



A Review on Suitability of Materials for Providing Potholes Repair Solutions and Comparisons of their Characteristics

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Abstract: Increase in numbers of potholes has been major problems with urban areas. The formation of potholes not only affects the aesthetic appearance of the road but it also causes numbers of serious accidents. Rubber and Plastic are the waste product often found in industries. It has been huge environmental problems due to disposal of waste generated plastic and rubber from industries as it takes longer duration for decomposition. Present studies is focused on four main advance techniques used for repairing the potholes. (Bituminous Rubber, Bituminous Plastic, Concreting and Cold Mix Asphalt) and Comparison of the basis of Cost-efficiency, Durability, Strength, Wear & tear and Stiffness. Laboratory tests were carried out on Bitumen, Aggregates and Plastic Bituminous. Softening point and Ductility test were performed on bitumen to check viscosity and ability to stretch. Test on aggregates and plastic bituminous were carried out in two different phases. In phase, I physical tests such as Los Angeles abrasion, Impact value test were conducted. In phase II, Marshall Stability and Flow value test was performed on plastic bituminous. Result of bituminous rubber technique shows that rubber crumbs have the best suitability for blending it with bitumen and can be used for filling potholes were as bituminous plastic technique indicates three kilograms of bitumen were saved from three kilograms of plastic waste used in this method. The results of concreting process showed the highest durability and more cost consuming technique and cold mix asphalt method reveals suitability in pavement construction and stability under the influence of water. Thus, this test results revealed that Rubber bituminous is the most suitable for repairing potholes with skid resistance, durability, cost- effectiveness and maintenance cost.

Key Words: Bitumen, Rubber, Concrete, Plastic, Potholes, Cold Mix

I. INTRODUCTION

Nowadays road traffic intensity has been growing with very rapid rate and volume on the road is high. The road network should be improved as far future traffic is concern and to provide good riding quality. However, there are many features which causes failure of roads and make it uncomfortable for users. One of major feature which causes major problem to the road pavement is pothole. It can be defined as a pit or hole produced by wear or weathering in a road surface. If they become large enough, damage to vehicle tyres and suspension can occur. Pot holes are a risk and damaged roads with loose gravel have made them accident-prone when a moving vehicle goes over a pothole. Potholes can pose a serious issue for road safety standards and can cause extensive damage and repair cost to vehicles though force of impact. In India, on an average more than 2,000 people lost their lives in 2018-19 due to the road accidents caused by potholes and more than 4,000 people were injured in over 4,800 road accidents, according to the latest data given by the government in Parliament. So it is very necessary to pay attention on finding various convenient techniques for treatment of potholes and increase in life of roads. Continued progress is made towards developing varied potholes patching techniques, with these techniques being promoted as long term pavement investments. Study of this project mainly focused on four advance techniques (Bituminous Rubber, Bituminous Plastic, Concreting, and cold mix asphalt)

Bituminous Rubber Technique: As vehicles are used regularly the wear and tear of their tires are apparent. Due to wear and tear of tires the life of tire reduces and at last it becomes useless. The disposal of these tires has become a serious problem. Disposal by burning causes air pollution and dumping causes valuable land to be wasted for stacking up the tires. So an attempt to use this waste tire rubber for improving the properties of bitumen by blending it with crumb rubber and ultimately a new method to be introduced to reduce pollution problems and protect our environment.

Bituminous Plastic Technique:

In this method plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction material. As plastic has strong binding property, the road last longer besides giving added strength to withstand more loads. The plastic coated concrete when exposed to rains does not get damage and last long.

Concreting:

Ready Mix Concrete is used for repairing the potholes. It has been observed that cement bond is well when used as filling material in potholes but cost consumption is more in this technique.

Cold Mix Asphalt:

The Bituminous mixes used in the construction of the surfacing and base course layers are hot-mixed, hot laid and compacted and are normally referred to as “Hot-Mixes”, or Bituminous concrete, or Asphalt Concrete. Thus, processes involved in producing the hot mixes utilize enormous energy such as electricity, fuel oils and or firewood. This is one of the causes of high construction costs. Focus is on examination and understanding of performance and cost-effectiveness of various cold-mix materials and procedures for repairing potholes in asphalt concrete pavements. Routine maintenance of potholes is considered essential to the serviceability of a road pavement, with road agencies budgeting for such costs. However it is necessary to research whether this cost could be reduced through increased knowledge of the key factors that influence the formation of potholes which may lead to solutions that are proactive and treat potential potholes during their initiation phase. There are many techniques used for treatment of potholes but majority of occurrence of potholes is in winter and monsoon seasons so treatments related to hot mix asphalt are not useful. Hence, the study of this project is to find and compare various techniques related to cold mix asphalt, use of various plastics and rubber waste in asphalt concrete for solving problems of potholes efficiently.

