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Use of Crumb Rubber in Flexible Pavement

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Abstract: ***Today the clearance of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby area because many of them are non-biodegradable. Crumb rubber is one of them. Soil, stone aggregate, sand, bitumen, cement etc. are used for road construction. Natural materials are limited in nature, its quantity is decreasing and cost is increasing. Afraid about this, engineers are looking for other materials for highway construction, by which the quality of road is increased with low cost. Keeping in mind the necessity for bulk use of these solid wastes in India, it was thought convenient to test these materials and to develop conditions to enhance the use of waste tyres in road making in which higher profitable returns may be possible. The waste tyres can be recycled in the form of aggregate which on mixing with bitumen in suitable size. The article presents a comparison of the mechanical characteristics measurements of the structural layers of road pavements built from the recycled and natural aggregate. Under this research the utilization of waste tyres that can be used as a good purpose for the preparation of the flexible pavement is done.***

1. Introduction

Waste tyre rubber is an important source of minor raw materials. All countries with developed road system have problems with waste tyres. That is why in recent years a lot of effort in research has been devoted to the development of new effective methods for the recovery of waste tires or their disposal. Waste tyres are the tires that completed their service life and they come mostly from passenger cars and trucks. Roadways are an integral aspect of transportation structure. Road construction engineers must consider the primary user's requirements of safety as well as the economy. To attain this objective, designers should take into account three fundamental requirements which include environmental factors, traffic flow, and asphalt mixtures materials. The task of current asphalt researchers and engineers is to look for dissimilar kinds of polymer modified asphalt such as crumb rubber. The waste tyres can be used in the form of aggregate which on mixing with bitumen in suitable size. This reduces the pollution arisen due to waste tyres as well as minimizes the use of natural aggregate, which help in reducing global warming as well as health problems.

2. Related Work

a) **Utkarsh Sharma and Sitesh Kumar Singh (May 2008)** "Use of Crumb Rubber in Flexible Pavement and Comparison in Strength & Quality" using crumb rubber finds that the water absorption percentage of rubber is 1.22 and of aggregates is 0.92.So in the end of this they got outcomes which are satisfying all the objectives, like: It modifies the flexibility of surface layer. Waste rubber tyres to be used are between the ranges of 5% to 20%. Problem like thermal cracking (Fatigue) and permanent deformation (Rutting) are reduce in hot temperature region.

b) **Asim Hassan Ali and Mohamed Rehan Karim (2001)** "Using Crumb Rubber in Reinforcement of Asphalt Pavement" review use of crumb rubber in the reinforcement of asphalt is considered as a smart solution for sustainable development by recycling waste materials, and it is believed that crumb rubber modifier (CRM) could be an alternative polymer material in improving hot mix asphalt performance properties.

c) **Mr. Nirajkumar Gupta, Prof. Dhananjay Yadhav (2016)** the waste problem considered as one of the most major problems facing the world as a source of the environmental pollution. During last recent years, many improvements in India have occurred in all parts of life such as social, industrial, economical etc., this will lead to generate new ways of living and increase the human requirements and will also increase types and quantities of the waste in India, without any active processes to provide solution to this problem.

3. Materials and Methodology

The materials used for this research are aggregates, crumb rubber and bitumen. These materials should be tested carefully and the results of these tests are summarized in result section. Waste rubber tyres were collected from roads sides, dumpsites and waste-buyers. The collected waste tyres were sorted as per the required sizes for the aggregate. The waste tyres were cut in the form of coarse aggregate of sizes ranging from 22.4 mm to 6.00 mm (as per IRC-SP20) in the tyre cutting machine. The waste rubber tyres can be managed as a whole tyre, as slit tyre, as shredded or chopped tyre, as ground rubber or as a crumb rubber product. The rubber of tyre usually engaged in bituminous mix, in the form of rubber particles are subjected to a dual cycle of magnetic separation, then screened and recovered in different sizes and can be called as Rubber aggregate. It was cleared by de-dusting or washing if required. The rubber pieces (rubber aggregate) were sieved through 22.4 mm sieve and retained at 5.6 mm sieve as per the specification of mix design and these were added in bituminous mix, 20 percent by weight of the stone aggregate. These rubber aggregates were mixed with stone aggregate and bitumen.

4. Result

1) Sieve analysis of aggregates

The sieve analysis of aggregates is done as per IS: 2386 (Part I) – 1963. And the results are shown below in table.

Sieve size	Mass retained in gm	% retained	Cumulative % retained	Cumulative % passing
20mm	0	0	0	100
16mm	52	5.2	5.2	94.8
12.5mm	536	53.6	58.8	41.2
10mm	320	32.0	90.8	9.2
4.75mm	92	9.2	100	0
Total	1000gm			

2) Impact value test

This test is used to determine the toughness of aggregates. This test is done as per IS: 2386 (Part IV) – 1963. The result of this test is given below.

- **Impact value test on aggregates**
  Weight of sample (W1) =388 gm
  Weight of aggregate after sieving through 2.36mm sieve (W2) =67 gm
  Impact value= W2÷W1×100 %
  = 67÷388×100
  = 17.26 %
- **Impact value test on aggregate with rubber**
  Weight of sample (W1) =364gm
  Weight of (aggregate + rubber) after sieving through 2.36mm sieve (W2) =32gm
  Impact value= W2÷W1×100 %
  = 32÷364×100
  = 8.79 %

3) Los Angeles abrasion test

This test is used to determine the hardness of aggregates. The test results are given below.

- **Abrasion test on aggregates**
  Weight of sample (W1) =5000 gm
  Weight of sample after tested and sieving through 1.7 mm sieve (W2) =1211 gm
  Abrasion value = W2×100÷W2
  = 24.22%
- **Abrasion test on aggregate with rubber**
  Weight of sample (W1) =5000 gm
  No of balls used = 12
  Weight of sample after tested and sieving through 1.7 mm sieve (W2)=870 gm
  Abrasion value = W2×100÷W2
  = 17.4%

4) Crushing value test

The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a slowly applied compressive load. The result of this test is given below.

a) Crushing value of aggregates
Weight of sample (A) = 3250gm
Weight of sample after sieving from 2.36mm sieve (B) = 305gm
Crushing value = B/A * 100
Crushing value of aggregate= 9.38%

b) Crushing value of aggregates with rubber
Weight of sample (A) = 3600gm
Weight of sample after sieving from 2.36mm sieve (B) = 120gm
Crushing value = B/A * 100
Crushing value of aggregate= 5%

5) Specific gravity and water absorption test

Specific gravity test of aggregates is done to measure the strength or quality of the material whereas water absorption test determines the water holding capacity of the coarse and fine aggregates. The test results are shown below in the table.

Material	Specific gravity	Water absorption
Aggregate	2.64	0.81%
Aggregate with rubber	1.26	1.31%

5. Conclusion

In the present study, the importance was to add the shredded waste crumb rubber to aggregate and to estimate the various mix properties like Impact value, abrasion value, crushing value, etc. And also, to check the property of Crumb rubber aggregate. So in the end of this we get outcomes which are satisfying all the objectives, like: It modifies the flexibility of surface layer. Waste rubber tyres to be used are between the ranges of 5% to 20%. Problem like thermal cracking (Fatigue) and permanent distortion (Rutting) are reduce in hot temperature region. Rubber has property of sound absorption, which also helps in reducing the sound pollution of heavy traffic roads. The use of rubber can improve the quality and performance of road. We can be save a certain quantity of natural stone aggregate.

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