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Roadway and Infrastructure Development in Konkan Region by using Waste Material

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Abstract: *The disposal of plastic is major threat of a environmental problem. If the highway of the potholes and corrugation is also major problem. Plastic pavement will be a better solution to the above stated problems. A material that contain one or more organic polymer of large molecular weight, solid in its finished state, is also can be the shaped by its flow is called as "plastic". The durability of plastic is high and it degrades very slowly. And also plastic has high resistant to degradation. Plastic can be divided in to two major categories- thermoses & thermoplastics. Thermoses have high durability and strength because it solidifies irreversibly when heated, henceforth can be used primarily in construction application. Plastic is a non-degradable waste, causes green-house effect and global warming. The various experiments have been carried out whether the waste plastic can be reused productivity. The various literature indicated that the waste plastic when added to hot aggregates will form a fine coat of plastic over the aggregate and such aggregate when mixed with binder is found to have higher strength, higher resistance and better performance over a period of time. Also along with the bitumen , use waste plastic increases its life and smoothness. It is economical and eco-friendly. Addition of plastic waste in construction of pavements reduces the plastic shrinkage and drying shrinkage. The use of waste plastic improves the abrasion & slip resistance of asphalt pavement. In India, because of hot and extremely humid climate, plastic pavements of greatest advantage.*

Keywords: Transportation, Road Pattern, Road Transport Service

I. INTRODUCTION

In order of a absorb the smoke from the vehicles; titanium di-oxide can be used. It also enhances the mechanical properties of the plastic, resulting in higher strength and high resistance.

Studies have revealed that waste plastics have great potential for use in bituminous construction as its addition in small doses, about 5-10%, by weight of bitumen helpsin substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous mix, leading to improved longevity and pavementperformance. The use of waste plastic thus contributes to construction of green roads.

Depending on their physical properties, they may be classified as thermoplastic and thermosetting materials. Thermoplastic materials can be formed into desired shapesunder heat and pressure and become solids on cooling. On subjected to the same conditions of heat and pressure, they can be remolded. Thermosetting materials which once shaped cannot be softened/remolded by the application of heat. The examples of some typical Thermoplastic and Thermosetting materials are tabulatedin Table 1. **Thermosetting materials are not used in pavement construction**.

TABLE: Typical Thermoplastic and Thermosetting Resins

Thermoplastic	Thermosetting
Polyethylene Terephthalates (PET)	Bakelite
Polypropylene (PP)	Epoxy
Poly Vinyl Acetate (PVA) Poly Vinyl Chloride (PVC)	Melamine Polyester
Polystyrene (PS)	Urea- Formaldehyde
LOW Density Polyethylene (LDPE)	Alkyd

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High Density Polyethylene (HDPE)	

1.4 plastics can also be classified according to their chemical source. According to source of plastic, there are six general groups: Cellulose Plastics, Synthetic Resin Plastics, Protein Plastics, Natural Resins, Elastomers and Fibers. Table 2 gives the source of waste plastic generation. Only plastic conforming to Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), PET and Polyurethane shall only be used in pavement construction.

Table 2 Waste Plastic & its Source

Waste Plastic	**Origin**
Low Density Polyethylene (LDPE)	Carry bags, sacks, milk pouches, bin lining, cosmetic and detergent bottles.
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Polyethylene Teryphthalate (PET)	Drinking water bottles etc.
Polypropylene (PP)	Bottle caps and closures, wrappers of detergent, biscuit, water packets, microwave trays for readymade meal etc.
Polystyrene (PS)	Yoghurt pots, clear egg packs, bottle caps.
Foamed Polystyrene	Food trays, egg boxes, disposable cups, protective packaging etc. Mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders and pens, medical disposables; etc.

1.5 There are two processes namely dry process and wet process for manufacturing bituminous mixes after shredding in hot aggregates where as in the wet process, processed waste plastic in the form of powder is added in the hot bitumen. using waste plastic. In the dry process, processed waste plastic is added

II. BACKGROUND

Since 2001 , the plastic man of india R.Vasudevan, dean, Thiagarajar College of Engineering, Madurai, and his team the Centre for studies on solid waste management (CCWM) have been researching on feasibility of using plastic in construction of roads. Laboratory result of mixing waste plastic with heated bitumen and coating the mixture over stone proved positive and he implemented the use of plastic waste on a road constructed inside the premises of his college in 2002. In 2006, the Thiagarajar college of Engineering received the patent for this technology. Later, a performance appraisal by the central Board (CPCB) Showed that plastic roads did not develop defects potholes, rutting, raveling or edge flow, even after four years.

