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Effective Use Of Used Tyres In The Repair Work Of Damaged Bituminous Roads

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Abstract- Pavements are the major part of transportation in the view of highway constructions. Transportation involves within two wheelers to heavy wheelers. In the transportation point of view the pavement condition is very important. If the pavement condition is good, then the transportation will be done with ease. The major problem in pavements damages is due to heavy loading and environmental causes. When the load acting on the pavements heavily, the damage will effect mostly on surface course as well as base course. In environmental point the damages occurs by the heavy rains and earthquakes.

Keywords- transportation, Bituminous Roads etc.

I. INTRODUCTION

In India top 7 large tyre companies are responsible for 85% tyre productions. The sale of automobile tyres was 8.8 million units in 1982 which had increased to 17.7 million in the year of 1991, representing the growth rate of more than 100% in ten years. The disposal of these used tyres has become a global problem. Developed and industrialized countries are facing a monumental problem in the disposal of used tyre. Waste tyre creates a suitable breeding place for vermin and insects and thus poses health risk. A more serious problem is that it is combustible. A huge volume of scrap tires has been stockpiled in many countries causing adverse impact on the environment in the volume of waste tyre generated is 1.5 billion per year owing to the increase in the number of vehicles worldwide

The objective of this project is to find out the alternative solution of geo-materials which have good strength parameters as well as deformation parameters is a burning task for various geo-engineering applications. Several researchers are exploring the possibility of using different by products or waste materials like fly ash, fibre, rice husk ash and recycled tyre materials as geo materials. Waste tyre have been used for reinforcing soft soil in road construction and retaining wall back fill India has one of the largest networks of roads in the world. Due to rapid growth in traffic, the existing roads have become structurally inadequate. Traditionally design and construction practices do not fulfil construction standards. To overcome these constraints, researchers are forced to seek alternative using sub-standards materials and innovative design practices. Waste tyre products have helped designers to solve several types of engineering problems. In India there are so many variations in soil state to state. Some soil having very low load bearing capacity like black cotton soil because it absorbs water, swells and lose their strength, so in those areas it is essential to improve the quality of soil by mixing of waste tyre in desired quantity. The use of recycled tyre rubber as an engineering material has increased significantly in the last decade Day by day with the increase in number of automobiles in India during recent years the demand of tyres as original equipment and has replacement also increased. As every new tyre produced is designed to go to waste stream for disposal or recycling or reclamation, despite its passage through re-treading process, the number of used tyres being discarded is going to increase significantly. Timely action regarding recycling of used tyres is necessary in view to solve the problem of disposal of used tyres keeping in view the increasing cost of raw material, resource constraints and environment problem including fire and health hazard associated with the stockpiles of the used tyres.

The world generate about 1.5 billon of waste tyre annually, 40% of them in emerging markets such as China, India, south America, southeast Asia, south Africa and Europe. In India, all new vehicles have radial tyres so now there are piles of radial tyres here. Analysis indicates that 0.6 million Tons of tyres scrape is generated in the country annually. It is commonly accepted in the tyre industry that about one tyre one person per year is discarded. Since there is no industry group or industry or governmental agency that monitors tyre disposal in the country, the best estimates that can be made are based on tyre production. So supply situation of scrap tyre is only going to be improving in years to come as result of going vehicle population in India.

Mandatory scraping of end-of-life vehicle, in metros by 2010-11 and across India by 2012-13 is also likely to insure large scale availability of scrap tyre at select locations there by encouraging organized players. The management of scrap tyre has growing problem in recent years, scrap tyres represent one of several special wastes that are difficult to municipalities to handle. Whole tyres are difficult to landfill because they tend to float to the

surface. These stockpiles are also direct loss of energy and resources in addition to fire & health hazards and also environmental issues. The main constituent of tyre is rubber and the largest single application of rubber is vehicle tyres. Also, the requirement of tyre is directly related to growth of automobile

