

## A Proposed Design of Flexible Pavement using Waste Plastic

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### I. ABSTRACT& INTRODUCTION

In the current era of economic development with such a hefty population, it is required to have a dense network of road for the smooth transportation of goods & passengers. India, despite having one of the largest railway network moves mostly on roads. Be it passenger or freight all move on roads. Nearly 65% of freight and 85% of passenger traffic use roads for their movement. Today India has 3.34 million km of road network out of which 65579km is the network of national highways.

Category of road	Length in Km
Total road network	3.34 million
National Highways	65,569
State Highways	1,30,000
Major Distt. Road, Rural road & Urban road	3.14 million

- India having 3.34 million kilometers of road network is the second largest in the world.
  - As per present estimate, road network carry nearly 65% of freight and 85% of passenger traffic.
  - Traffic on roads is growing at a rate of 7 to 10% per annum while the vehicle population growth is of the order of 12% per annum.
- Since the road network is used so extensively in our country, therefore we need road network which is:
- Long Lasting,
  - Durable,
  - Strong,
  - Reliable,
  - Niggle Free,

- Environment Friendly &
- Cost Effective

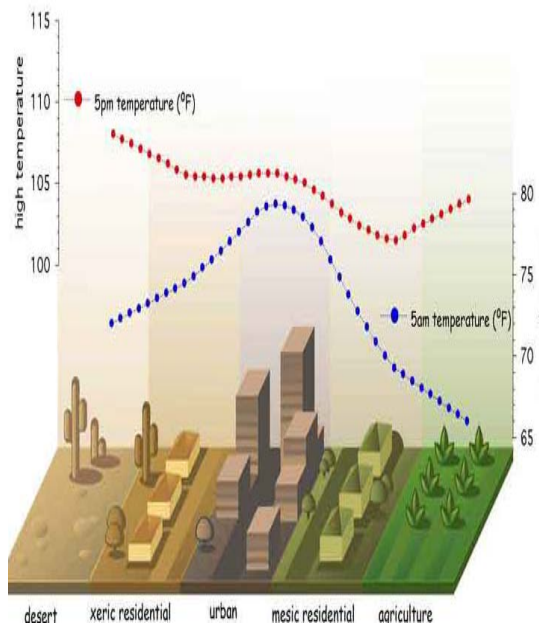
Roads either have Flexible pavement or have Rigid pavement. To construct & maintain such a dense network of roads we need heavy amount of raw materials. The conventional roads have some environmental concerns.

### II. ENVIRONMENTAL CONCERNS PERTAINING TO THE CONVENTIONAL ROADS

The roads used today are either Flexible pavement or Rigid pavement. Both of these pavements help in environment degradation. Both of these pavements are good absorber of heat & for the construction of both of these pavements exploitation of natural resources has to be done on large scale.

#### (a) Heat absorbing property- the "heat island" effect

In the flexible pavement chief constituent is bitumen which is a petroleum product. Due to obvious reason petroleum products are rich in carbon. The materials rich in carbon generally exhibit green house effect & bitumen is one of those materials. The heat absorbed by these pavements help in the increasing the temperature of the area nearby. This effect is called "heat island" effect. This effect is not confined to the Flexible pavement only but is exhibited by Rigid pavements also. Rigid pavements generally use Portland cement for their construction, which is again a good absorber of heat when converted into concrete or mortar.



Graph courtesy of the national Center of Excellence SMART Innovations for Urban Climate and Energy at Arizona State University.

### III. PLASTIC WASTE - AS A ROAD CONSTRUCTION MATERIAL

Owing to its properties, Plastic can be a good road construction material. The properties of the plastic which makes it a good road construction material are:

- **Castability-** Plastics generally have a low melting point & can be casted in any desired shape. This makes it a good recyclable material. In India alone approximately 8000 tonnes per day plastic wastes are recycled. The waste plastic can be melted & used for the making layers of pavement,
- **Water Repellent-** Plastic is a good water repellent. Plastic is a waterproof material. Therefore, the road made by plastic cannot be degraded due to water,
- **Excellent Binding Capacity-** Plastic is an excellent binder. It can be used to bind the aggregates together with excellent efficiency (even better than the bitumen) Roads constructed using waste plastic are called waste plastic roads,

