

Bituminous pavement recycling

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Introduction

The bituminous pavement rehabilitation alternatives are mainly overlaying, recycling and reconstruction. In the recycling process the material from deteriorated pavement, known as reclaimed asphalt pavement (RAP), is partially or fully reused in fresh construction. Some of the advantages associated with pavement recycling are (i) less user delay (ii) conservation of energy (iii) preservation of environment (iv) reduced cost of construction (v) conservation of aggregate and binder (vi) preservation of existing pavement geometrics etc. It is also reported that recycled mix has higher resistance to shearing and scuffing, which in turn increase the rutting resistance [1]. Chances of reflective cracking are found to be less with recycled mix [2].

Bituminous pavement recycling technology is not yet a popular in India. However, in advanced countries, bituminous material is the most recycled material in the construction industry. For example, in USA, 33 million tons of RAP is used per year for recycling purpose which is around 80% of the total amount of RAP collected from old bituminous pavements [3]. The amount of RAP used for recycling per year is about 0.84 million tons in Sweden, 7.3 million tons in Germany, 0.53 million tons in Denmark and around 0.12 million tons in Netherlands [3]. In the year 1995, 20 million tons of recycled hot mix was produced in Japan, which constituted 30% of the total hot mix production [4].

The RAP, as mentioned earlier, is a deteriorated bituminous mix that contains aged bitumen and aggregates. Hence, its performance is poorer when compared to the fresh mix. The purpose of the bituminous recycling is to regain the properties of the RAP, such that it tends to perform as good as fresh mix. Thus, the process of bituminous recycling involves mixing of the RAP, fresh bitumen, rejuvenators and new aggregates in suitable proportions. Rejuvenators are low viscosity oily substance, which helps to bring down the high viscosity of aged bitumen. The present article intends to discuss briefly the various possible methods of bituminous pavement recycling.

Recycling Methods

Based on the process adopted in recycling the bituminous mix, it can be broadly classified as central plant recycling and in-situ recycling. If the RAP is modified at a plant, away from construction site then the process is known as central plant recycling. In-situ recycling process the RAP modified in place, where from it is available. Further, the RAP could be heated to condition it. If heat is applied then the process is known as hot mix recycling. In case of cold mix recycling, old materials are conditioned using recycling agent (like, low viscosity emulsion) without application of heat. The classification system is presented schematically in Figure 1.

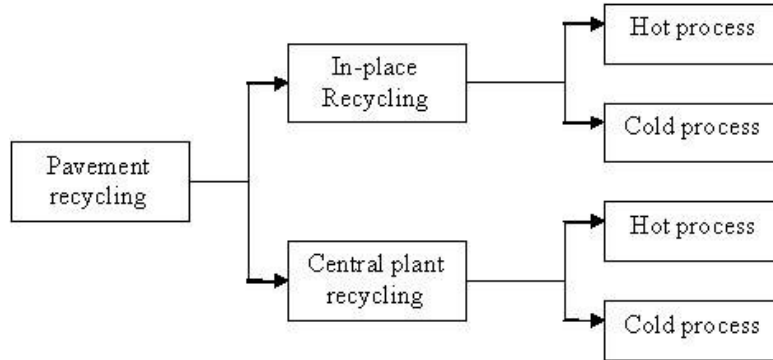


Figure 1: Classification of recycling methods based on processes

Another way of classification could be based on the depth of the old pavement removed [5]. If the top layers of pavement fail, then the upper layers are removed and laid again. This process is known as surface recycling. However, if base failure occurs then the pavement layers up to base layer is removed and constructed again. This process is known as full depth reclamation. The following paragraphs elaborate further the various recycling processes based on the classification scheme presented in Figure-1.

Hot in-place recycling

Initially the pavement intended to be recycled is heated to a higher temperature using suitable heating arrangement. This facilitates easier removal of materials. After heating, the pavement surface is scarified to the required depth. Further, depending on the requirement fresh aggregate and binder are added. The material is mixed well and compacted to the required thickness. As this process consumes less time, least disruption to traffic is caused. Also the transportation cost is less, as materials need not be taken away. Machinery required for this purpose being bulky in nature, sufficient right-of-way is required. This becomes an important consideration for in-place recycling within the city areas [6].

Cold in place recycling

In cold in-place recycling process, first, the pavement is scarified with a scarifier. The scarified material is crushed to the required gradation. Then the required amount of fresh aggregates and binder in cold form (emulsion or cutback) is added. It is compacted and left for aeration. During this process additives like, cement, quick lime, fly ash may be used. The cold mix recycling takes care of local geometric correction, correction of pavement distresses like surface cracks [7]. Being an in-situ process the hauling cost is considerably low. The air quality related problems during construction is almost negligible as compared to hot mix process [2]. Similar to hot in place recycling process the machinery required being bulky, sufficient maneuvering space should be available for operating the equipment. Also, the lane needs to be closed for certain time so that sufficient time is available for curing of freshly laid course. Moisture content (when bitumen emulsion is used) needs to be given importance as it influences gradation control, mixing and workability of recycled mix to a large extent [7].

Hot central plant recycling

In this process, RAP is combined with required quantity of bituminous binder, and fresh aggregates in a hot mix plant. The resultant mix is heated to an elevated temperature and mixed thoroughly. The hot mix is transported to paving site, placed, and compacted to the required compaction level. The main advantage of this process is that the mix properties and performance is comparable to that of virgin mix [8]. Epps *et al.* [5] have noted that the quality control in this process is better when compared to hot in-place recycling. As RAP is susceptible to moisture, care needs to be taken while storing it. Less workspace is required for laying the recycled mix, hence this is suitable for the roads where the right-of-way is somewhat restricted. The RAP should not be exposed to extremely high temperature as it causes pollution due to smoke emission [1, 8].

Cold central plant recycling

This is the similar process as is the hot central plant mixing, except it does not involve any heating, and therefore emulsion bitumen is used binder in most of the cases. Precise control on the mixing time is important, over-mixing may cause premature breaking of emulsified bitumen, under-mixing results in insufficient coating of aggregates.

Closure

This article has described briefly the various processes of bituminous pavement recycling and their relative advantages and disadvantages. Pavement recycling technique is an excellent way of rehabilitation of deteriorated pavements. With reference to Indian context – (i) depleting natural resources, (ii) unwanted increase of road elevation due to periodical overlay (specially with the city roads), (iii) disposal problem with the RAP etc. necessitate adoption pavement recycling techniques in near future.

References

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