2. MATERIAL AND METHODS:*Sourcing of materials:*

The material used in asphalt concrete such as fine and coarse aggregates (10-15mm), fly ash was obtained from local market of Navi Mumbai. Plastic waste was collected from roads, garbage trucks, dumpsites or compost plants, or from school collection programs, or by purchase from rag-pickers or waste-buyers at Rs 5-6 per kg Rag-pickers. Rubber waste was collected from local scrap tire shredders.

2.1 Bituminous Plastic:

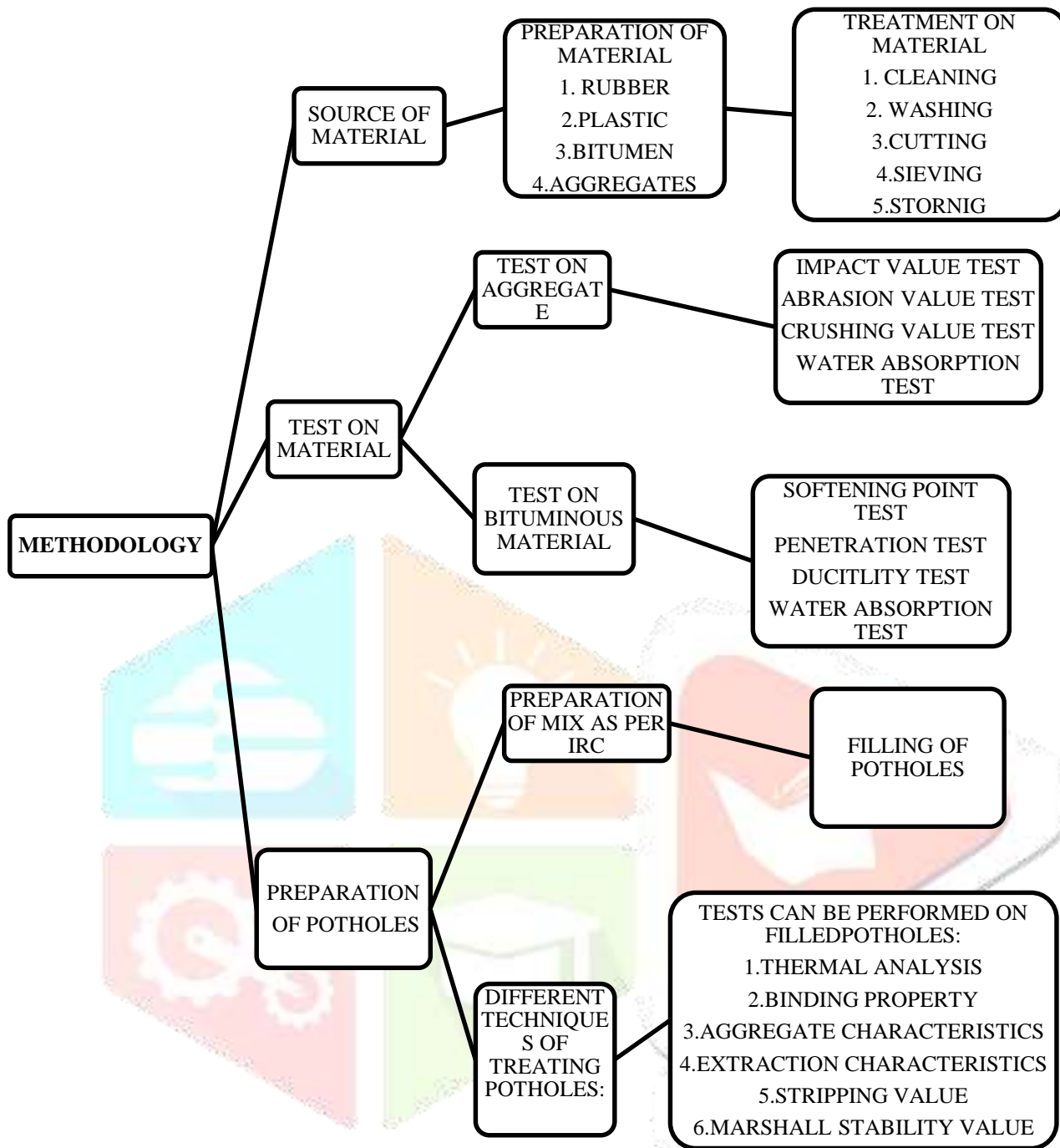
Figure 2.1: Mixing of shredded Waste plastic Aggregate and Bitumen



Figure 2.2: Laying of bituminous mix

Fig 1 displays the mixing of aggregates, bitumen and plastic. In this case bitumen should be heated up to 160°C and then should be utilize for mixing

Fig 2 displays the plastics waste coated aggregate mixed with hot bitumen and then final mixed is used filling potholes shown in Fig 2.2.