These tyres are often deposited in an uncontrolled manner, because of thenoticeable rapid depletion in sites available for waste disposal, causing majorenvironmental problems. Water accumulation inside the tyres provides idealtemperature and moisture conditions for the spread of mosquitoes, mice, rats andvermin. At the same time, the quantity of oxygen that exists in the interior of thetyres is enough to cause

II.MATERIALS AND METHODOLOGY

Soil

Soils can be studied effectively if they are classified according to certain principles into a definite system. A system is an ordered grouping of certain elements in a discipline according to pre-defined principles. Just as classification or grouping is practised in scientific disciplines such as chemistry, zoology and botany, it is used in Geotechnical Engineering as well.

The general requirements of an ideal soil classification system are

- It should have a scientific basis.
- It should be relatively simple and objective in approach.
- The number of groupings and properties used as the criteria should be limited.
- The properties considered should be relevant to the purpose of classification.
- A generally accepted uniform soil terminology should be used.
- It should indicate the probable performance of the soil to a satisfactory degree of accuracy.
- Group boundaries should be drawn as closely as possible where significant changes in soil properties occur.
- It should be acceptable to all engineers.
- The following properties are desirable in soil aggregates used the construction of roads:

1. Strength

It is the resistance to crushing which the aggregates used in road construction, especially in the top layers and wearing course, have to withstand the stresses due to wheel loads of the traffic in addition to wear and tear.

2. Hardness

It is the resistance to abrasion of the aggregate at the surface. The constant rubbing or abrading action between the tyres of moving vehicles and the exposed aggregate at the road surface should be resisted adequately.

3. Toughness

This is the resistance to impact due to moving traffic. Heavily loaded trucks and other vehicles cause heavy impact loads on the road surface while moving at high speeds, and while accelerating and decelerating. Even steel-typed vehicles, though moving slow, cause heavy impact on the aggregates exposed at the surface. Hence, resistance to such impact forces is a desirable quality.

4. Durability

It is the resistance to the process of disintegration due to the weathering action of the forces of nature. The property by virtue of which the aggregate withstands weathering is called soundness. This is also a desirable property.

5.Cementation

It is the ability of the aggregate to form its own binding material under traffic, providing resistance to lateral displacement. Limestone and laterite are examples of stones with good cementing quality. This becomes important in the case of water-bound macadam roads.

6. Appropriate Shape

Aggregates maybe either rounded, cubical, angular, flaky, or elongated. Each shape is appropriate for a certain use. Too flaky and too elongated aggregates have less strength and durability; so they are not preferred in road construction. Rounded aggregates are good for cement concrete because of the workability such aggregates provide. Cubical or angular aggregates have good interlocking properties; since flexible pavements derive their stability due to interlocking, such aggregates are the preferred type for construction. Thus, the appropriate shape for a particular use is also a desirable property.

7. Adhesion with Bitumen

The aggregates used in bituminous pavements should have less affinity to water than to bitumen; otherwise, the bituminous coating on the surface of the aggregate will get stripped off in the presence of water. So, hydrophobic characteristic is a desirable property for aggregates to be used in the construction of bituminous roads.

8. Attrition

This is mutual rubbing of aggregates under traffic; adequate resistance to attrition is a desirable property.

9. Texture

This is a measure of the degree of fineness or smoothness of the surface of the aggregate. Gravels from river beds are fairly smooth; as a rule, fine grained rock is highly resistant to wear and is preferred for surface courses.

Soil shall be broadly divided into three divisions:

- Coarse-grained soil – More than 50% of the total material by weight is larger than 75 μm IS sieve size.
- Fine-grained soil: More than 50% of the total material by weight is smaller than 75 μm IS sieve size.
- Highly Organic Soil and Other Miscellaneous Soil Materials:

These soils contain large percentages of fibrous organic matter such as peat and particles of decomposed vegetation. In addition, certain soils containing shells, cinders and other non-soil materials in sufficient quantities are also grouped in this division. Coarse-grained soils shall be divided into (a) gravels and (b) sands.

