Application of Polymer (Rubber) for Construction of Elastic Pavements (Roads) Using Used Tyre – Best from Waste

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Abstract

Plastic Pollution Coalition is a growing global alliance of individuals, organizations, businesses, and policymakers working toward a world free of plastic pollution and its toxic impacts on humans, animals, waterways and oceans, and the environment. Plastic pollution and climate change are parallel global emergencies. Due to its biodegradability it creates stagnation of water and allied hygiene problems due to urban and rural areas to discover drain artificial bags, waste tyre rubber and additional category of synthetic packing material litter the roads as well as drains. There are many ways you can help to stop plastic pollution. Lots of small individual actions can have a big impact on the planet. In order to have reduced this problem, experiments have been conducted out whether this waste synthetic can be reused fruitfully in the manufacture of roads. So our paper represents Construction of Eco-friendly Flexible & Rigid Pavements (Roads) Using Waste Tyre Powder Hence, it is anticipated that we may use waste synthetic from used tyres in the construction of roads.

Keywords: Plastics, Pollutions, Tyre, Construction of roads

Introduction

Plastic wastes are durable and non-biodegradable. The improper disposal of plastic may cause breast cancer, reproductive problems in humans and animals, genital abnormalities and much more. These synthetic wastes get assorted with water, crumble, and take the forms of small pallets which cause the death of fishes and other aquatic life who mistake them as food material. Polymer concrete (PC) is a composite material in which the binder consists entirely of a synthetic organic polymer. It is variously known as synthetic resin concrete, plastic resin concrete or simply resin concrete. Because the use of a polymer instead of Portland cement represents a substantial increase in cost, polymers should be used only in applications in which the higher cost can be justified by superior properties, low labor cost or low energy requirements during processing and handling. It is therefore important that architects and engineers have some knowledge of the capabilities and limitations of PC materials in order to select the most appropriate and economic product for a specific application. Polymer concretes can be an nonconventional because they have admirable motorized properties with high power and the curative time can be restricted; as a result, they can equalize cement concrete's shortcoming. We are becoming more and more cautious of conservation of energy and materials, interest has grown in improving the strength, toughness, ductility and durability of pavments, polymer concretes are the best material for the repair of pavements (ROADS) that needs rapid maintenance for immediate loading. The properties of polymer concrete make it suitable for the repair of concrete structures and for the placement of Impermeable, skid-resistant overlays. Polymer' concrete and premixed over lays can be cast in place and will cure rapidly over a wide range of temperatures, develop high strength in a few hours, bond well to Portland cement concrete. The impermeable polymer concrete overlays will help extend the life span.

The dimensional compatibility is determined by the drying shrinkage, thermal expansion, and modulus of elasticity of the materials. In this study, highly compliant polymer concretes were considered to alleviate thermal residual stress at the interface between the polymer concrete as a repair material and the cement concrete substrate under service conditions. Tire waste powder, were mixed in concrete in order to construct compliant polymer concretes and waste polythene were used in asphaltic concrete to improve their property. Several combinations of materials were tried in an effort to find the most appropriate mixing ratio as pavement repair material, and laboratory test were carried out to evaluate the mechanical performance of each combination of materials.

Experimental Work

Material and Methods

Tyre waste powder is preferred by mixing with hot aggregates with homogeneous mixing. Then heated to approximately 150^0C to 170^0C, in molten state, extend over the aggregates as a thin liquid covering. Tests were conducted by using these synthetic covered aggregates and outcome show enhanced values.

Asphalt Formulation (Tyre waste powder modified bitumen)

The bitumen about 400 gm was heated in oven till fluid form and tyre waste dust covered aggregates was gradually added. The speed of the mixer was maintained at 200 rpm and temperature was kept between 160°C and 170°C. The concentration of tyre waste powder coated aggregates used, were 0, 2, 4, 6, 8, and 10% by mass tyre waste powder is used. Mixing was continued for 30 min to produce homogenous mixtures.

Preparation of Concrete Moulds

Tyre waste powder covered aggregates is mixed with cement, sand and water to prepare concrete mix as per IS 10262-2009. The concentration of tyre waste powder covered aggregates used, were 0, 2, 4, 6, 8, and 10% by mass tyre waste powder is used. Addition was continued for 30 min to produce homogenous mixtures. Now concrete cubes are casted with dimension of 15x15x15cm.The specimens are kept for curing and tested for its compressive strength for different days.

Results and discussion

A series of tests were carried out on unmodified and customized materials that are tyre waste powder covered aggregates for different percentages of materials. The tests that were conducted include the aggregate Tests such as aggregate impact, aggregate crushing, Los Angeles abrasion test, water absorption and performance tests such as Marshall Stability. Compressive strength of concrete cubes by using plastic coated aggregates in cement concrete cubes.

Properties of Aggregate required for roads

The properties of aggregates have been increased by the addition of tyre waste powder as a covering over aggregates by increasing the percentage of powder and results were tabulate in Table 3.1 & 3.2. The results show that there is an increase in the properties of aggregates. There is an enhancement in impact value, abrasion value and Los Angeles value. Fig 1, 2 and 3 shows the comparative graph between % of plastic and aggregate properties.

