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Improving Road Life Using Plastic Wastes

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Abstract: *Now a day's mostly peoples are attracted towards plastic for their daily needs. It is estimated 55% of global plastic was discarded, 25% was incinerated & only 20% of plastic is recycled. The discarded waste plastics in the land spoil the fertility of the soil, prevents the rain water absorption capacity of the soil. Burning of the waste plastics produces smoke containing carbon-monoxide and some harmful gases in the atmosphere. This can induce air pollution recycling processes; plastic road is one of the best ways for recycling plastics.*

Keywords: Plastic Waste.

I. INTRODUCTION

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'plastic,. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics can be divided in to two major categories: thermo set and thermoplastics. A thermo set solidifies or "sets" irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobile and construction applications. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene, polytetrafluorethylene. A thermo Plastic softens when exposed to heat and returns to original condition at room temperature. Thermoplastics can easily be shaped and moulded into products such as milk jugs, floor coverings, credit cards, and carpet fibres. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane. According to recent studies, plastics can stay unchanged for as long as 4500 years on earth with increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. Plastic in different forms is found to be almost 5% in municipal solid waste, which is toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastics packing material littering the roads as well as drains. Due to its biodegradability it creates stagnation of water and associated hygiene problems. In order to contain this problem experiments have been carried out whether this waste plastic can be reused productively. The experimentation at several institutes indicated that the waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time. Waste plastic such as carry bags, disposable cups and laminated pouches like chips, pan masala, aluminium foil and packaging materials used for biscuits, chocolates, milk and grocery items can be used for surfacing roads. Use of plastic along with the bitumen in construction of roads not only increases its life and smoothness but also makes it economically sound and environment friendly. Plastic waste is used as modifier of bitumen to improve some of bitumen properties roads that are constructed using plastic waste are known as plastic roads and are found to perform better compared to those constructed with conventional bitumen. Further it has been found that such roads were not subjected to stripping when come in contact with water. Use of higher percentage of plastic waste reduces the need of bitumen by 10%. It also increases the strength and performance of the road. Plastic increases the melting point of bitumen and hence missing can be done in more better and easier way. According to Dr. R. Vasudevan, Dean ECA and professor, Department of chemistry, Thiagarajar college of Engineering, Madurai, plastics waste replaces 10% to 50% of bitumen, and thereby saves approximately Rs.35000 to Rs.45000 per kilometer of a road stretch. Inclusion of plastic waste in road construction eliminates the plastic shrinkage cracking of road surface and reduces the drying shrinkage to some extent.

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II. PROBLEM STATEMENT

The debate on the use and abuse of plastics vis-à-vis environmental protection can go on, without yielding until practical steps are initiated at the grassroots level by everyone who is in a position to do something about it. The plastic wastes could be used in road construction and the field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the road and also solve environmental problems. The present write-up highlights the developments in using plastics waste to make plastic roads. The rapid rate of urbanization and development has led to increasing plastic waste generation. As plastic is non-biodegradable in nature, it remains in environment for several years and disposing plastic wastes at landfill are unsafe since toxic chemicals leach out into the soil, and underground water and pollute the water bodies. Due to littering habits, inadequate waste management system/ infrastructure, plastic waste disposal continue to be a major problem for the civic authorities, especially in the urban areas. As stated above, plastic disposal is one of the major problems for developing countries like India, at a same time India needs a large network of roads for its smooth economic and social development. Scarcity of bitumen needs a deep thinking to ensure fast road construction.

II. OBJECTIVES

Basic intention is to efficiently utilize the waste plastic in constructive way so that it can be beneficial to society however main objectives of current project work are:

- To coat the aggregates with the waste plastic materials.
- To check the properties of bituminous mix specimen.
- To check the properties of bituminous mix specimen due to coating of waste plastic material.
- To compare the properties of bituminous mix specimen with the properties of coated aggregate.

