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PLASTIC BITUMEN MIX ROAD

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ABSTRACT
Roads are the main system of transport which serves the house to house access to the people. The roads are given chief priority in the economy and the security of the country. The countries having no roads or fewer roads are still facing the problems.
Dr. Ahmad Khan an owner of a plastic company first thought that his product is not only a boon to the world but a big curse also. He first carried out tests to practically use the plastic in the road construction. He developed a technology in which he successfully used the plastic bitumen mix in patching of pot holes in roads.
This technology inspired many technicians and many more tests were performed for its use in the road construction. Dr.Vasudevan was one of those who successfully performed the tests and stated his patents for the construction of plastic bitumen mix roads using 10% plastic. The CRRI Delhi has also made a patent of using 8% plastic in the road construction.
The plastic bitumen mix roads serve the best for the roads construction as these material does not allow the pot holes to form and are much potholes resistant, there is literally not more than 10% stripping observed in the roads already constructed in Madurai, Pune, Chennai, etc.This roads are more beneficial in the areas like Mumbai where the roads are frequently facing potholes, rutting and stripping. This technology has best application in rural areas which face more problems related to soil like that of black cotton soil. If proper drainage layer is provided there is literally no pothole formation in the roads. This road construction technology is not very different than the ordinary method of road construction. The only difference is that the aggregate used in the mix design is coated with the molten plastic. The rest procedure from laying to compaction and design is similar to the ordinary method of road construction.

INTRODUCTION
Plastic in different forms is found to be almost 5% in municipal solid waste, which is toxic in nature. It is a common site in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. Due to its Bio-Degradability nature, it creates stagnation of water and associated hygiene problems.
In order to contain this problem, experiments have been carried out whether this plastic can be reused productively in the construction of roads.
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 binder is found to give higher strength , higher resistance to water and better performance over a period of time. Therefore, it is proposed that we must use waste plastic for construction of rural and urban roads.

K. Ahmed Khan is an Indian Scientist and Business man who made success in using waste plastic for road construction. He is the founder of KK Plastic Waste Management Pvt. Ltd. He along with his brother Rasool Khan, stung the protest to ban plastic, hit upon the idea of recycling plastic and mixing it with bitumen to lay roads . They have so far laid almost 1000 kms of roads in Lalbagh Road, Cunningham Road, Old Madras Road, etc.

The technology used in this road construction is still new and a proudly Indian developed method of road construction. The use of plastic in the construction of roads does not only prove to be economical but also is economically feasible. The environmental impact caused by the waste plastic is proposed to be reduced to a large extent by this method of reuse of the plastic waste. The reduced environmental impact and economy achieved by this method on a large scale is proposed to be beneficial for the development of the country.

SOLID WASTE FLOW CHART

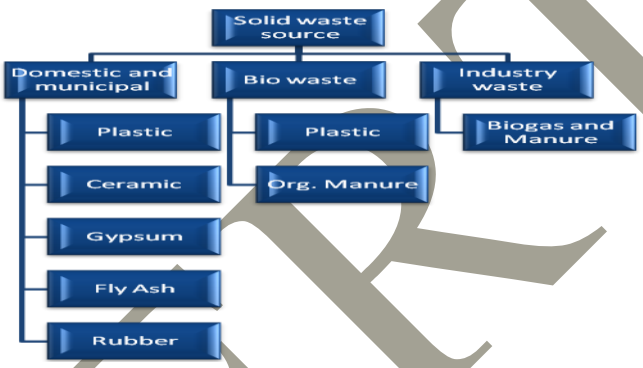

Fig 1. Solid Waste Flow Chart

SPECIFICATION FOR WASTE PLASTIC TO BE USED

The following types of waste plastic can be used in the construction of rural roads:

- Films (Carry bags, cups) thickness up to 60 micron (PE, PP and PS)
- Hard foams (PS) any thickness
- Soft foams (PE and PP) any thickness
- Laminated plastics thickness up to 60 microns (Aluminum coated also) packing materials used for biscuits, chocolates, etc.
- Poly Vinyl Chloride (PVC) sheets or Flux should not be used in any case.
- The waste plastic shall conform to the size passing 2.36 mm sieve and retained on 600 micron sieve.
- Dust and other impurities shall not be more than 1 percent. .
- To ascertain the ability of plastic to mix with the binder, the melt-flow value shall be tested as per ASTM D 1238-2010, for which the range shall be as follows:
    - For LDPE: 0.14-58 gm/10 min
    - For HDPE: 0.02-9.0 gm/10 min

ROAD PAVEMENT STRUCTURE

- Sub grade or formation
- Granular sub-base/ drainage layer
- Granular base course WBM

- Tack coat
- Premix carpet
- Seal coat

As per IRC SP-20 – 2002 (considering rainfall and traffic data)

1. SUBGRADE OR FORMATION

The finished and compacted surface of earthwork on which a road pavement rests is called sub grade or formation. The sub grade consists of loose and good quality soil that can be compacted to the required density which is greater than 15.2 kN/m^2 so that more than 95% of compaction can be achieved. The standard or modified proctor test can be used to find out the optimum moisture content to get the required density of the sub grade material. The soil if has a higher level of swelling should be stabilized properly. The material should be compacted by standard roller of 8 ton in layers of 50 – 100 mm thickness. The required camber should be given to the sub grade which is carried over to the last layer of the pavement. The sub grade supports the road pavement and also carries the entire load of pavement including the load of traffic. The maximum allowable size of soil aggregate is 50mm.

- **ESSENTIAL REQUIREMENTS OF SOIL PROPERTIES CONSIDERED SUITABLE FOR THE CONSTRUCTION OF SUBGRADE**
  - liquid limit to be less than 50 percent
  - plasticity index to be less than 25
  - non expansive soils with limited proportions of fines; expansive clays are not allowed in subgrade as well as 500 mm portion just below the subgrade.
  - Maximum laboratory density not to be less than 15.2kn/m^3.

2. GRANULAR SUB-BASE OR FORMATION

The granular sub-base course (GSB) has to serve as an effective drainage layer of the pavements and also has to sustain lower magnitude of compressive stresses than the base course. Therefore aggregates of lower strengths having good permeability may be used in the GSB layer. Crushed stone aggregates are often used in the GSB layer of important highways as this material has high permeability and serves as an effective drainage layer. Coarse graded aggregates with low percentage of fines (less than 5.0% finer than 0.075 mm size) will serve as good drainage layer. The GSB cum drainage layer is laid above the subgrade covering the full width of the formation between the longitudinal drains. The part of the rainwater which may enter in to the pavement layers through the shoulders or the pavement surface will get drained out quickly into the longitudinal or road-side drains. Thus it is possible to retain the subgrade and other pavement layers in relatively dry condition.

MATERIAL FOR GSB LAYERS

- Crushed stone aggregate
- Gravel
- Coarse sand
- Selected soil such as moorum with less fines

- **THE SPECIFIED REQUIREMENTS OF MATERIAL USED FOR GSB LAYER ARE**
  - Passing 0.425 mm sieve shall have liquid limit less than 25% and plasticity index less than 6.0%.
  - Fines passing 0.075 mm sieve, less than 10%.
  - CBR value not less than 20 to 25%

3. GRANULAR BASE COURSE

The granular base course is considered as the most important component of flexible pavement layer which sustains the wheel load stresses and disperses through larger area on the granular sub base layer below. A good base course enhances the load carrying capacity of the flexible pavement structure. Good quality coarse aggregate are generally used in the granular base course of flexible pavements. As per the specifications laid down by the Ministry of Road Transport and Highways, Govt. of India (MORTH), the aggregates used in the base course should have low aggregate impact value (less than 30%) and low Los Angeles abrasion value (less than 40%).

