

Road Recycling Methods and Failure Criteria for Pavements

Some Important Terms:

Asphalt refers to the bituminous substance used to bind aggregate together to make asphalt concrete (AC). The aggregate makes up the bulk of the AC, while the asphalt binder comprises about 5 to 7 percent.

Reclaimed asphalt pavement (RAP) is used AC pavement that has been processed.

Recycled asphalt concrete (RAC) is the product of mixing RAP with new aggregates, asphalt and/or recycling agent.

A recycling agent is used to soften and rejuvenate the existing asphalt pavement.

Pavement's top layer is made of portland cement concrete (PCC) or AC. The pavement is supported by the base and sub-base, which consist of aggregate and other materials. The pavement can be crushed and used as recycled aggregate base or, if it is AC, it can be reprocessed into RAC.

Cold planing, also called cold milling, is the removing or milling of a layer of pavement by a cold planing machine. The exposed surface can be used temporarily as a driving surface and is usually overlaid with new material.

Road Recycling Methods

Purpose

Roads are rehabilitated to correct deficiencies such as rutting, cracking, brittleness, irregular shrinkage, and aggregate stripped of asphalt.

The following are the methods of roadway rehabilitation (i.e., recycle old pavement into new).

Cold, In-Place Recycling:

The pavement is removed by cold planing to a depth of 3 to 4 inches. The material is pulverized, sized, and mixed with an additive. New aggregate may be added to modify RAP characteristics. An asphalt emulsion or a recycling agent is added. Then, the material is placed and compacted. An additional layer is optional, such as a chip seal, or 1 to 3 inches of hot-mix asphalt.

A 3-piece "train" may be used, consisting of a cold planing machine, a screening/crushing/mixing unit, and conventional lay down and rolling equipment. This "train" occupies only one



lane, thus maximizing traffic flow. According to the Asphalt Recycling and Reclaiming Association, cost savings can range from 20 to 40 percent over conventional techniques. Because no heat is used, energy savings can be from 40 to 50 percent.

Hot Recycling:

At a central plant, RAP is combined with hot new aggregate, and asphalt or a recycling agent to produce AC, using a batch or drum plant. The RAP is usually obtained from a cold planing machine, but could also be from a ripping/crushing operation.

Hot, In-Place Recycling:

The pavement is softened by heating, and is scarified or hot milled to a depth of 3/4 to 1-1/2 inches and mixed. New hot mix material and/or a recycling agent is added in a single pass of the machine. A new wearing course may also be added with an additional pass after compaction.

Hot Mix—Remixing:

The road is heated to 1-1/2 to 2 inches, and the existing AC is removed to that depth. It is then mixed with new mix and/or rejuvenating agents and laid as a single course.

Hot Mix—Repave:

This method is the same as remixing, but it is overlaid with new hot mix.

Hot Mix--Heater Scarification:

This method is appropriate for roadways that have a stable and structurally adequate base. The road is heated, scarifiers scrape and loosen the pavement, rejuvenating agent is applied, and the surface is leveled in preparation for the addition of a final, thin, wearing course.

Full-Depth Reclamation:

All of the asphalt pavement section and a portion of the underlying materials are processed to produce a stabilized base course. The materials are crushed and additives are introduced; the materials are then shaped and compacted, and a surface or wearing course is applied.

Failure Criteria for Pavements

Flexible Pavement:

- Failure condition (In Britain): max. 25 mm deformation in the wheel tracks with respect to original level of pavement. Optimum condition for remedial works: 15 to 20 mm deformation. (Here remedial works mean provision of overlay or replacement of the surfacing)
- In practice, measurements are made with a 2 m straight edge. Failure condition is represented by a 20 mm gap under the straight edge. Optimum condition for remedial work: 12 to 18 mm gap
- According to AASHTO, failure condition for flexible pavement corresponds to PSI value between 2 and 2.5.

Rigid Pavement:

For concrete pavements in Britain a failure condition corresponding to a total length of cracking of 250 m per 100 m of lane width has been adopted. This includes all the following types of cracking:

- Hair cracks, which often become apparent only when the concrete is drying and which are normal features of concrete**
- Fine cracks, which are less than 0.5 mm wide at the surface of the concrete**
- Narrow cracks, which are between 0.5 and 1.2 mm wide at the surface**
- Wide cracks, of width exceeding 1.2 mm at the surface**

SELECTED SUBGRADE MATERIALS AND CAPPING LAYERS: (Road Note-31)

These materials are often required to provide sufficient cover on weak subgrades. They are used in the lower pavement layers as a substitute for a thick sub-base to reduce costs. The requirements are less strict than for sub-bases. A minimum CBR of 15 per cent is specified at the highest anticipated moisture content measured on samples compacted in the laboratory at the specified field density. This density is usually specified as a minimum of 95

per cent of the maximum dry density in the British Standard (Heavy) Compaction Test, 4.5 kg rammer. In estimating the likely soil moisture conditions, the designer should take into account the functions of the overlying sub-base layer and its expected moisture condition and the moisture conditions in the subgrade. If either of these layers is likely to be saturated during the life of the road, then the selected layer should also be assessed in this state. Recommended gradings or plasticity criteria are not given for these materials. However, it is desirable to select reasonably homogeneous materials since overall pavement behaviour is often enhanced by this. The selection of materials which show the least change in bearing capacity from dry to wet is also beneficial.