coconut fiber is an additive in asphaltic concrete. It is characterized by increasing percentage of weight of total flow mix. This property of CF can increase stability, skid resistance, resilient modulus. Significantly improves the engineering properties of asphalt mixture with modified bitumen.

### 5. Evaluating the dynamic stabilities of asphalt concrete mixtures incorporating plasterboard wastes.

BY: Dina kamal kuttah, Kenichi Sato, Chikashi Koga  
Publishing year : 2015

This work states that to encourage the recycling of gypsum wastes with asphalt mix. It increase with percentage which decreases asphalt workability. It is a by-product waste which exist dynamic stabilities with incorporating plasterboard waste. It also act as a asphalt binder.

### 6. Pothole Repair Technology – A Review

BY : Tanuj Parmar, Prof. C.B. Mishra, Dr. Sangita, Prof. N. F. Umrigar  
Publishing year : 2016

This paper studied on pothole, their causes and properties. It states that there are different types of technology which used for pothole repair. Investigation and potentials of hot mix and cold mix technology explained. They also give review about commercially available pothole repair mixes.

## III. METHODOLOGY

### Materials and Methods:

**1.Cigarette Butt (CB)** - There are two experiments of using CB as a waste material. Incorporating and encapsulating CB makes modification of bitumen.

### • Encapsulation of cigarette butt with bitumen:

In this,CBs are collected and waste i.e; paper & tobacco is removed so that to obtain sponge in CBs. After that CBs are encapsulated with hot bitumen. Then moulds are prepared by mixing CBs with aggregates. And stability test is carried out.



Fig.3. Encapsulation of cigarette butt with bitumen

- **Encapsulation of cigarette butt with paraffin wax**  
In this, CBs are collected and waste i.e; paper & tobacco is removed so that to obtain sponge in CBs. After these butts are submerged in heated paraffin wax. Then moulds are prepared by mixing encapsulated CBs with aggregates. And stability test is carried out.



Fig.4. Encapsulation of cigarette butt with paraffin wax.

2. **Non-newtonion Fluid** - There is contamination of material is when load is applied it will increase with increased stress. When hands pull out from fluid, it will again behave like a solid.

- **1st method**

Firstly potoles are identified. Non-newtonion fluid is prepared by adding adequate quantity water in material so as to become non-newtonion fluid. Then uniform layer of mixture is placed in pothole. Testing is done by placing weight on patch.

- **2nd method**

In this method mixture of non-newtonion fluid is prepared. Mixture of material fill in geosynthetic bag. And these geosynthetic bags are placed over the pothole. Testing is done by placing human and bike weight on it.

**3.Scrap Rubber Tyre-** Bitumen is highly influenced by the production process of crumb rubber. There is analysis and modularity as a elastomer property. Crumb rubber act as polymer modified bitumen.

- **For thermo-mechanical properties of bitumen**

In this, polymeric additives are use as an elastomer agent in mould prepared. Then stability and rheology testing is done.

- **For mechanical properties of bitumen**

In this method, characterization of rubber is done by grinding process. Crumb rubber is mixed with hot bitumen. After applying modified bitumen in potholes fracture toughness testing is done.

4. **Plaster of Paris-** In addition to this mixing by-product gypsum with the asphalt mixture resistance deformation. Mixing ratio of 40% POP filler for asphalt mixture it could be increased up to 50%. By using different mix design approaches. It makes as a formation of a thin layer of binder.

- **Incorporating process**

In this process by-product of POP waste is collected. Then mineralogical composition is done (before and after burning). Gypsum filler is used as a modified asphalt. Stability testing is done with various composition of materials

5. **Coconut Fibre (CF)-** There is composition of minerals which has greater resistance and hardness. It contains cellulose fibre to prevent asphalt flow and bleeding. Due to CF there is greater tensile strength between aggregates and asphalt.