- **WATER BOUND MACADAM:**

The pavement base course made of crushed or broken aggregate mechanically interlocked by rolling the voids filled with screenings and binding material with the help of water. The thickness of each compacted layer of WBM layer depends on the size and gradation of the aggregates used. The three gradations namely grading-1, grading-2, grading-3 with different size range have been suggested by IRC and also by MORTH specification. Among this three gradations grading-1 contains the largest sizes of coarse aggregates and grading-3 the smallest.

- **MATERIALS:**
  - **COARSE AGGREGATES:**

For base course Los Angeles abrasion value to be less than 40% or aggregate impact value to be less than 30%

Table 1. Sieve passing of Aggregates

Grading Number	Size range, mm and layer thickness	Sieve size, mm	Passing the sieve by weight, percent
1	90 to 45 (100mm thick)	125	100
		90	90 to 100
		63	25 to 60
		45	0 to 15
		22.4	0 to 5
2	63 to 45 (75mm thick)	90	100
		63	90 to 100
		53	25 to 75
		45	0 to 15
		22.4	0 to 5
3	53 to 22.4 (75 mm thick)	63	100
		53	90 to 100
		45	65 to 90
		22.4	0 to 10
		11.2	0 to 5

- **SCREENINGS:**

The screenings are used to fill the voids in the compacted layer of coarse aggregates. The screenings consist of the same material as the coarse aggregates, but of smaller size. The grading requirements for screenings are given in table. Type-A screenings are to be used with the coarse aggregates grading-1; Type-B screenings may be used with coarse aggregate grading-3; either type- A or type –B screenings may be used with coarse aggregates grading -2. There is no need to use screenings in case of crushable type of coarse aggregates.

Table 2. Classification of Screening

Grading classification of screening	Size of screenings, mm	Sieve size, mm	Passing the sieve by weight, percent
A	13.2	13.2	100
		11.2	95 to 100
		5.60	15 to 35
		0.18	0 to 10
B	11.2	11.2	100
		5.60	90 to100
		0.18	15 to 35

- **BINDING MATERIAL**

Binding material consisting of fine grained material passing 0.425mm sieve is used in WBM construction to prevent raveling of the stones. Kankar nodules or lime stone dust may also be utilized, if locally available. The plasticity index of binding material should be less than 6.0 in the case of WBM layers used as base course. If the screenings used of crushable material like moorum or soft gravel, there is no need to apply binding material, unless the plasticity index value is less than 4.0.

4. TACK COAT

Tack coat is the application of small quantity of liquid bituminous binder of low viscosity over either a primed granular surface or over an existing bituminous or cement concrete surface. Application of tack coat is also an important part of preparations before laying a bituminous pavement layer over any other pavement layer. The main objective of tack coat is to provide adequate interface bond between the receiving pavement surface and the new bituminous layer being overlaid. The binder of the tack coat is not expected to penetrate into the pavement surface and plug the voids

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- **QUALITY OF MATERIAL FOR TACK COAT**

Cationic bitumen emulsion of grade RS-1(rapid setting) or suitable paving bitumen of low viscosity such as VG-10 grade bitumen may be used as tack coat material. The emulsion type is mostly preferred as it is more economical. The emulsion type binder is laid at a rate of 25kg/100m^2 whereas the bituminous tack coat is laid at the rate of 50kg/100m^2.

5. OPEN GRADED PREMIXED CARPET

Open graded premix carpet consists of coarse aggregates of nominal size 13.2mm (passing 20mm and retained on 10mm) premixed with a suitable type and grade of bituminous binder and pre coating it with plastic of size less than 50 micron, spread and compacted to a thickness of 20mm followed by the application of seal coat, to serve as a thin surface course of the pavement. Being an open graded construction, the PC layer shall invariably be covered by a suitable seal coat immediately or as soon as possible, but before exposing the surface to rain or traffic.