III. LITERATURE REVIEW

- **Verma S.S** (2008). Concluded that plastics will increase the melting point of the bitumen. This technology not only strengthened the road construction but also increased the road life.
- **Dr. R. Vasudevan.** When it used for road construction it can withstand it can withstand higher temperature and load. The coating of plastics reduces the porosity, absorption of moisture and improves soundness. Hence the use of plastic waste for flexible pavement is one of the best methods for easy disposal of waste plastics. The results indicated that there was an improvement in strength properties when compared to a conventional mix. Therefore, the life of pavement surfacing using the waste plastic is expected to increase substantially in comparison to the use of conventional bituminous mix. Hence the use waste plastic for flexible pavement is one of the best methods for easy disposal of waste plastics. This technology not only strengthened the road construction but also increased the road life.
- **Zoorab & Suparma** reported the use of recycled plastics composed predominantly of polypropylene and low density polyethylene in plain bituminous concrete mixtures with increased durability and improved fatigue life. Dense bituminous macadam with recycled plastics, mainly low density polyethylene (LDPE) replacing 30% of 2.36-5mm aggregates, reduced the mix density by 16% and showed a 250% increase in Marshall stability; the indirect tensile strength (ITS) was also improved in the 'Plastiphalt' mixtures D.N. Little worked on the same theme and he found that resistance to deformation of asphaltic concrete modified with low density polythene was improved in comparison with unmodified mixes. It is found that the recycled polyethylene bags may be useful in bituminous pavements resulting in reduced permanent deformation in the form of rutting and reduced low temperature cracking of pavement surfacing Bitumen. Investigates the benefits of stabilizing the stone mastic asphalt (SMA) mixture in flexible pavement with shredded waste plastic.

IV. MATERIALS AND METHOD

4.1 Aggregates

The aggregates are bound together either by bituminous materials or by cement. In a few cases, the rock dust itself when mixed with water forms slurry which acts as a binding medium. The aggregates may be classified into natural and artificial aggregates. The natural aggregates again are classified as coarse aggregates consisting of crushed rock aggregates or gravels

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and fine aggregates or sand. The blast furnace slag obtained as by-product from blast furnaces is the one extensively used as road construction material. Stone aggregate used for road work should be hard, tough, durable and hydrophobic for bituminous surface. Gravel should be well graded (6.4mm to 38mm) and should have a fineness modulus of not less than 5.75 sand should be sharp, well graded, clean of all silts, clay and organic matter. The quantity of aggregates used in first coat of surface dressing should be 0.15 m3 per 10 m2 area of 12mm nominal size. On the other hand, the quantity of aggregate used in second coat of surface dressing should be 0.15 m3 per 10 m2 areas and of 10mm nominal size.

4.2 Bitumen

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. As per definition given by the American society of testing materials bitumen has been defined as "Mixtures of hydrocarbons of natural or pyrogenous origin, or combination of both, frequently accompanied by their non-metallic derivatives, which may be gaseous, liquid, semi-solid, and which are completely soluble in carbon disulphide. "Bitumen found in natural state known as asphalt contains large quantities of solid mineral matter. When petroleum crude is refined in a refinery, they are separated by fractional distillation in the order of decreasing volatility. On distillation of the residual bituminous residue, straight-run bitumen is obtained. This bitumen is known as penetration grade bitumen or steam refined petroleum bitumen. The grades of bitumen used for pavement construction is known as paving grades and that used for water proofing of structures is known as industrial grades. The grade of straight run bitumen is chosen depending upon the climatic conditions of the region in which surface dressing is to be constructed. In most parts of India 80/100 and 180/200 grades bitumen is used. Heavier grade cut backs, rapid setting emulsions or heavier grade tars may also be used. The grade of basic bitumen is altered either by controlled refining or by mixing with diesel oil or other oils. For single dressings on WBM base course, quantity of bitumen needed ranges from 17 to 195kg per 10 m2 areas and 10 to 12kg per 10 m2 area in case of renewal of black top surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12kg per 10 m2 area. Bulk bitumen Lorries with tanks of capacity ranging from 5000 to 15000 litres are used to transport bulk bitumen. As per PMC, the bitumen content in a mix should be 4% of weight by total mix for B.M. The paving bitumen available in India is classified into two categories: Paving bitumen from Assam petroleum denoted as A-type designated as grades A35, A90, etc. Paving bitumen from other sources denoted as S-type and designated as grades S35, S90, etc.

Important properties of bitumen are:

- **Viscosity of bitumen** should be adequate at the time of mixing and compaction. It is achieved by heating prior to mixing and by use of cutbacks and emulsion. In presence of water bitumen should not strip off from aggregate. Bitumen should be durable in all seasons. It should not become too soft during summers and develop cracks during winters.
- **Bitumen grade:** 60/70, 80/100 grade bitumen.