Study of Marshall Stability for Bitumen Mix

The bitumen mix design is done according to 10262-2009.The plastic covered aggregates were mixed with the bitumen. Cubes were casted and tested for Marshall Stability. The results are shown in Table No. 3.3. From the figure 4, it is indicated that there is a considerably change in the bitumen Marshall Stability.

Study on Concrete Cubes

The mix design is done according to 10262-2009.The plastic coated aggregates were mixed with the cement, sand and water. Cubes were casted and tested for compressive strength. The outcome are shown in Table No. 3.4. From the figure 5, it is experimental that there is a considerably change in the compressive strength.

Table 3.1 – Test results of Physical Tests coated by Tyre waste powder

Percentage of Plastics	Specific Gravity	Water Absorption (%)	Stripping Value (%)
0	2.4	2.1	NA
2	2.5	0.2	1
4	2.65	0.5	2
6	2.78	0.0	0.0
8	2.89	0.0	0.0
10	2.93	0.0	0.0

Fig 1 – Graph of % Plastic coated on of the Aggregate Aggregates Vs Propertis

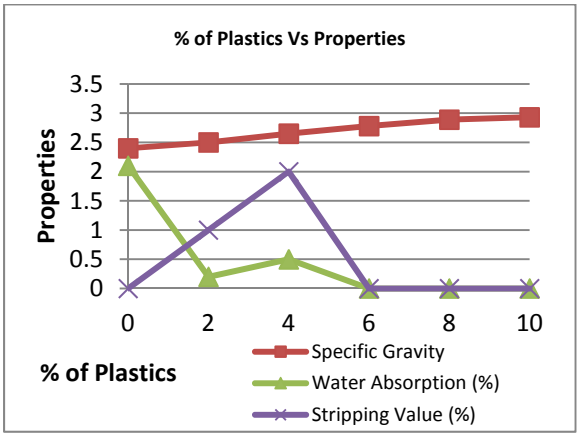


Table 3.2 – Test results of Mechanical Tests of the Aggregate coated by Tyre waste powder

Percentage of Plastics	Impact Value (%)	Crushing Value (%)	Abrasion Value (%)
0	5	27	20.75
2	4.3	21.3	17.55
4	3.9	18.3	14.93
6	3.3	15.7	12.64
8	2.9	12.45	10.57
10	2.5	7.20	8.57

Fig 2 – Graph of % Plastic coated on Aggregates Vs Propertis.

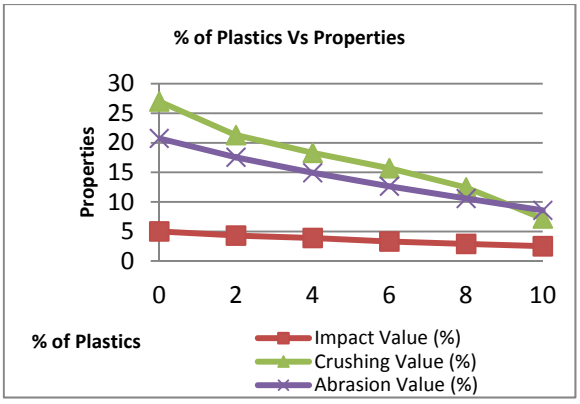


Table no. 3.3 – Marshall stability analysis With various percentage of plastic

Sr. No.	% of Plastic	Tyre Waste powder coated Aggregate Mould
1	0	805
2	2	1031
3	4	1160
4	6	1294

Fig 3 - Graph of % Polymer Vs Marshall stability of bitumen

5	8	1433
6	10	1356

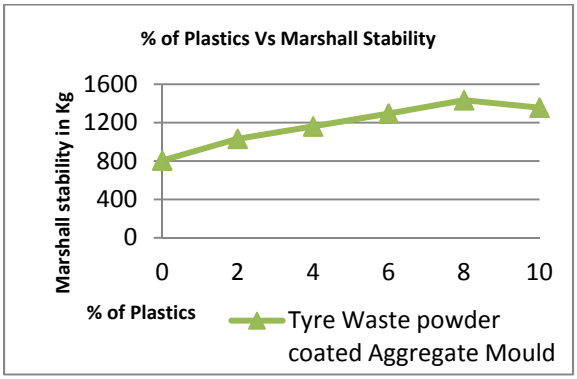
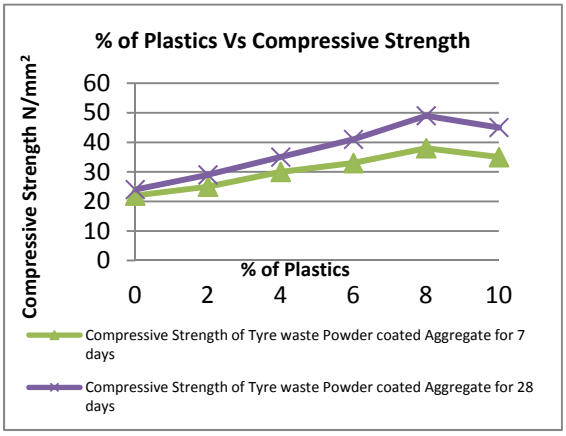


