RECLAIMED ASPHALT PAVEMENT **User Guideline**

Granular Base

INTRODUCTION

Reclaimed asphalt pavement (RAP) can be used as granular base or subbase material in virtually all pavement types, including paved and unpaved roadways, parking areas, bicycle paths, gravel road rehabilitation, shoulders, residential driveways, trench backfill, engineered fill, pipe bedding, and culvert backfill.[1,2]

Although the use of RAP in granular base applications does not recover the asphalt cement potential in the old pavement, it does provide an alternate application where no other markets (asphalt paving) are available or where unsuitable material (such as soil or mud) may have been combined with the RAP so that it cannot be used as part of a recycled pavement.

PERFORMANCE RECORD

RAP that has been properly processed and in most cases blended with conventional aggregates has demonstrated satisfactory performance as granular road base for more than 20 years and is now considered standard practice in many areas. At least 13 state agencies (Arizona, Illinois, Louisiana, Maine, Nebraska, New Hampshire, North Dakota, Oregon, Rhode Island, South Dakota, Texas, Virginia, and Wisconsin) have used RAP as aggregate in base course. At least four state agencies (Alaska, New York, Ohio, and Utah) have used RAP as unbound aggregate in subbase, and at least two states (California and Vermont) have experience with RAP use in stabilized base course.[3]

In addition to the states listed above, it has also been reported that RAP has been used as a base course additive in Idaho and New Mexico, and as a subbase additive in at least 10 other states, including Connecticut, Georgia, Iowa, Kansas, Massachusetts, Minnesota, Montana, Oklahoma, Tennessee, and Wyoming.[4] It has further been reported that Kentucky has had some limited experience with the use of RAP in roadbase, although no information is available concerning its performance.[5]

Overall, the performance of RAP as a granular base or subbase aggregate, or as an additive to granular base or subbase, has been described as satisfactory, good, very good, or excellent.[3,4] Some of the positive features of RAP aggregates that have been properly incorporated into granular base applications include adequate bearing capacity, good drainage characteristics, and very good durability. However, RAP that is not properly processed or blended to design specification requirements may result in poor pavement performance. Increasing the RAP content results in a decrease in the bearing capacity of the granular base. In addition, where conventional granular material has been placed over processed RAP (and not homogeneously blended), the coarse granular material (sometimes referred to as float material) tends to ravel under traffic.[6]

MATERIAL PROCESSING REQUIREMENTS

Crushing and Screening

Stockpiled RAP must be processed to the desired aggregate gradation using conventional equipment consisting of a primary crusher, screening units, secondary crusher (optional), conveyors, and a stacker.

Blending

To avoid agglomeration of crushed RAP, it should be blended as soon as possible with conventional aggregate (using a cold feed system) to a homogeneous mixture. However, blended material that is stockpiled for a considerable period of time, particularly in warm weather, may harden and require recrushing and rescreening before it can be incorporated into granular base applications.

Stockpiling

Blended RAP-aggregate stockpiles should not be allowed to remain in place for extended time periods in most climates because the stockpiled material is likely to become overly wet, possibly requiring some drying prior to use.

Placement by In-Place Processing

In-place processing consists of self-propelled pulverizing units that break up and crush the existing asphalt concrete, (typically up to a depth of about 100 mm (4 in)) and underlying granular material to a total maximum depth of 200 mm (8 in) and thoroughly mix the materials in place. The depth of processing must be closely monitored since cutting too deep can incorporate subbase material while cutting too shallow increases the percentage of RAP in the blend.

ENGINEERING PROPERTIES

Some of the engineering properties of RAP that are of particular interest when RAP is used in granular base applications include gradation, bearing strength, compacted density, moisture content, permeability, and durability.

Gradation: The gradation for milled RAP is governed by the spacing of the teeth and speed of the pulverizing unit. Wider tooth spacing and higher speed result in larger particle sizes and coarser gradation. RAP can be readily processed to satisfy gradation requirements for granular base and subbase specifications, such as AASHTO M147.[7]

Bearing Strength: The bearing capacity of blended RAP is strongly dependent on the proportion of RAP to conventional aggregate. The bearing capacity decreases with increasing RAP content. The California Bearing Ratio (CBR) is reduced below that expected for conventional granular base when the amount of RAP exceeds 20 to 25 percent.[8] CBR values have been shown to decrease almost directly with increasing RAP contents.[6]

Compacted Density: Due to the coating of asphalt cement on RAP aggregate, which inhibits compaction, the compacted density of blended granular material tends to decrease with increasing RAP content.[6]

Moisture Content: The optimum moisture content for RAP blended aggregates is reported to be higher than for conventional granular material, particularly for RAP from pulverizing operations, due to higher fines content and the absorptive capacity of these fines.[8]

Permeability: The permeability of blended granular material containing RAP is similar to conventional granular base course material.[8]

Durability: Since the quality of virgin aggregates used in asphalt concrete usually exceeds the requirements for granular aggregates, there are generally no durability concerns regarding the use of RAP in granular base, especially if the RAP is less than 20 to 25 percent of the base.