Presently global production of plastic is about 360 million tone .

Average worldwide utilization of plastic is 45 kg/ person.

Many plastics are discarded after a very short lifecycle (e.g.;- single use),which causes colossal waste accumulation and critical environment concerns. Approximately 3% of each year's plastic waste ends up in the sea, harming the environment and wildlife

Safe disposal of waste plastic is a serious environmental problem.

Plastic is a non-biodegradable material which can last as lomg as 4,000 years.

If dumped in landfills, it can find its way back to the environment through air and water erosion, can choke the drains and drainage channels, can be eaten by grazing animals causing them illness and death and can contaminate the construction fill.

Further, dumping on open land will result in wasteful use of scares land resource.

Land pollution and disposal of waste plastic challenge can reduce significantly if these materials are utilized in road construction.

III. LITERATURE REVIEW

Dr.R.Vasudevan,(2007) - stated that the polymer bitumen blend is a better binde compared to plain bitumen. Blend has increased softening point and decreased penetration value with a suitable ductility.

Zahra Insofar Kalantar(2012) – Many researches on PMA mixture have been conducted for the past two decades. Although addition of virgin polymers to asphalt for the purpose of enhancing the properties of asphalt over a wind temperature range in paving application was contemplated quite some time ago, recycled polymer added to asphalt have

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also shown almost the same result in improving the road pavement performance as compared to virgin polymers. This paper is a review of the use of polymer in asphalt is pavement .in this study, a critical review on the history and benefits of using waste and virgin polymer in asphalt is presented followed by a review of general studies on using polymers in asphalt in order to improve the properties of pavement.

Amit Gawande (2012) – the quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization activities and changes in life style which leading widespread littering on the landscape. Thus disposal of waste plastic is a menace and become a serious problem globally due to their non- biodegradability and un aesthetic view. Since these are not disposal scientifically &possibility to create mechanical characteristics for particular road mix. In conventional road making process bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made which can be used as a top layer coat of flexible pavement. this waste plastic pieces and bitumen mix show better binding property, stability, density and more resistant to waste.

Sunil J. Kulkarni (2015) – Minimization of waste material is important aspect of the modern growth and development initiatives. Plastic is used in various domestic and industrial applications. Use of plastic bags and bottles is very common. The disposal of plastic waste is major problem due to non-biodegradable nature of plastic. The plastic can be used as feedstock for ethanol like products. It can be used for road construction and other construction related activities. The current review summarizes the research on use of waste plastic.

Rishi Singh Chhabra (2014) – In the highway infrastructure, a large number of originates materials and technologies have been invented to determine their suitability for the design construction and maintenance of these pavements. Plastics and rubbers are one of them also considering the environmental approach, due to excessive use of polythene in day to day business, the pollution to the environment is enormous. The use of plastic materials such as carry bags, cups, etc. is constantly increasing day. Since the polythene are not biodegradable, the need of the current hour is to use the waste polythene in some beneficial purposes. The use of these materials as a road construction proves eco-friendly, economical and use of plastic gives strength in the sub-base course of the pavement.

IV. METHODOLOGY

The dry process can also be carried out using central mixing plant. The shredded plastic is added along with the aggregate in the conveyor belt. This is transferred into the hot cylinder. There aggregate is coated with plastic first and then with the bitumen. The mixer so prepared is then loaded in the dipper lorry and transported for road laying. CMP helps to have better control of temperature and better mixing of this material thus helping to have a uniform coating. This is adopted in our project.

The comparative study is done by testing the normal aggregates & plastic coated aggregates, and the bitumen and modified bitumen (10% of bitumen replaced by plastic). The various tests that are carried out for the comparative study are

- Test on aggregates
- Aggregate crushing test
- Los Angeles abrasion test
- Impact test
- Test on bitumen
- Penetration test
- Softening point test
- Viscosity test
- Marshall Stability test.

Tests on Aggregates

4.1 Aggregate Crushing Test

The strength of the coarse aggregate may be assessed by aggregate crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under gradually

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applied compressive load.To achieve a high quality of pavement, aggregates possessing high resistance to crushing or low aggregate crushing value re preferred.

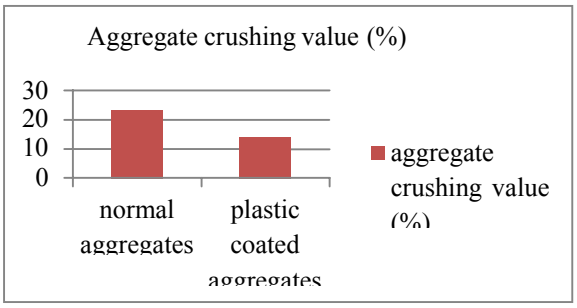


Figure 1 – Aggregate crushing value.