Fig 4 - Graph of % Polymer Vs Compressive Strength for 28 days water curing

Table no 3.4 – Compressive strength tests for 7 & 28 days with water curing & various Percentage of plastic

Sr. No.	% of Plastic	Compressive Strength of Tyre waste Powder coated Aggregate for 7 days	Compressive Strength of Tyre waste Powder coated Aggregate for 28 days
1	0	22	24
2	2	25	29
3	4	30	35
4	6	33	41
5	8	38	49
6	10	35	45



Conclusions

a) Due to tyre waste powder covering, specific Gravity of the aggregate increase. Water Absorption is also reduced to zero for covered aggregates.

b) Tyre waste powder covered aggregate shows decrease in Impact value. This reduction in value was shows that the robustness of the aggregate was increased to face the impacts.

c) It also covered aggregate shows decrease in Crushing Value. Low aggregate crushing value indicates strong aggregates, as the crushed part is low.

d) Stripping Value was reduced and this shows that covered aggregate are more appropriate for bituminous construction than basic aggregates.

e) From above data it is proved that by adding confident quantity of tyre waste powder in the flexible and rigid concrete, it gains potency and thus becomes more robust and sturdy. The covering of polythene & tyre powder reduces the porosity, absorption of moisture and improves reliability. Hence the use of tyres waste powder as a flexible pavement material is one of the best methods for effortless removal of wastes.

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References

[1] Bindu C S and Dr K S Beena "Waste plastic acts as a stabilizing additive in Stone Mastic Asphalt" International Journal of Engineering and Technology Vol.2 (6), 2010, 397-387.

[2] Moh. Awwad and Lina Shbeeb "The use of Polythene in Hot Asphalt Mixtures" American Journal of Applied Sciences Vol. 4 Issue 6, 2007, 390-396.

[3] Amit Gawande "Utilization of Waste plastic in asphalting roads" Science review & Chemical communication Vol.2 (2), 2012, 147-157.

[4] Reddy B D, Aruna J. S and Ramesh P. B, (2013) Experimental Investigation on Concrete by Partially Replacement of Ware Aggregate with Junk Rubber, The International Journal Of Engineering And Science (IJES), Volume 2, Issue 12, Pages 61-65.

[5] Panda K. C, Parhi P.S and Jena T, (2012) Scrap-Tyre- Rubber Replacement for Aggregate in Cement Concrete: Experimental Study, International Journal of Earth Sciences and Engineering, Volume 05, No. 06.

[6] Gupta. R.C, Blessen Skariah Thomas, Prachi Gupta,(2012) Utilization of copper slag and discarded rubber tyres in construction, International journal of civil and structural engineering volume 3, No 2.

[7] Afroz Sultana SK and K.S.B. Prasad "Utilization of Waste Plastic as a Strength Modifier in Surface Course of Flexible and Rigid Pavements" International Journal of Engineering Research and Applications Vol.2, Issue 4, 2012, 1185-1191.

[8] P B Rajmane, A K Gupta, D B Desai "Effective Utilization of Waste Plastic in Construction of Flexible Pavements for Improving their performance" Journal of Mechnical and Civil Engineering, ISSN:2278-1684, PP:27-30.

[9] Bandopandhyay T. K., (Jan. - Mar. 2010), "Construction of Asphalt Road with Plastic Waste", Indian Center for Plastic in Environment (ICPE), ENVIS – Eco- Echoes, Vol.11, Issue 1.

[10] Dhodapkar A N., (Dec. 2008), "Use of waste plastic in road construction", Indian Highways, Technical paper, journal, P No.31-32.

[11] R. Vasudevan.,(2011), "A technique to dispose waste plastics in an ecofriendly way – Application in construction of flexible pavements", Construction and Building Materials,Vol-2.

[12] Khan I. and Gundaliya P. J. (2012), "Utilization of waste polyethylene materials in bituminous concrete mix for improved performance of flexible pavements", Journal of applied research, volume 1, issue 12, pp. 85-86.

[13] Swami V., Jirge A., Patil K., Patil S., Patil S. and Salokhe K. (2012), "Use of waste plastic in construction of bituminous road", International Journal of Engineering Science and Technology, Volume 4, pp. 2351- 2355.

[14] Rokade S, " Use of waste plastics and waste rubber TYREs in flexible highway pavements", 2012 International conference on Future environments and Energy, IPCBEE Vol.28(2012), IACSIT Press, Singapore.

[15] In-Taek Roh, Kyung-Chae Jung, Seung-Hwan Chang, Yoon-Ho Cho, "Characterization of compliant polymer concretes for rapid repair of runways" Construction and Building Materials 78 (2015) 77–84. A.

[16] Blaga and J.J. Beaudoin. "Polymer Modified Concrete", Division of Building Research, National Research Council Canada, Canadian Building Digest, Ottawa, 1985.