### IV. WASTE PLASTIC ROADS

- Utilize the waste plastic thus disposing the waste plastic for some useful purpose,
- Are stronger,
- Are eco-friendly,
- Are more durable,
- Are more cost efficient,
- Consumes less amount of conventional raw materials,

## V. IMPORTANCE OF DRY PROCESS FOR PLASTIC TAR ROAD LAYING PROCESS

There are two processes for the laying of Plastic Tar Road & they are:

#### **Wet Process**

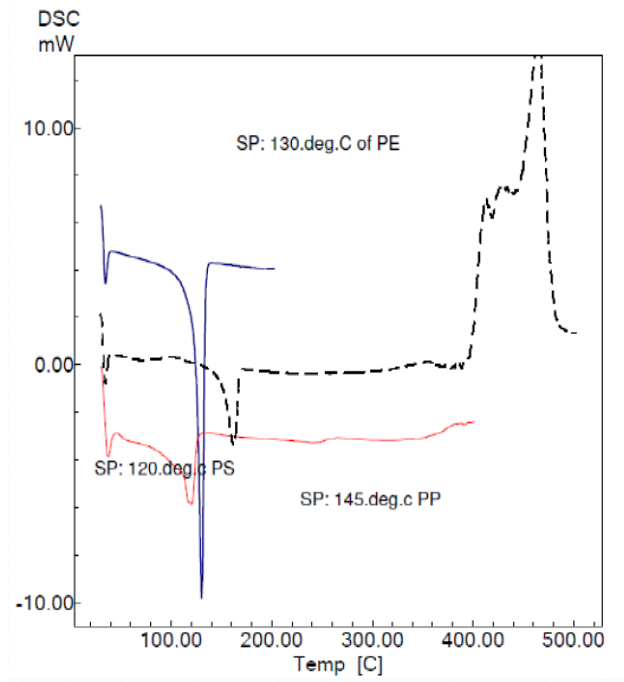
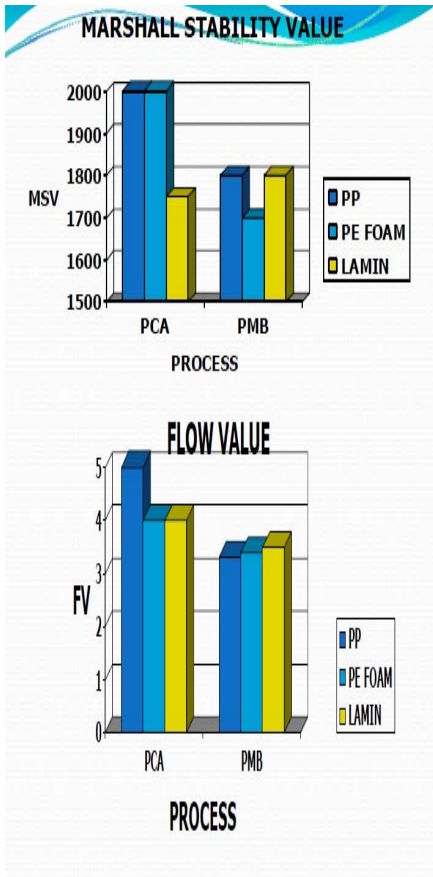
- Wet process is basically the polymer enriched/modified bitumen (PMB) process.
- In this process 3-4% molten plastic is mixed with the molten bitumen with the aim of increasing the binding capacity of the bitumen.
- Plastic roads mainly use plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction material.
- When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road.