4.2 Abrasion Tests

Due to the movements of traffic, the road stones used in the surface course are subjected to wearing action at the top. Hence road stones should be hard enough to resist the abrasion due to traffic. Abrasion tests are carried out to test the hardness property of stones and to decide whether they are suitable for the different road construction works. The abrasion test on aggregate may be carried out using any one of the following threetests

Los Angeles abrasion test

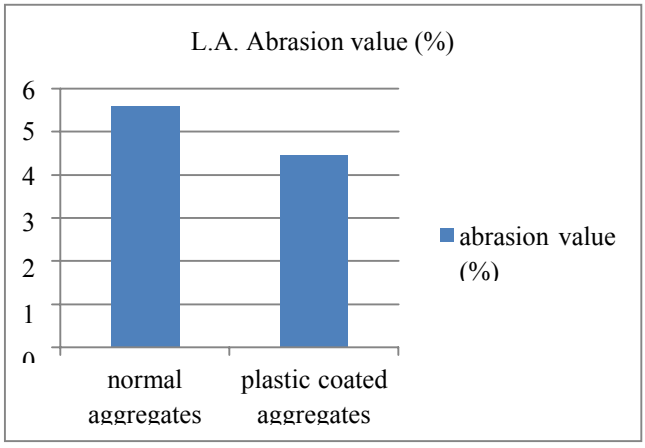
Deval abrasion test

Dory abrasion test

However Los Angeles abrasion test is preferred as the test results have been correlated with pavement performance.

4.3 LOS Angeles Abrasion Test

The principle of Los Angeles abrasion test is to fine the percentage wear due to the relative rubbing action between the aggregate and steel bails used as abrasive charge. Pounding action of these balls also exists during the test and hence the resistance to wear and impact is evaluated by this test.



Aggregate Los Angeles abrasion value

4.4 Impact test

The test is designed to evaluate the toughness of stone or the resistance of the aggregates to fracture under repeated impacts is called impact test. The aggregate impact test is commonly carried out to evaluate the resistance to impact of aggregates and has been standardised by ISI.

The aggregate impact value indicates a relative measure of aggregate to impact, which has a different effect than the resistance to gradually increasing compressive stress.

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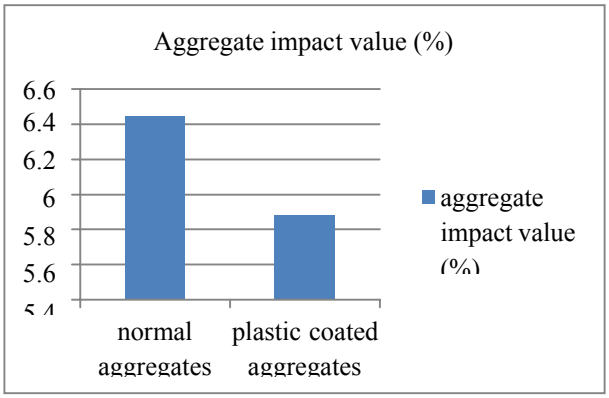
The aggregate impact value should not normally exceed 30% for aggregate to be used n wearing course of the pavements. The maximum permissible value is 35% for bituminous macadam and 40% for water bound macadam base course.



Aggregate Impact value

4.5 Tests on Bitumen penetration Test

Penetration test is to determine the hardness of the bitumen. The penetration of a bitumen is the distance in tenths of millimeter, that a standard needle will penetrate into the bitumen under a load of 100gm applied for 5 seconds at 25 ˚c. Penetration value indicates the softness of bitumen(higher the penetration ,softer is the bitumen).

Table 1 – test result of penetrations value of bitumen vs. penetration value (mm) modified bitumen

SR NO	PENETRATION VALU (mm) PLAIN BITUMEN	PENETRATION VALE (mm) MODIFIED BITUMEN (10% PLASTIC REPLACED)
1	79	67
2	63	49

4.6 Softening Point Test

The principle behind this test is that softening point is the temperature at which the substance attains a particular degree of softening under specified condition of the test softening point denoted the
temperature at which the bitumen attains a particular degree of softening under the specifications of this test.
The test is conducted by ring and ball apparatus. A brass ring containing test sample of bitumen is suspended in liquid like water or glycerin at a given temperature. A steel ball is placed upon the bitumen sample and the liquid medium is heated at a rate of 5 C/ minute. Temperature is noted when the softened bitumen touches the metal plate which is at a specified distance below. Generally, higher softening point indicates lower temperature susceptibility and is preferred in hot climates.