- **MATERIALS FOR PREMIXED CARPET**
  - **BITUMENOUS BINDER**

Either paving grade bitumen or modified bituminous binder is used for the preparation of hot mix for open graded premix and also for the seal coat. The grade of bitumen binder may be 80/100, 60/70, 30/40 (equivalent to VG-10, VG-30, VG-40 respectively). The grade used in the project preparation is VG-40. Total quantity of bitumen binder required for the preparation of the premix of both the sizes of coarse aggregates is 1.46kg/m^2 of road area.

  - **PLASTIC REQUIRED**

The plastic to be used for the aggregate coating prior to the mixing of hot bitumen should be of a size less than 50 micron. The lesser size of plastic is required because the larger the size of plastic the higher temperature of softening point it has, so the plastic having size lesser than that of 50micron can get melted while heating of the aggregates. The PVC plastic is avoided in the construction as it is harmful for the environment as it emits dioxin on heating. The plastic should be shredder to the size of 2.5mm to 4mm pieces to ease its melting and application. The plastic in a central batching plant can be added to the aggregate on the conveyor itself. The quantity of plastic is 10% by weight of bitumen used i.e., 0.146kg/m^2 area of the road.

  - **AGGREGATES REQUIRED**
    - Impact value <30%
    - Flakiness index <25%
    - Stripping value <10%
    - Water absorption <2%.

Angular fragments of clean and hard variety of crushed gravel are used as coarse aggregate for the construction of open graded premix carpet surface course. Two size of coarse aggregates are mixed and used, namely

1. 0.18m^3 aggregates of nominal size 13.2mm(passing 22.4mm and retained on 11.2mm sieve) and
2. 0.09m^3 of aggregate of nominal size 11.2mm (passing 13.2mm and retained on 5.6mm sieve)

Per 10m^2 area for the construction of open graded premix carpet surface course.

6. SEAL COAT

For the application of seal coat or 'liquid seal coat', 0.09m^3 of fine aggregates of nominal size 6.7mm (passing 11.2mm and retained on 2.8mm sieve) is used per 10m^2 area of seal coat to be applied over the premix carpet layer. The quantity of liquid binder required for the application of type-A seal coat is 0.98 kg per 1m^2 area.

BENEFITS OF LAYING PLASTIC BITUMEN MIX ROADS

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

CASE STUDIES IN INDIA

- In Tamil Nadu, length of roads around 1000 m in various stretches were constructed using waste plastic as an additive in bituminous mix under the scheme "1000 km Plastic Road", and found that, the performance of all the road stretches are satisfactory.
- The performance of the road stretches constructed using waste plastic in Bangalore (Karnataka) is also found to be satisfactory. More than 2000 km have been laid so far.
- In Delhi a number of test sections about 50 km were laid and most of them are performing well.
- The plastic bitumen mix road constructed in Pune on Golibar maidan is a single lane road costing about Rs. 350/m^2.

CONCLUSION

Here we conclude that the innovative concept of using a plastic bitumen mix road in a place which does not carry heavy traffic is quite economical. The project becomes effective in not only the economical perspective of the development of the country but also the environmental preservation. The technology implemented does not only give a low cost benefit but also give a maintenance benefit.

This technology becomes a boon to the environment as we are using a lot of garbage which used to be dumped or burned leading to air, land and water pollution. This technology without affecting the aesthetics traditions and equipments requirement serves a better road for the people in the vicinity.

The equipment requirement of this road is similar to that of the ordinary road and hence no further costs are incorporated. Thus in order to construct the road no further training of the labors for the handling of new product is required.

The project shows the innovative vision towards the infrastructure development of the country and hence is sure to be widely accepted in the near future. Being in the experimental stage it has shown excellent results and hence is ought to be accepted for the future projects too.

Thus here we conclude that the road will serve the tenure of its construction for the betterment of the people residing in the vicinity of the road. And serve a good property value for the future projects proposed by the construction agencies sharing the route.

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