#### **Dry Process**

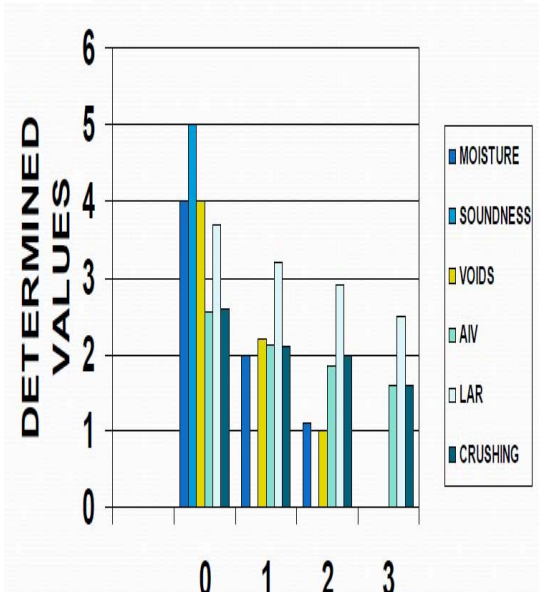
- This process is basically poly coated aggregate (PCA) process,
- In this process aggregate is heated to a temperature of 170 degree centigrade & the dry shredded plastic is then added to it which melts & gets coated over the aggregate thus transforming the aggregate into poly coated aggregate,
- Then this PCA is mixed with bitumen & this road mix is used for road laying at 110 degree centigrade.

## VI. ADVANTAGE OF DRY PROCESS OVER WET PROCESS

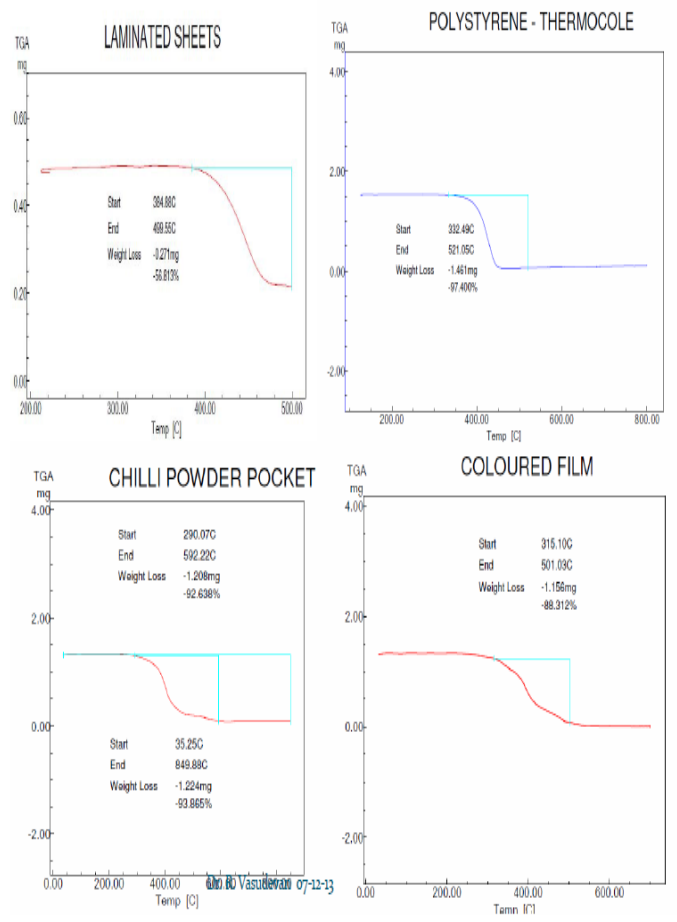
- No evolution of harmful gases as no burning of the plastic waste is done,
- Process is simple,
- Easy handling as the dealing is done with the normal dry shredded plastic waste unlike the wet process where the dealing is done with the hot molten plastic waste,
- No danger of uneven mixing of molten plastic & bitumen & hence loose binding of aggregate,