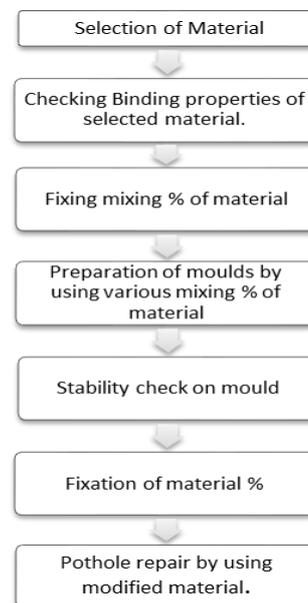
- **Pulverized process**

In this process Removal of CF from outer shells of coconut. Then CFs are shredded mechanically after DE husking. after that penetration testing on aggregates and pulverized CF is done. Stability testing is carried out with prepared mould of pulverized CF.

- **Dry process**

In dry process CFs are removed manually. CFs directly mix with asphalt mixture. Reinforcing mechanisms check is done.

**Method to be adopted:**



1. **Selection of Material –**

According to the requirements of properties like binding, thermal conductivity we search some materials like Non Newtonian fluid, Cigarette butts, plaster of paris, by studying the properties of materials.

2. **Checking Binding properties of selected material**

After collecting materials we should perform test on each materials to achieve required properties which will use in

pothole repair work. (Test includes - Marshall Stability, Binder content, Penetration and Softening Point.

### 3. Fixing mixing % of material –

After checking binding properties of material we should confirm final % of each content and materials on preparation of mold.

### 4. Preparation of moulds by using various mixing % of material –

After fixing mixing % of material mold should be prepared on which marshal stability test is carried to fixation on final dosage.

### 5. Stability check on mould –

By using marshal stability apparatus we should check stability of various mould of various % of dosage.

### 6. Fixation of material % -

After satisfying result on testing mould material % should be fixed.

### 7. Pothole repair by using modified material –

After testing we should confirm final dosage of each content and materials on field practical work for pothole repair. Implementation work of pothole repair should be done on specific selected area.

### Various % of mixing of material.

Material	Mould 1	Mould 2	Mould 3
Bitumen	5%	5.5%	5%
Cigarette butts	3%	3%	2%
Crumb Rubber	4%	3%	3%
Plaster of paris	6%	6%	4%
Corn Starch	3%	4%	2%

Table 1: % of mixing material

Above percentage of materials are percnatge of weight of aggregate.For preparation of mould VG30 bitumen is to be use.

#### • Mould1:

Mould 1 is to be prepared by using 1200gm of fine aggregate, bitumen of 5% by weight of aggregate i.e; 60, crumb rubber of 4% by weight of aggregate i.e; 48gm, Plaster of paris of 6% by weight og aggregate i.e; 72gm, cigarette butts of 3% by weight of aggregate i.e; 36gm and corn strach 3% of weight of aggregate i.e;36gm.

#### • Mould2:

Mould 2 is to be prepared by using 1200gm of fine aggregate, bitumen of 5.5% by weight of aggregate i.e; 66gm, crumb rubber of 3% by weight of aggregate i.e; 36gm, Plaster of paris of 6% by weight og aggregate i.e; 72gm, cigarette butts of 3% by weight of aggregate i.e; 36gm and cor n strach 4% of weight of aggregate i.e; 48gms.

#### • Mould3:

Mould 3 is to be prepared by using 1200gm of fine aggregate, bitumen of 5% by weight of aggregate i.e; 60gm, crumb rubber of 3% by weight of aggregate i.e; 36gm, Plaster of paris of 4% by weight og aggregate i.e; 48gm, cigarette butts of 2% by weight of aggregate i.e; 24gm and corn strach 2% of weight of aggregate i.e; 24gms

### Tests on modified material:

#### • Marshall stability Test :

Marshall stability test is performed to determine the properties of mix, marshal stability and flow analysis and finally the determination of optimum bitumen and new material content.



Fig.5. Marshall Stability Test Apparatus.

## V. CONCLUSION

These all study, investigations and technologies represents pothole repair solution by using diffeent wsate materials. It conclude that there is use of ecoomical, ecofriendly and recyclable materials. It satisfies all engineering properties to achieve good binding strength other than regular repair work. By replacing bitumen with additives materials which results as modified bitumen for pothole repair. So there is most favour of achieve strength by using waste binding agent materials.

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