(a) Gravels – More than 50% of coarse fraction (+75 μm) is larger than 4.75 mm IS sieve size.

(b) Sands – More than 50% of coarse fraction (+75 μm) is smaller than 4.75 mm IS sieve size. Fine-grained soils can be subdivided into

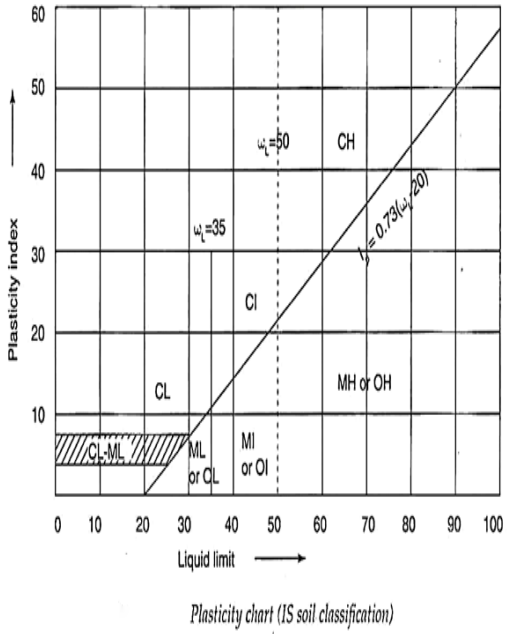
(i) Silts and clays of low compressibility – Liquid limit less than 35% (L).

(ii) Silts and clays of medium compressibility – Liquid limit greater than 35% and less than 50% (I).

(iii) Silts and clays of high compressibility – Liquid limit greater than 50% (H).

Coarse-grained soils shall be further subdivided into eight basic soil groups, and the fine-grained soils into nine basic soil groups; highly organic soils and other miscellaneous soil materials shall be placed in one group.

The Plasticity Chart used in IS system of soil classification is shown in below Graph



Plasticity chart (IS soil classification)

Fig.1 Plasticity chart of soil classification

Fig.2layers of soil

Fig. 3 Types of soil

Coarse Aggregates

Stone aggregate, or mineral aggregate, as it is called, is the most important component of the materials used in the construction of roads. These aggregates are derived from rocks, which are formed by the cementation of minerals by the forces of nature. Stone aggregates are invariably derived by breaking the naturally occurring rocks to the required sizes. They are used for granular bases, sub-bases, as part of bituminous mixes and cement concrete; they are also the primary component of a relatively cheaper road, called water-bound macadam.

A study of the types of aggregates, their properties, and the tests to determine their suitability for a specific purpose is of utmost importance to a highway engineer. Properties such as strength and durability of aggregates are generally influenced by their origin of occurrence, mineral constituents and the nature of the bond between the constituents. Examples of un-foliated types are marble (from limestone) and quartzite (from sandstone). (Marble and gneiss are used for flooring and face work in buildings.) Gravels from river beds are fairly smooth; as a rule, fine grained rock is highly resistant to wear and is preferred for surface courses.

Fig4. coarse aggregates

3.1.4 Tar

Tar is a black or brown to black, viscous, non-crystalline material having binding property. This is, therefore, the other category of bituminous materials. Tar is obtained from the destructive distillation of organic materials such

as coal, petroleum, oil, wood and peat, in the absence of air at about 1000°C. It is completely soluble in carbon tetrachloride (CCl_4). It contains more volatile constituents than bitumen and is therefore more susceptible to change in temperature. Generally, tar is used for surface dressing on the wearing course since it has good adhesion in damp conditions.

Fig. 5 Asphalt

Some more terms relating to tar are:
1. Coal tar – Tar produced by the destructive distillation of bituminous coal.
2. Coke-oven tar – A variety of coal tar obtained as a by-product from the destructive distillation of coal in the production of coke.
3. Oil-gas tar – A petroleum tar produced by cracking oils at high temperature in the production of oil-gas.
4. Water-gas tar – A petroleum tar produced by cracking oils at high temperature in the production of carburetted water-gas.
5. Refined tar – Produced from crude tar by distillation to remove water and to produce a residue of desired consistency.