3.1 Bituminous Rubber



Figure 3.1: Selection & marking of pot holes



Figure 3.2: Cleaning of pot hole by using wire brush



Figure 3.3: Making Bituminous Rubber Mix



Figure 3.4: Pouring of mix in pothole



Figure 3.5: Finishing of potholes

4.1 Concreting:



Figure 4.1: Selection and Marking of pothole



Figure 4.2: Pouring of concrete



Figure 4.3: Tamping of pothole by using hammer



Figure 4.4: Finishing of pothole

5.1: Tests performed on material in accordance to the standard specifications as below:

Table 1: Standard results

Test	Requirement	Test method
Grain size analysis	Max. 5% passing 0.075 micron	IS 2386 Part I
Crushing value	Max 40%	IS 2386
Los Angeles Abrasion Value	Max. 40%	IS 2386 Part IV
Aggregate Impact Value	Max. 30%	IS 2386 Part IV
Specific gravity	2.8	IS 2386 PART III
Water absorption	Max. 8%	IS 2386 Part III
Bulk density test	MIN 1120 Kg/M ³	IS 2386 Part III
Penetration test	80/100	IS 1201
Softening point test	80/100	IS 1203-1978
Ductility test	5 to 100cm	IS 1208-1978

Table 1 displays standard results as per Indian Standard Code. The properties of both aggregates and Palm Kernel Shell was verified with standard results. Results showed that both the material were satisfying standard requirements.

3 Test and Result:

Bituminous plastic technique was used for repairing of potholes. When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface. Binding property of plastic gave more strength and was able to withstand more load

Table 2: Bituminous plastic result

Material needed	Plain bitumen Process	Plastics coated aggregate (PCA)
80/100 Bitumen	11250Kg	10125Kg
Plastic waste	-----	10125Kg
Cost	Rs. 393750	(BIT)Rs.354375+(plastic) Rs.13500 = Rs. 367875
Cost Reduced	NIL	Rs. 25875.00
Carbon Credit Achieved on avoiding burning of plastics		3.5 tonnes

Cost Bitumen Approx.: 35,000/ton and Waste Plastic: Rs. 12000/tons

Savings of bitumen = 1 ton

Use of Plastics waste – (11, 25,000) carry bags (1.125 ton)

Table 2 displays three kilograms of bitumen were saved and three kilograms of waste plastics were used.

3.1 Properties of material

Table 3: Properties of materials obtained from standard test performed.

Sr. no.	Test	Cold mix	plastic	rubber	Coarse aggregate	BITUMEN
1	Air voids	17.4%	NIL	3-5%		
2	Marshall stability (kg)	480	2450	340		
3	Flow value (mm)	6	4.75	4	-	
4	Water absorption	3%	0.12-1%	1.8%	2%	
5	Crushing value		20%		25%	
6	Abrasion value		29%		35.5%	
7	Impact value		18.50%		14%	
8	Penetration	76mm	-		-	4
9	Softening point	40*c	100-120*C	62*C	-	55*C
10	Ductility test					37cm

Table 3 displays the properties of various materials such as aggregates, bitumen, plastic, cold mix and rubber. Properties of all material used in asphalt concrete were within the permissible limits as per Indian standard Code.

Table 4: Characteristics Properties

	plastic	rubber	Cold mix	concrete
characteristics	10-15% reduction in bitumen consumption	Skid resistance, good splash and spray characteristic	Skid resistance, Fast production, 10-20% cheaper road	
	Enhance load carrying strength	Less noise compared to concrete	Noise reduction	
	Environmentally friendly	Environmentally friendly	Environmentally friendly	
	Energy saving	Good in hot and cold climate	Energy efficient	
Cost- effective	Costly than conventional method	Cost effectiveness and reduce maintenance cost	Less Economical method	Costly method
Durable	Longer life than conventional method	Durable surface wearing course	More durable	Highly durable than plastic and rubber

Table 4 shows characteristic properties of material used in asphalt concrete for repairing potholes. Table 4 also shows comparison made between all the four techniques used in filling potholes.

6. CONCLUSION

In a conclusion, it is not denied the fact that cost of bitumen is much more than that of plastics and this material used in asphalt concrete also helps to save the natural resources. In addition, bituminous plastic has no maintenance cost of a minimum period of five years and the process is cheap and eco-friendly. Furthermore, other conclusion can be putting forward when all the four-material used in asphalt concrete and compared with characteristic, cost-effectiveness and durability. Thus, bituminous rubber is considered to be more effective against all the four materials. Concrete is considered to be highly (durable) than plastic and rubber but cost expense is more when used in construction. Cold Mix revealed the highest stability under the influence of water but less economical when compared with rubber and plastic.

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