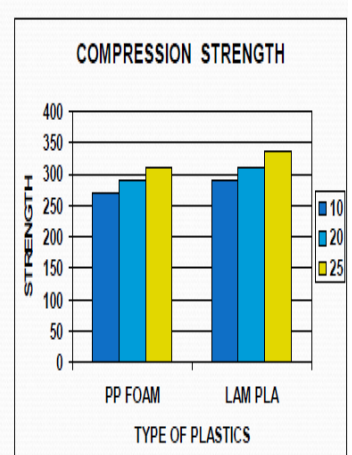
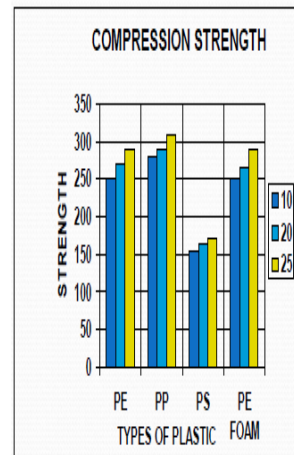
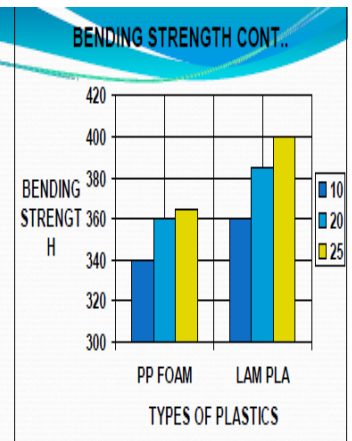
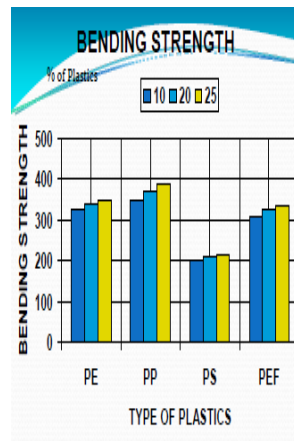
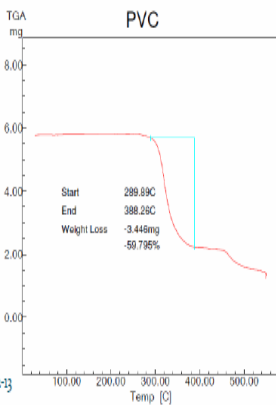
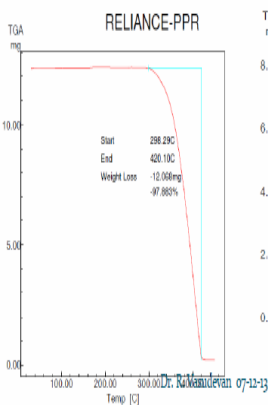
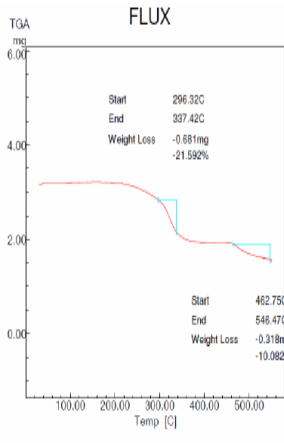
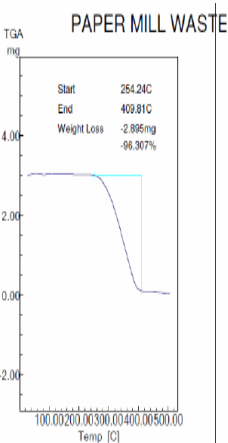
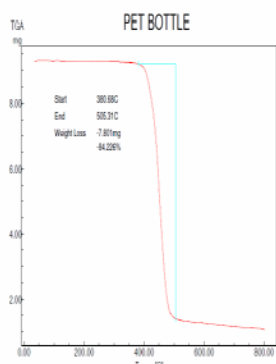
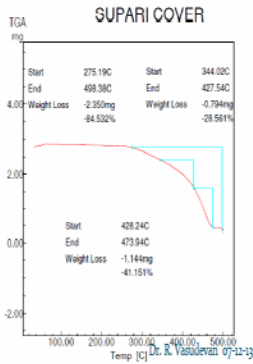
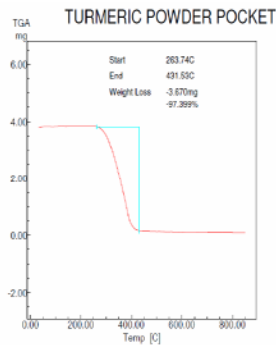
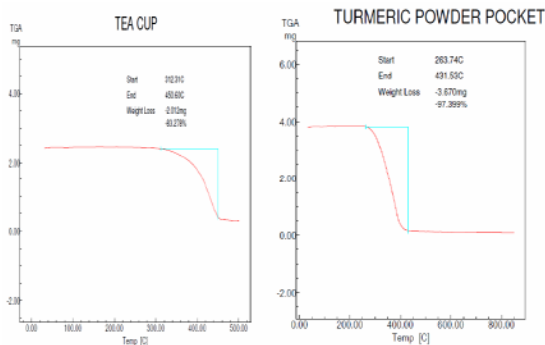