TYRES

We use tyres that are to be thrown into the environment it means we use the tyres that are already used and in a condition that are no more used.

Selection of Damaged Portion:

Asphalt will deteriorate almost quickly, causing road distresses to appear, regardless of how well a road is designed. Traffic, dampness, and a lack of preventive maintenance treatment are all factors that speed up the deterioration of a road. Depending on the method used, mending a pothole on the road might be simple or complex. In some circumstances, dumping a mixture into a pothole, compacting it with a shovel, and turning away is a simple procedure. In other cases, pulverizing the pothole and laying down new pavement may be necessary. The sort of asphalt repair procedure required is determined by the nature and severity of the damages to an asphalt road. It is important to note that the longer it is taken to repair damaged asphalt, the worse the damage will become. Extensive damage is also more expensive since it necessitates more difficult repair methods, including removal, replacement, or resurfacing. As a general guideline, it is essential to inspect asphalt road for damage once a week or once a month, depending on how much traffic it receives. Parking lots with a lot of traffic will undoubtedly require more upkeep than those with less traffic. Thus, it is necessary to implement procedures as per the hole sizes along with their nature.

Fig.6 Damaged Portion

Removal of Surface & Base Course :-

It is the layer immediately under the wearing surface. As base course lies close under the pavement surface it is subjected to severe loading. The material in a base course must be of extremely high quality and its construction must be done carefully. In this project we remove the base course in the damaged portion. For that we need to remove it carefully and do not disturb the other portion of the road.

Fig.7 Base course Removal

Placing the Used Tyres :-

Fig.8- Placing used tyres.

Fill The Base with Coarse Aggregates :-

Coarse aggregates are also used in the preparation of breaking moisture under slabs and vapour barriers.Also, they are part of base preparation for driveways and roadways.These types of aggregates are used to facilitate drainage to maintain perimeter drains, septic leach fields, and retaining walls.Also, used in temporary road surfaces (think of gravel roads) and to create tire knock areas for trucks leaving construction sites.

Fig.9 Coarse Aggregate

Compaction :-

The compaction process plays an important role in improving the strength and bearing capacity of materials for use in road construction. The degree of compaction achievable is dependent on the grading, particle morphology, organic content and metal content of MIBA, as well as the moisture conditions and the compaction effort applied.This compaction gives the good strength to the base course and reduces the void ration . By compacting this layer reduces the thickness and provides us a good layer over top for laying the bituminous layer.The compaction has to be done using the rollers where we don't get voids are any loose compaction once we compact road using roller it is worth for many years this compaction is to be done by roler by applying some amount of water.

Fig.10 Compaction of Base course

Laying of Bituminous Road :-

After completion of Coarse aggregate laying and compaction we go for the laying of bituminous road . The laying of this road is permitted to the only damaged Portion. A good quality Mix is used for a Standard road and gives us more durability

III. RESULTS AND DISCUSSION

Standard proctor compaction test:

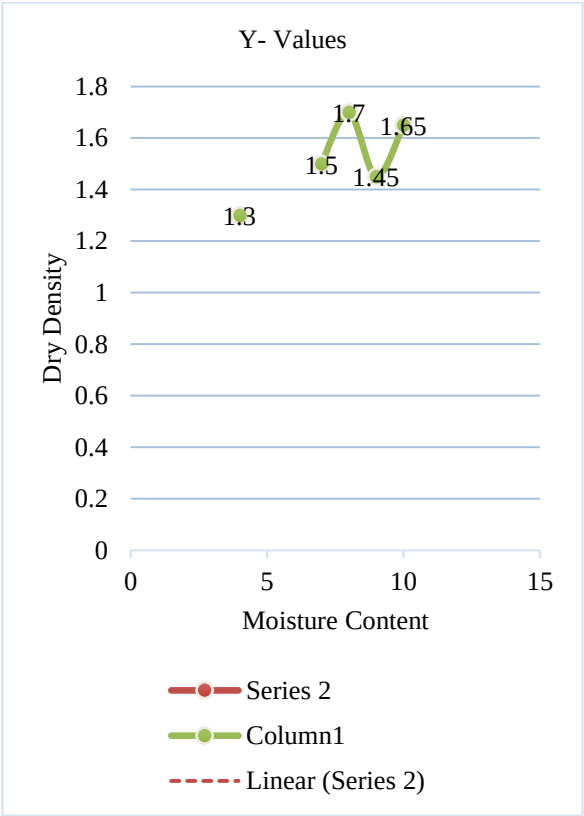
The wet Density or Bulk Density of soil is computed as:

r = weight of compacted soil/volume of mold.

After determination of moisture content of the soil, the Dry Density of Soil is computed as: **rd = r / 1+m.**

Moisture Content Determination.

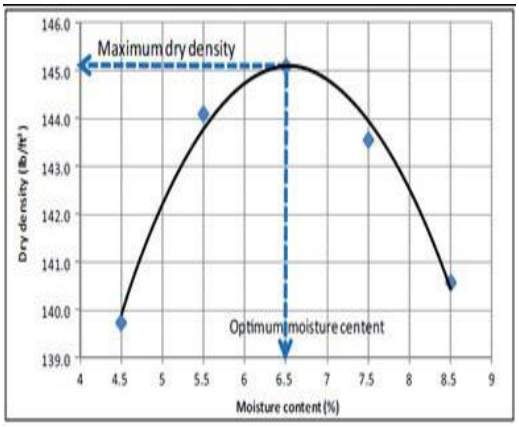
The optimum moisture content of soil: 95



Graph 10 ry density and moisture content of soil

Table 1standard proctor test results

Description	4%	6%	8%	10%	12%
Bulk density(gm/cc)	1.40	1.5	2	1.65	1.9
Water content%	0.112	0.0517	0.157	0.122	0.163
Dry density(gm/cc)	1.27	1.44	1.72	1.42	1.63



Graph3: maximum dry density and moisture content

California bearing ratio test results

Table: 2 observations of cbr test on normal value

Penetration	Load dial reading	load
0.0	0	0
0.5	4	5.4
1.0	6	7.2
1.5	7	9.5
2.0	10	12.2
2.5	12	16
3.0	15	18.5
4.0	17	19
5.0	18	20.5

Table3 : standard load values of cbr test

Penetration(mm)	Standard load(kg)
2.5	1350
5.0	2055

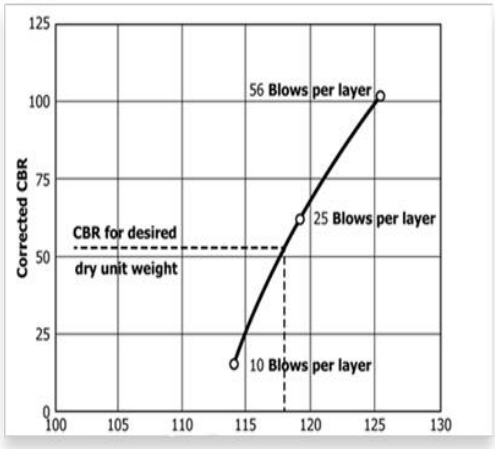


Fig.11 density value with blows

IV.CONCLUSION

Moreover, tyre rubber can be used as a bitumen modifier or as aggregate in Asphalt mixtures. This can be done either by the wet or by the dry process. Pavements made of rubberised asphalt mixed with aggregates have been constructed widely with great success. Such sections have better skid and rutting resistance, and improved fatigue cracking resistance, while their service life can be greater than that of conventional sections. Tyre rubber can be used in a substantial number of civil engineering works. It has good potential for development but this depends largely on the ability of the building and construction designers involved to convince the authorities and the relevant constructors of the advantages of these applications we can use this kind of roads where the permeability of soil is good as we use tyres underground they have chances of water getting staged underground hence the properties of soil are mandatory before we opt for this kind of road construction. Therefore we can conclude that the roads or pavements that are reconstructed or constructed are good to use as they are very comfortable in the view of pollution reduction and also the properties of the pavement done using tyre have flexibility.