DESIGN CONSIDERATIONS

The key design parameter for incorporating processed RAP into granular base material is the blending ratio of RAP to conventional aggregate that is needed to provide adequate bearing capacity. The ratio can be determined from laboratory testing of RAP aggregate blends using the CBR test method[9] or previous experience. It has been reported that blends of up to 30 percent asphalt-coated particles from RAP have been incorporated into blended granular base material.[10]

The presence of asphalt cement in the RAP, however, does have a significant strengthening effect with time. It has been reported that specimens with 40 percent RAP blended in granular base material have produced CBR values exceeding 150 after 1 week.[8] RAP produced by grinding or pulverizing has a lower bearing capacity than crushed RAP, due to the higher generation of fines.[11] As a result, for use in load-bearing applications, granular RAP is usually blended with conventional aggregates.

Conventional AASHTO pavement structural design procedures can be employed for granular base containing reclaimed asphalt pavement. The AASHTO Design Guide[12] is recommended for the thickness design of base course or subbase layers that contain RAP as a percentage of, or possibly even all of, the base or subbase. If the RAP is only a portion of the base or subbase material (less than 30 percent), the structural layer coefficient normally recommended for granular base materials (0.11 to 0.14) can be used. If the RAP constitutes a greater percentage, or even all, of the base or subbase material, some adjustment of the structural layer coefficient may be considered.

CONSTRUCTION PROCEDURES

Material Handling and Storage

Essentially the same equipment and procedures used to stockpile, handle, and place conventional aggregates in granular base are applicable to blended granular material containing RAP. For major projects where control of engineering properties is critical, controlled blending of the RAP with conventional granular material at a central plant provides better consistency than the product of in-place, full-depth processing.

Since each source of RAP will be different, random sampling and testing of the RAP stockpile must be performed to quantify and qualify the RAP. Samples of the stockpiled RAP should be used to determine the optimum blend of materials.[13] Additional care is required during stockpiling and handling to avoid segregation or re-agglomerating.

Placing and Compacting

Recycled asphalt pavement, which is recovered, crushed, screened, and blended with conventional aggregates, is placed as conventional granular material. Alternatively, in-place processing, which involves pulverizing the existing pavement and

thoroughly mixing the individual surface and granular base course layers into a relatively homogeneous mixture and recompacting it as granular base, can also be used.

Conventional granular aggregates do not bond well with RAP or blended granular material containing RAP. Consequently, raveling can occur if thin layers of conventional aggregates are placed over material containing RAP.

During placement, finish grading can be difficult because of the adhesion of asphalt in the RAP. Particular attention should be paid to obtaining adequate compaction to avoid postconstruction densification of granular base materials containing RAP.

Both blended granular material and pulverized material can be similarly compacted using conventional compaction equipment. It has been reported that compaction is improved if little or no water is used.(6)

Quality Control

The same test procedures used for conventional aggregate are appropriate for granular base/subbase containing RAP. The same field test procedures used for conventional aggregate are recommended for granular base applications when using RAP. Standard laboratory and field test methods for compacted density are given by AASHTO T191,(14) T205,(15) T238,(16) and T239.(17)

Testing of moisture content and compaction using nuclear gauges is affected by the presence of RAP. Both parameters tend to be overestimated because of the presence of hydrogen ions in the asphalt cement contributing to the total count. To avoid this problem, compaction of granular base containing RAP may be carried out using a control strip.(6) Laboratory moisture checks should be completed to calibrate nuclear density gauge moisture content readings.

UNRESOLVED ISSUES

There is a need to establish standard specifications for the incorporation of RAP into granular base and standard methods for determining in-place compacted density.

In addition, there is a need to resolve some environmental concerns regarding leachability characteristics for RAP, as well as various RAP-aggregate blends, in order to develop procedures for the stockpiling and placing of base or subbase materials containing RAP in situations where there may be groundwater contact.

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[Embankment or Fill] [Material Description] [Asphalt Concrete (Hot Recycling)] [Asphalt Concrete (Cold Recycling)]