4.3 Plastic Material

Plastic are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemicals process used in their synthesis, such as condensation, polyaddition, and cross linking. There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluorethylene (PTFE) in the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulphur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky. The properties of plastics are defined chiefly by the organic chemistry of the polymer. Such as hardness, density, and resistance to heat, organic solvents, oxidation, and ionizing radiation.

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4.4 Types of Plastic

1. Polyethylene terephthalate (PET)
2. High-density polyethylene (HDPE)
3. Polyvinyl chloride (PVC)
4. Low-density polyethylene (LDPE)
5. Polypropylene (PP)
6. Polystyrene (PS)

Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Since the 1950s, one billion tons of plastic have been discarded any may persist for hundreds or even thousands of years. Perhaps the biggest environmental threat from plastic comes from hurdles, which are the raw material from which all plastics are made. They are tiny pre-plastic pellets that kill large numbers of fish and birds that mistake them for food. Prior to the ban on the use of CFCs in extrusion of polystyrene (and general use, except in life-critical fire suppression systems; see Montreal protocol), the production of polystyrene contributed to the depletion of the ozone layer; however, non-CFCs are currently used in the extrusion process. Thermoplastics can be remelted and reused, and thermoset plastics can be ground up and used as filler, although the purity of the material tends to degrade with each reuse cycle. There are methods by which plastics can be broken back down to a feedstock state.

V. CLASSIFICATION OF PLASTIC

5.1 Classification of Plastic Waste

A. Polyethylene

- **LDPE (Low Density Poly-Ethylene):** Low density poly-ethylene this plastic waste available in the form of carry bags generally in stores these plastic bags are very thin and also easily available.
- **HDPE (High Density Poly-ethylene):** Generally high density poly-ethylene type of plastic waste is available in the form of carry bags and easily available in the market.

B. Polypropylene

This plastic may be available in the form of carry bags or solid plastic it's depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

C. Preparation of Plastic Waste Material

Plastic Waste Scenario

The use of plastic materials such as carry bags, cups, etc. is constantly increasing. The consumption of plastics has increased from 4000 tons/annum. To 4million tons/annum and it is expected to rise 8 million tons/annum during the year 2010. Nearly 50 to 60% of the total plastics are consumed for packing.

D. Basic Processes

1. Segregation
2. Cleaning process
3. Shredding process
4. Collection process

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VI. METHODOLOGY AND PROCEDURE

6.1 Plastic Waste Blending Materials

A. Preparation of Blend

Polyethylene carry bags are cut into pieces using a shredding machine. They are sieved and the plastic pieces passing through 4.75mm sieve and retaining at 2.36mm sieve gets collected. These plastic pieces are added slowly to the hot bitumen of temperature around 170^0-1800^0C. The mixture stirred well using mechanical stirrer for about 20-30 minutes. Polymer-bitumen mixtures of different compositions can be prepared and used for carrying out various tests.

B. Separation Test

Samples of different composition can be subjected to the separation test. Homogeneity can be obtained approximately up to 1.5% blend. Beyond this composition, the variation of softening point is much higher for the top and bottom layer of the test samples showing that there is a separation of polymer from bitumen on standing.

C. Characterization of plastic waste-bitumen blend for flexible pavement

The utility of the plastic waste blended bitumen-aggregate mix for flexible pavement construction is characterized by studying stripping value and Marshall Stability value of the mix for blends having a maximum of 1.5% plastic waste.

D. Preparation of plastic-waste coated aggregate

The aggregate are heated to around 170^0 C the plastic waste shredded to the size varying between 2.36mm and 4.75mm. This shredded plastic waste is added over hot aggregate with constant mixing to give a uniform distribution. The plastic get softened and coated over the aggregate. The hot plastic waste coated aggregates are mixed with hot bitumen 60/70 or 80/100 grade.

Procedure:

The stone is collected to a desired size. The stone is heated in a reactor for 160^0 – 170^0 C. The plastic wastes are collected & separate to the types. The collected plastic wastes are shredded into small pieces. And the bitumen is heated in a reactor for 155^0 – 163^0 C. The stone, plastic and bitumen are mixed in another reactor for particular time. When it comes to a molten stage. It is applied to the surface where we want to put a road. The road is allowed to dry for a day. Now it is ready to use. We have made three types of preparation of plastic road.

1 type = the road is made in the mixture of 10% of plastic
2 type = the road is made in the mixture of 15% of plastic
3 type = the road is made in the mixture of 20% of plastic

Finally, type 3 (20% of plastic) is very strong and it is good water resistance and durability.

