PDHonline Course C184 (3 PDH)

Reclaimed Asphalt Pavement (RAP)

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RECLAIMED ASPHALT PAVEMENT **User Guideline**

Embankment or Fill

INTRODUCTION

In addition to recycling into asphalt paving or incorporation into bases or subbases, some reclaimed asphalt pavement (RAP) has been used for embankment construction. It can also be used as a fill material. When used as an embankment or fill material, the undersize portion of crushed and screened RAP, typically less than 50 mm (2 in), may be blended with soil and/or finely graded aggregate. Uncrushed or more coarsely graded RAP may be used as the embankment base.

Although the use of RAP in embankment construction does not take any advantage of the asphalt cement component, it does, nevertheless, provide an alternate application where no other markets for reuse are readily available, or where the RAP may be unsuitable for use in asphalt concrete pavement. The properties of RAP are largely dependent on the properties of the constituent materials and asphalt concrete type used in the old pavement.(1,2)

PERFORMANCE RECORD

Although use of RAP as an embankment construction material does not appear to be extensive, it has been reported that at least nine states have made some use of RAP for this purpose. States that have made use of RAP as an additive in embankment construction include Connecticut, Indiana, Kansas, Montana, New York, and Tennessee. States that have used RAP directly as an embankment base material include California, Connecticut, Illinois, Louisiana, and Tennessee.(3) The performance of RAP in these applications was generally considered to be satisfactory to good.

MATERIAL PROCESSING REQUIREMENTS

Crushing

Processing requirements for embankment or fill applications are minimal. Primary crushing may be necessary to satisfy gradation requirements. However, some jurisdictions permit the use of broken pieces of old asphalt pavement, provided the specified maximum size (similar to boulders) is not exceeded.

Blending

Crushed RAP is sometimes mixed with conventional earth fill materials or crushed aggregates and used in embankment construction.

ENGINEERING PROPERTIES

Some of the engineering properties of RAP that are of particular interest when RAP is used in embankment applications include gradation, compacted density, moisture content, shear strength, consolidation characteristics, permeability, durability, drainage characteristics, bearing strength, and corrosivity.

Gradation: The gradation of RAP is controlled by crushing and screening. The gradation and physical requirements of AASHTO M145(4) are usually readily satisfied by RAP or blends of RAP and soil or crushed aggregate. If used as an embankment base material, the maximum particle size of RAP will probably be less than 600 mm (24 in).

Compacted Density: Due to its asphalt cement content, the compacted unit weight of RAP (1600 to 2000 kg/m^3 (100 to 125 lbs/ft^3)) is likely to be somewhat lower than that of earth or rock.(5) The finer the RAP is crushed and sized, the higher its compacted density.

Moisture Content: The optimum moisture content for RAP-aggregate blends is reported to be higher than for conventional embankment material, particularly for RAP from pulverizing operations, due to higher fines generation.(6)

Shear Strength: The shear strength of RAP that has been crushed and sized will be based on internal friction, with little or no cohesion, and should be comparable to that of a similarly graded natural aggregate. RAP-aggregate blends should also have an internal friction angle in the same range as the natural aggregate. The shear strength of RAP-soil blends will likely be based mainly on internal friction, with little or no cohesion, and will be dependent on the relative proportions of the RAP and the soil.

Consolidation Characteristics: The compressibility or consolidation characteristics of RAP-soil blends will probably be within the range of a granular soil, depending on the gradation, moisture content, and proportion of soil added to the RAP. For coarsely graded RAP, or RAP-aggregate blends, the potential for compressibility should, for all practical purposes, be negligible.

Permeability: The permeability of blended RAP is similar to that of conventional granular material or soil-aggregate blends having similar gradation.[6]

Durability: Since the quality of virgin aggregates used in asphalt concrete usually exceeds the requirements for embankment/fill material, there are generally no durability concerns regarding the use of RAP in this application.

Drainage Characteristics: RAP is nonplastic, free draining, is not frost susceptible, and can be blended and compacted with other suitable fill materials.

Bearing Strength: The bearing strength of an embankment is mainly of importance only in the top 1 meter (3 ft), which is the portion of the embankment that provides the subgrade support for the pavement structure. The bearing strength of subgrade materials is usually determined by the California Bearing Ratio (CBR) test. The CBR value for RAP should be comparable to that of crushed stone of a similar gradation. The CBR of RAP-soil blends should be comparable to that of a well-graded granular soil. The top portion of an embankment will normally consist of soillike materials, with the coarser materials (crushed stone or rock) in the lower portions of the embankment.

Corrosivity: On the basis of limited testing results, RAP is considered noncorrosive.[7,8]

DESIGN CONSIDERATIONS

The design requirements for RAP in embankment construction are the same as for similar sized soil-aggregate blends, conventional aggregates, or shot rock fill. Where pieces of broken asphalt pavement are used as embankment base, size and placement restrictions should apply in the same manner as for boulders and cobbles. It is recommended that such uncrushed materials not be placed where they may have an impact on future construction activities. Some jurisdictions require that a minimum separation be maintained between watercourses and fill materials containing RAP to avoid submersion of RAP in water, which may or may not be a potential environmental concern.[9]

Design procedures for embankments or fill containing RAP are the same as design procedures for conventional embankment materials. The design should take into consideration slope stability, settlement or consolidation, and bearing capacity concerns. If the embankment is to be constructed using a blend of RAP with soil and/or crushed aggregate, a representative sample of the blended material should be tested, if possible, for triaxial compression[10] and California Bearing Ratio (CBR).[11] The maximum particle size for the triaxial test is 5 mm (No. 4 sieve). The maximum particle size for the CBR test is 19 mm (3/4 in sieve).

CONSTRUCTION PROCEDURES

Material Handling and Storage

The same methods and equipment used to store or stockpile conventional aggregates are applicable for reclaimed asphalt pavement.

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. Representative samples of the stockpiled RAP should be used in the optimum blend design.[2] Additional care is required during stockpiling and handling to avoid segregation or re-agglomeration.

Placing and Compacting

The same methods and equipment for compacting conventional fill can be used for compacting crushed RAP or blends of soil and RAP. It is reported that granular materials containing RAP appear to compact better if little or no water is used.[5] Where large, broken pieces of old asphalt pavement are incorporated in embankment construction, additional attention is needed during compaction to ensure that no large voids are formed within the fill that could contribute to subsequent long-term differential settlement. Standard laboratory and field test methods for compacted density are given by AASHTO T191, [12] T205,[13] T238, [14] and T239.[15]

Quality Control

The same field test procedures used for conventional soils or crushed aggregate materials are also appropriate for RAP, or blends of RAP and soils or crushed aggregates.

When RAP is used for construction of an embankment base or foundation material, compaction operations must be visually inspected on a continuous basis to ensure that the specified degree of compaction can be achieved, or that there is no movement under the action of compaction equipment. The construction of embankment bases or foundations containing rock or oversize materials usually requires a method specification, in which the procedures and type of equipment for placement and compaction are stipulated, but no testing methods or acceptance criteria are indicated.

UNRESOLVED ISSUES

Although RAP is not frequently incorporated into embankments, there is a need to establish standard specifications for the use of RAP in embankment construction, either by itself as an embankment base material, or blended with soil and/or crushed aggregate.

Although the available body of technical data indicate that RAP is a nonleachable material, there is a need to develop a procedure for stockpiling and placing of fill materials containing RAP in situations where there may be groundwater contact or concerns about runoff quality.

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[Material Description] [Asphalt Concrete (Hot Recycling)] [Asphalt Concrete (Cold Recycling)] [Granular Base]