REFERENCES

[1]Khaloo A.R., Dehestani M. and Rahmatabadi P. (2020), “Mechanical properties of concretecontaining a high volume of tire-rubber particles”, Waste Management, available online26 March 2008.

[2]Tortum A., Celik C. and Aydin A.C. (2018), “Determination of the optimum conditions fortire rubber in asphalt concrete”, Building and Environment, 40, 1492–1504.

[3] Turatsinze A., Bonnet S. and Granju J.-L. (2015), “Mechanical characterization of cement-based mortar incorporating rubber aggregates from recycled worn tyres”, Building andEnvironment, 40, 221–226.

[4]Rahman M.M., Airey G.D and Collop A.C. (2008), “Laboratory investigation to assessmoisture sensitivity of dry process CRM asphalt mixtures”, in Proceedings of theInternational Conference Organized by the Concrete and Masonry Research Group, Kingston University-London, Eds M.C. Limbachiya and J.J. Roberts, Sustainable WasteManagement and Recycling: Used-Post-Consumer Tyres, Thomas Telford, pp. 151–162

[5] Kettab R. and Bali A. (2004), “Modified bituminous concrete using rubber powder”, inProceedings of the International Conference organized by the Concrete and MasonryResearch Group, Kingston University, London, Thomas Telford, pp.163–170.

[6] Khalid H.A. and Artamendi I. (2002), “Exploratory study to evaluate the properties ofrubberized asphalt modified using the wet and dry processes”, 3rd International Confer-ence on Bituminous Mixtures

and Pavements, J&A Publishers, Thessaloniki, Greece, pp.15–25.

[7] Punith V.S., Thyagaraj M.N. and Veeraragavan A. (2002), “Studies on tensile strengthcharacteristics of dense bituminous macadam mix with crumb rubber as modifier”, inProceedings of the 3rd International Conference on Bituminous Mixtures and Pavements,Thessaloniki, Greece, pp. 547–556.

[8] Hunt E.A. (2002), “Crumb rubber modified asphalt concrete in Oregon”, Oregon Depart-ment of Transportation, OR, USA.

[9] Airey G.D., Collop A.C. and Singleton T.M. (2001), “Rheological and cohesive propertiesof bitumen cured in crumb rubber”, in Proceedings of the International Symposium ofConcrete Technology, University of Dundee,

[10] Raghavan D., Huynh H. and Ferraris C.F. (1998), “Workability, mechanical properties andchemical stability of a recycled tire rubber-filled cementitious composite”, Journal ofMaterials Science, 33(7), 1745–1752.

[11] Topçu I.B. (1995), “The properties of rubberized concrete”, Cement and Concrete Research,25(2), 304–310.

[12] Ahmed I. and Lovell C.W. (1993), “Rubber soils as lightweight geomaterial”, Transporta-tion Research Record, 1422, 61–70.

[13]Benazzouk A., Douzane O, Langlet T., Mezreb K., Roucoult J.M. and Quéneudec M., (2007),“Physico-mechanical properties and water absorption of cement composite containingshredded rubber wastes”, Cement and Concrete Composites, 29, 732–740.

[14] Bosscher P.J., Edil T.B., Eldin N.N. (1992), “Construction and performance of a shreddedwaste tire test embankment”, Transportation Research Record, 1345, 44–52

[15] Eds R.K. Dhir, M.C. Limbachiya and K.A.Paine, Recycling and Reuse of Used Tires,281–298.