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Construction of plastic coated bitumen road

Plastic waste collection

Plastic waste is segregated

Plastic waste is shredded (2-4mm)

Plastic waste is cleaned and dried

Stone aggregate is heated(160°-170° C)

Shredded plastic is added to heated agg

Up to 4 layers of the mixture is

The Bitumen (temp.155◦C-163◦C) is then added and mixed with the coated aggregate

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Diagram of the Process

Plastic Waste Collection

Stone Aggregated is Heated

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Stone is heated at (160^0 C- 170^0 C)

Shredded plastic added to stone

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Temperature at (180^0 C)

Bitumen is heated

Added and mixed with the coated aggregate

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Temp at (155^0 C – 163^0 C)

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VII. Significant Features of This Process

Significant features of this process

1. Durability
2. Environmental advantage
3. Economic advantage
4. Safety advantage

7.1 Durability

The normal bitumen roads in India tend to break down very quickly. This to a large extent is due to the high temperatures prevalent in some parts of the country. However even in the best of conditions in India, roads often break down within 5 years. Dr. Vasudevan conducted a number of tests which illustrate that the durability of the plastic road will be significantly higher.

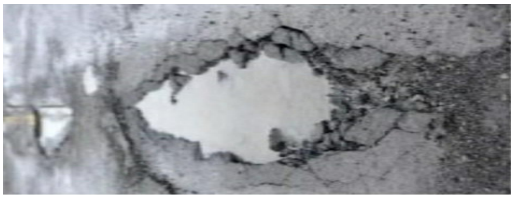
7.2 Binding Test

This test measures the bending strength and the compression strength of the mixture used to make the road. Bending strength refers to the mixtures ability to resist deformation under heavy load. Compression strength refers to the mixtures ability to resist forces that attempt to compress or squeeze it.

For this test the hot mixture was compacted using a compacting using machine and then compressed using a universal testing machine. The test was done for mixtures with 10%, 20% and 25% plastic and the test was repeated using different plastics. The results illustrate that the greater the proportion of plastic the greater the bending strength and the greater the compression strength. For example with polyethylene the bending strengths were 325kg, 340kg and 350kg at 10%, 20% and 25% respectively while the compression strengths were 250 tonnes 270 tonnes and 290 tonnes respectively.

7.3 Moisture Absorption Test

The moisture absorption test is done to determine the extent to which the aggregate absorbs water. If the water absorption is high the road is likely to break down and develop pot holes in the event of any water logging. In order to determine how resistant the road is to water absorption a fixed mass of the mixture was taken and immersed in water. After 24 hours the mixture was removed and reweighed. The difference in mass was the mass of water absorbed. This was identified for plastic concentrations of 0%, 1%, 2% and 3%. The moisture absorbed has been quoted as a % of the mass of the mixture added. The results were 4%, 2% and 1.1% for 0%, 1% and 2% of plastic added. For 3% plastic only negligible amounts of water were absorbed.



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7.4 Soundness Test

This test measures the mixture's resistance to weathering by conducting tests that simulate weather cycles in an accelerated manner. The weathering occurs because when water enters pores and voids in the mixture, the salts dissolved in the water, crystallize, when the water evaporates more crystal is formed and this crystal causes the mixture to crack and break. The freezing and thawing can cause the porous aggregate tends to disintegrate prematurely.

The test conducts 5 accelerated weathering cycles and measures the mass of the mixture that was lost. The % mass lost should not exceed 12% when sodium sulphate solution is used. Just like in the test for moisture 0%, 1%, 2% and 3% plastic were used. The results indicated that the % lost for the 0% plastic (plain aggregate) was 5% ± 1% but for 1%, 2% and 3% plastic no mass loss was observed. This suggests that the plastic in the mixture increases the mixture's resistance to weathering. This could be explained by the fact that the % voids in the mixture decreased as the % plastic increased. The values were found to be 4%, 2.2% and 1% for 0%, 1% and 2% plastic while for 3% plastic no voids were observed.

7.5 Aggregate Impact Strength

The test is used to determine the aggregate's resistance to fracturing. It means the ability of the road to resist impact or to measure how tough the road is. Continuous movement of heavy vehicles on the road subjects them to nonstop impact causing it to disintegrate. Often, to begin with, it resembles a crocodile skin before completely breaking down.