Table 2 – test result of softening point of bitumen and modified bitumen (bitumen replaced by

SR NO	SOFTENING POINT (C) (PLAIN BITUMEN)	SOFTENING POINT (C) 10% BITUMEN REPLACED BY PLASTIC
1	69.2	80.7
2	70	81.2

4.7 Viscosity Test

Viscosity is defined as the inverse of fluidity. Viscosity thus defines the fluid property of bituminous material. Viscosity is the general term for consistency and is the measure of resistance to flow. Many researchers believe that grading of bitumen should be by absolute viscosity units instead of the conventional penetration units.
The degree of fluidity of the binder at the application temperature greatly influences the strength characteristics.

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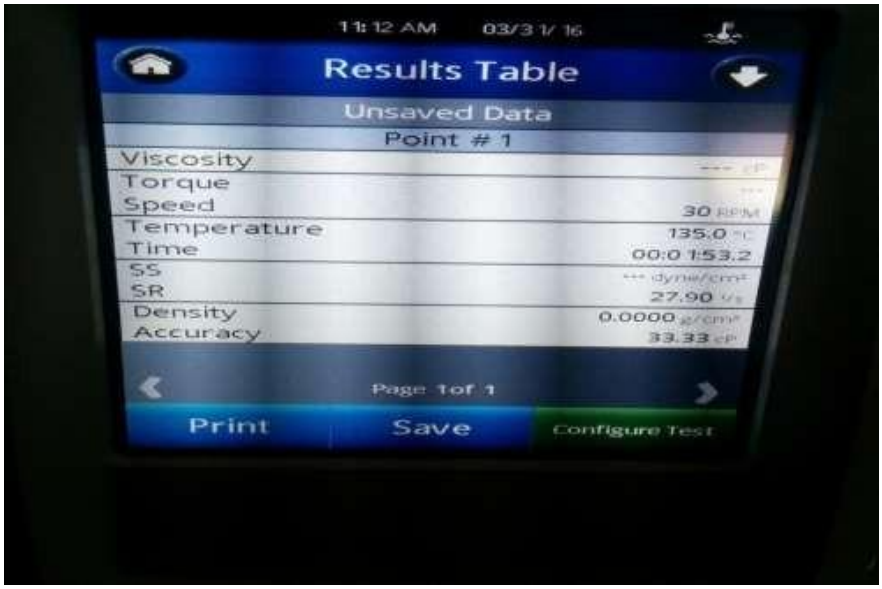

Digital Test Result Representation of Viscosity.

4.8 Marshall Stability Test

Table 3 – Percentage of bitumen content

SR NO	BITUMEN CONTENT (%)	MODIFIED BITUMEN (gm.)
1	4.5	5.9
2	5.0	0.6
3	5.5	6.6
4	6	7.2

Table 4 – Test Results of Marshall Stability Test

S.No	Bitumen Content(%)	Weight of mix(g)	Weight in air(g)	Weight in water(g)	Stability of bitumen Stability of modified		Flow (mm)	Diame -ter(cm)	Height (cm)
					Plain bitumen	Modified bitumen			
1	4.5	1255.5	1256.5	733	14.7	17.95	1.99	10	6.3
2	5	1253	1255.5	734	19.47	23.44	2.38	10	6.4
3	5.5	1257	1259	736	13.46	18.21	2.88	10	6.5
4	6	1268	1270	748	8.9	13.10	2.59	10	6.4

V. RESULT AND DISUSSION

- The Crushing value reduces from 23.32 to 14.22 for normal and plastic coated aggregate. The Value was reduced by 40% Lower the aggregate crushing value higher is the strength.
- The aggregate impact value of plastic coated aggregate was reduced by 9% than the normal aggregate. It's the higher toughness of plastic coated aggregates.
- Los Angeles abrasion value indicates the hardness of the aggregates. The abrasion value plastic coated aggregates were 21% less than the normal aggregates .
- The penetration value of bitumen is higher than the bitumen with the plastic.
- The bitumen softens 10®c less than the bitumen replaced with plastic.
- The stability of modified bitumen (10% bitumen replace by plastic) is higher than the normal bitumen.

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VI. CONCLUSION

The plastic mixed with bitumen and aggregates is used for the better performance of the roads. The polymer coated on aggregates reduces the voids and moisture absorption. This results in the reduction of ruts and there is no pothole formation. The plastic pavement can withstand heavy traffic and are durable than flexible pavement. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road. This new technology is eco-friendly.

The use of smoke absorbent material (titanium di-oxide) by 10% of polymer content can reduce the vehicular pollution.

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