Softening point for virgin plastic- on DSC measurement



Variation in various properties with the increase in % plastic





## VII. POTENTIAL OF PLASTIC TAR ROAD IN DEVELOPING COUNTRIES

The WPRs absorb very less amount of heat compared to the ordinary flexible & Rigid pavements. The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. Roads laid with plastic waste mix are found to be better than the conventional ones. The binding property of plastic makes the road last longer besides giving added strength to withstand more loads. While a normal 'highway quality' road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years. Rainwater will not seep through because of the plastic in the tar. So, this technology will result in lesser road repairs. And as each km of road with an average width requires over two tonnes of polyblend, using plastic will help reduce non-biodegradable waste. The cost of plastic road construction may be slightly higher compared to the conventional method. However, this should not deter the adoption of the technology as the benefits are much higher than the cost. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. Already, a kilometre long test-track has been tested in Karnataka using this technology. The government is keen on encouraging the setting up of small plants for mixing waste plastic and bitumen for

road construction. It is hoped that in near future we will have strong, durable and eco-friendly roads that will relieve the earth from all type of plastic-waste.

**Scope of WPR**

With India producing 8000 tonnes recyclable plastic waste per day there is a huge scope of Waste Plastic Roads here. Municipal Waste Disposal is a serious concern in almost all Indian cities. Waste plastic roads absorbs lesser heat than the regular roads.

**VIII. METHODOLOG & DESIGN OF PROPOSED PLASTIC TAR ROAD**

**Methodology for Project**

Methodology for Project can be Divided into Four Parts:-

- **Process 1:** Plastics waste (bags, cups, thermocole) made out of PE (poly ethylene),PP(poly propylene)and PS(poly styrene) cut into a size between 2.36mm and 4.75mm using shredding machine, (PVC waste should be eliminated),
- **Process 2(a):** The aggregate mix is heated to 170°C and transferred to mixing chamber,
- **Process 2(b):** Similarly the bitumen is to be heated up to a maximum of 160°C to have good binding and to prevent weak bonding (Monitoring the temperature is very important),
- **Process 3:** At the mixing chamber, the shredded plastics waste is to be added. It get coated uniformly over the aggregate within 30 to 60 seconds, giving an oily look,
- **Process 4:** The plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction,
- The road laying temperature is between 110°C to 120°C,
- The roller used is 8-ton capacity.

**IX. CONCLUSION & RECOMMENDATION**

**Conclusion**



**Salient features of the Process**

- Multi layer films can be used
- No new machinery required
- No Industry Involvement
- No granulation or Powdering of plastics- only shredding
- In-situ process
- Eco friendly process
- Only stone is modified and not Bitumen
- Scraps can be used
- Value addition to waste plastics
- No need for land filling and Incineration

Additional to above advantages of the Dry Process Technique of the construction of the Flexible pavement using waste plastic, the process saves Rs. 96000 also.

The net cost of the proposed project comes out to be Rs. 7216200

**Recommendations**

**Benefits of laying plastic roads – Rural Roads**

1. Rural Roads- 24.5 lakhs Km if these roads are constructed as plastic tar roads – we need 24.5 lakhs tones of waste plastics!!!!!!-
2. We prevent nearly 75 lakh tones of Carbon Dioxide entering our atmosphere by burning waste plastics
3. We save 24.5 lakhs tons of bitumen
4. We save nearly Rs 12250 crores worth of bitumen
5. No maintenance cost for ten years
6. Total waste plastics used for packing material per in India is around 20 lakhs tones only.
7. The plastic available is insufficient for laying rural roads only.
8. In a nut shell the Government provides not only good roads but also uses all the waste plastics and reduces carbon dioxide – bitumen usage.
9. Not less than 20000 crores saved
10. To convert all roads in India to plastic roads we need import plastic waste from other countries
11. If all roads are converted in to plastic roads ???????????

## REFERENCES

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