In order to measure this sample of the mixture is taken and hit with a 14kg hammer 15 times. The % of mass that becomes powdered should not exceed 30%. The powdered mass will be identified as the mass passing through a 2.36mm sieve. The experiment was conducted for 0%, 1%, 2% and 3% of plastic and the results were found to be 25.4%, 21.2%, 18.5% and 17% respectively. This suggests that the plastic makes the mixture less susceptible to fracturing in the event of a large force.

7.6 Los Angeles Abrasion Test

The test used is the Los Angeles abrasion test. This test measures how resistant the aggregate used in the road is to abrasion. Soil particles present in the tyres of the vehicles and the on the road result in abrasion of the road as the vehicles move on the road. This test measures whether the road aggregate is hard enough to withstand abrasion. This is measured by rubbing the mixture with steel balls. This is done by placing the mixture on a 1.70mm sieve inside a rotating drum. A fixed number of steel balls were rotating in circular fashion at a rate of 30-33 rpm until 500 revolutions had been completed. The

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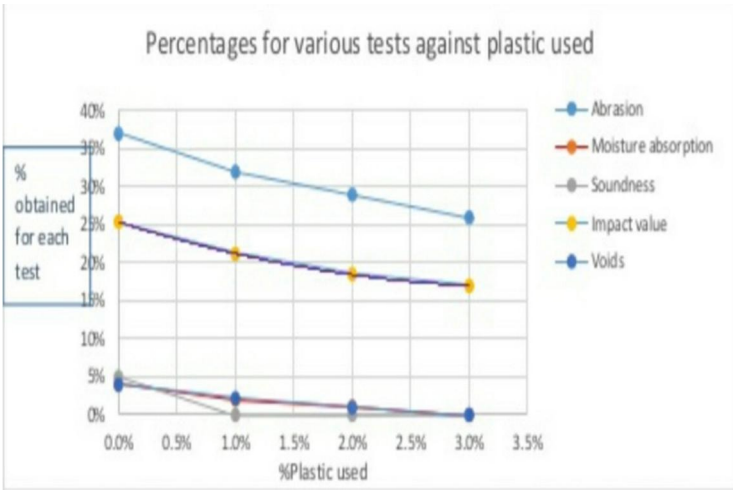
mixture was placed at a particular point on the circumference such that as each steel ball passed it rubbed the mixture. The % mass passing through the sieve should be less than 30%. The experiment was conducted for 0%, 1%, 2%, 3% of plastic and the % mass passing through the sieve were found to be 37%, 32%, 29% and 26% respectively. This suggests that the plastic coating improves the resistance to abrasion significantly and is essential in order to bring it below the 30% value.



7.7 Environmental Advantage

Our daily lives are inundated by the use of several products containing plastic in some form or the other. Its annual production amounts to over 275 million tonnes globally and India alone as a consumer accounts for over 11 million tonnes. Although it is non-biodegradable most of it is recyclable. The recycled products are even more environmentally harmful than the first time manufactured ones. This is because every time plastic is recycled it is subject to high intensity heat causing it to deteriorate and add to environmental pollution. The need of the moment is to find an effective way to deal with this non-biodegradable waste. The plastic road is one such solution.

The environmental advantage of plastic roads arises from the fact that it uses plastic that would otherwise be disposed through environmentally harmful means. One of the acceptable methods of dealing with plastic waste all over the world is incineration. Incineration, simply put is the burning of plastics in the presence of oxygen. However often incinerators used are not manufactured keeping in mind the recommended standards and guidelines. As a result when we burn plastics, in an attempt to dispose them, highly toxic emissions are released. These include carbon monoxide, Chlorine, Hydrochloric acid, Dioxin, Furans, Amines, Nitrides, Styrene, Benzene, 1, 3-butadiene, CCI4, and Acetaldehyde. These emissions cause air pollution resulting in acid rain, death of various animals and contribute to the greenhouse effect thereby magnifying global warming. Furthermore the incineration requires energy and this energy inevitably ends up coming from fossil fuels burnt

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elsewhere. Therefore, the impact of incineration, on the environment is twofold. The burnt plastic harms the environment as do the fuels burnt to produce energy for the burning of the plastics. To compound matters, the process of incineration produces an ash. This contains toxic heavy metals like lead and cadmium. If not kept in strong airtight containers, these may leach into surroundings. It has also been suggested that incineration can cause monsoon failure or drought. The usage of plastic is particularly significant because approximately 1 million carry bags are used to lay 1km of road. This translates into 1.125 tonnes of plastic per km of single lane road. Furthermore, the dry process does not result in the burning of plastics –they are only heated. Because the plastics are not burn 3 tonnes of carbon dioxide per km of road is not liberated into the atmosphere. The 2500 km of road that has been laid in India this way has saved over 2500 tonnes of plastic waste and this in turn has meant that 7500 tonnes less of CO_2 has escaped into the atmosphere. This in turn reduces the effect of global warming.

For every 1km of plastic road constructed, 1.125 tonnes of plastic waste does not end up in a landfill. This in turn will reduce the size/area of the landfills required for disposal of municipal solid waste. The more the municipal solid waste, the larger the area that is required for its disposal. Every time a new landfill is created a space is identified and cleared of all vegetation and along with the vegetation the existing ecosystem is either distributes or destroyed.

Plastic waste that lies around or in garbage disposal bins can find its way into the stomachs of animals and birds that source their food from such places. The toxins in the plastics once inside the bodies of the animals and birds cause intense suffering and pain. They can even cause death. Additionally they become a part of the food chain and indirectly affect even those who have not actually consumed any plastic. Plastic roads can definitely reduce and perhaps eventually eliminate this suffering.

The plastic roads, because they are less susceptible to damage and breaking down, provide better mileage and decrease fuel consumption resulting in reduction of greenhouse gases generated by the vehicles.

7.8 Economic Advantage

The merits of the plastic road are not merely environmental. They have a considerable financial impact as well. The cost of construction of roads decrease considerably with the use of plastic. Since 10%-15% of Bitumen is replaced plastic, the cost benefit is sizeable. According to Dr. Vasudevan report, the construction of 10m² of road costs nearly Rs.4 lakhs. The integration of plastic reduces the cost by Rs.25000. This translates to over 6% savings on the construction of the road. There is no additional time required for the construction of the road as compared to the bitumen road. The equipment used is also the same. The resulting road is superior to the bitumen road. It requires far less maintenance because the road is much more durable and can last for up to twice as long as normal roads and is resistant to most factors that cause a road to break down. This means that less material, labour and time is required to service to service the road thereby allowing for resources to be diverted towards the expansion of infrastructure instead of maintaining the existing one.

Plastic waste, it is required to be collected from various sources. The possibility of securing an income from plastic waste collection prompts the uneducated and unemployed to become rag pickers, waste plastic segregators or cleaners and seek employment in waste plastic shredding houses.

7.9 Safety Advantage

Plastic roads when compared with Bitumen roads have been proven to be more durable. Susceptibility to cracks, abrasion, weathering and pot holes is considerably reduced. It has an improved load bearing capacity and skid resistance. When compared to concrete roads they have better skid resistance in wet conditions. Since no toxic emissions occur in the process of road making, plastic waste is disposed in a safe and hazard free manner. This entire means is that there is less wear and tear of vehicles, reduced driver fatigue leading to lesser accidents and improved safety.

VIII. Advantages And Disadvantages

8.1 Advantages

- This is a very simple technology which does not involve any special machines deployment or there advanced skilled professionals.
- There is spot use of the waste plastic.
- These water proof roads provide considerably increased durability.

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- Have better resistance towards rainwater and water stagnation.
- No stripping of roads happens as this kind of roads resist the permeation of water.
- More employment can be generated as labours will be required in collection, segregation and shredding of waste plastics.
- Multi-layer films can be used which provide strength and durability.
- No maintenance will be required for years as the surface remains without any cracking or potholes.
- No effect of radiation of UV.
- The cost of road construction will also be decreased.

8.2 Disadvantage

- Most challenging task to be collected good quality of plastic waste, availability and segregating of unique objects.
- Toxics present in the co-mingled plastic waste would start leaching.
- During the road laying process, In the presence of chlorine will definitely release noxious HCL gas.
- After the road laying, the components of the road, once it has been laid, are not inert.
- The components of the road, once it has been laid, are not inert.

IX. RESULT

- The use of the innovative technology not only strengthened the road construction.
- But also increased the road life as well as will help to improve the environment and also creating a source of income.
- Plastics will increase the melting point of the bitumen.
- Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50^0C and torrential rains create havoc, leaving most of the roads with big potholes.
- It is hoped that in near future we will have strong, durable and eco-friendly roads which will relieve the earth from all type of plastic-waste.

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COST ESTIMATIONS

- Bitumen (100 per kg)×3 =300
- Bitumen liquid =200
- Thermometer =150
- Stone chips =500
- Others =500
- Total Amount =1650