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Standard Practice for Construction of Asphalt-Rubber Cape Seal¹

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1. Scope*

1.1 This practice covers asphalt-rubber cape seal, which is defined as the application of an asphalt-rubber seal coat placed onto an existing pavement surface, followed by the application of a conventional Type II or III slurry seal.

NOTE 1—An asphalt-rubber seal coat is also known as a stress absorbing membrane (SAM) which consists of an asphalt-rubber membrane seal followed by the application of precoated aggregate chips.

1.2 An asphalt-rubber cape seal is commonly used to extend the service life of low to medium trafficked and moderately distressed asphalt-surfaced pavements. The existing pavement condition can be used to determine the application rates for the asphalt-rubber binder and aggregate as well as the aggregate gradation. Pavements in relatively poor condition will require a coarser aggregate with a higher binder application rate.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.24 on Asphalt Surface Treatments.

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2. Referenced Documents

2.1 ASTM Standards:²

- C29/C29M Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
- C117 Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
- C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
- C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
- C131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
- D946 Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction
- D1139 Specification for Aggregate for Single or Multiple Asphalt Surface Treatments
- D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscometer
- D2419 Test Method for Sand Equivalent Value of Soils and Fine Aggregate
- D3381 Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
- D3910 Practices for Design, Testing, and Construction of Slurry Seal
- D4791 Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- D5360 Practice for Design and Construction of Bituminous Surface Treatments
- D5821 Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- D6114 Specification for Asphalt-Rubber Binder

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

D6373 Specification for Performance-Graded Asphalt Binder

D6433 Practice for Roads and Parking Lots Pavement Condition Index Surveys

3. Significance and Use

3.1 The procedure described in this practice is used to design and construct an asphalt-rubber cape seal that will provide a wearing course when subjected to low to medium traffic volumes and where the pavement distress is due to block-type cracking resulting from pavement aging or reflective cracking only (not where there are clear indications of fatigue cracking due to repeated heavy axle loads).

NOTE 2—Block cracking is defined in Practice **D6433**. See **Appendix X1** for an example of block cracking due to aging.

4. Materials

4.1 *Asphalt-Rubber Seal Coat (or Stress Absorbing Membrane—SAM):*

4.1.1 *Asphalt Cement*—The asphalt cement for the asphalt-rubber seal coat should comply with the requirements of Specifications **D946**, **D3381**, or **D6373**. Asphalt cement grade selection is based on considerations of local climatic and traffic conditions. The asphalt-rubber supplier should perform routine Q/C laboratory testing to ensure compatibility of the selected asphalt cement with the requirements of Specification **D6114**.

4.1.2 *Asphalt-Rubber*—The asphalt-rubber binder consists of an interacted blend of paving grade asphalt cement, ground recycled tire rubber, and other additives as needed to conform to the requirements of Specification **D6114**.

4.1.3 *Aggregate*—Aggregate consists of crushed materials conforming to the physical requirements of Specification **D1139** for degradation, soundness, and deleterious substances and, if the -4.75 mm [$-No. 4$] materials exceed 2 % of the total weight of aggregate, a minimum sand equivalent value of 50 when tested in accordance with Test Method **D2419** is required. At least 90 percent by weight of the coarse aggregate shall consist of crushed particles with at least two fractured faces as determined by Test Method **D5821**.

4.1.4 *Aggregate Gradation*—Aggregate size is often represented by one of the following gradations and determined in accordance with Test Methods **C136** and **C117**. Other similar gradations may be used, as appropriate.

Sieve Size	Percent Passing	Percent Passing
19.5 mm [$3/4$ in.]	100	100
12.5 mm [$1/2$ in.]	95–100	95–100
9.50 mm [$3/8$ in.]	0–20	70–85
4.75 mm [$No. 4$]	0–5	0–15
2.36 mm [$No. 8$]	0–2	0–5
0.075 mm [$No. 200$]	0–1	0–1

NOTE 3—The two examples shown in the table above are representative of typical gradations from current state highway or transportation departments or other user agencies and from industry specifications for asphalt-rubber seal coat. Either gradation may be used for pavements with block cracking (see **Appendix X1**). The first (predominately 12.5 mm [$1/2$ in.]) gradation is recommended for pavements with a high degree of block cracking. The second (predominately 9.5 mm [$3/8$ in.]) gradation is recommended for pavements with a lesser degree of block cracking (see Practice **D6433**, Figure X1.7 through X1.9).

4.1.5 *Selection of Coarse Aggregate*—Coarse aggregate shall have abrasion values of less than 30 % in accordance with

Test Method **C131**. Crushed gravel (if used) must have at least 90 percent particles with two faces and 95 percent particles with one face resulting from crushing in accordance with Test Method **D5821**. The percentage of flat and elongated particles should not exceed 10 %, with a ratio of 5:1 in maximum to minimum dimension, respectively, in accordance with Test Method **D4791**.

4.1.6 *Design*—Unless project documents indicate otherwise, the seal coat shall be designed in accordance with Practice **D5360** in general, modified for asphalt-rubber applications as described in this practice. The asphalt-rubber binder is spray-applied using an application rate specified in Section 5.1.2, followed by the application of aggregate chips using an application rate specified in 5.3.4.

NOTE 4—For more detailed asphalt-rubber seal coat design guidelines see the Caltrans Maintenance Technical Advisory Guideline (MTAG).³ Also shown in **Appendix X2** is a suggested FHWA asphalt-rubber surface treatment design procedure.

4.2 *Emulsified Asphalt Slurry Seal*—The design and construction of the slurry seal shall conform to Practice **D3910**.

5. Construction of Asphalt-Rubber Cape Seal

5.1 Application of Asphalt-Rubber Binder:

5.1.1 The following construction recommendations are representative of the state-of-the-art practice and are not a specification.

5.1.2 It is recommended that the asphalt-rubber binder for the asphalt rubber seal coat be applied at a rate of 2.0 to 3.0 L/m² [0.50 to 0.75 gallons/yd²]. For pavement classified in fair condition with a Pavement Condition Index (PCI) rating of 35 to 55 in accordance with Practice **D6433**, a lower application rate (generally with a finer aggregate gradation) is recommended and should generally range from 2.0 to 2.5 L/m² [0.50 to 0.65 gallons/yd²]. For pavement classified in poor condition with a PCI rating of 25 to 35 in accordance with Practice **D6433**, a higher application rate (generally with a coarser aggregate gradation) is recommended, generally in the range of 2.5 to 3.0 L/m² [0.65 to 0.75 gallons/yd²].

5.1.3 It is recommended that the Asphalt-rubber binder be placed upon a clean, dry pavement surface. The pavement surface temperature is generally limited to a minimum of 13°C [55°F] and rising when the asphalt rubber binder is applied. The recommended minimum atmospheric temperature should be 16°C [60°F] and rising.

NOTE 5—Placement of asphalt-rubber binder below the minimum temperatures may cool the material to such a degree that the aggregate may not embed and stick. This may lead to the premature loss of aggregate and bleeding or flushing of the surface.

5.1.4 Distributor bar height, distribution speed and shielding materials can be utilized to reduce the effects of wind on the spray distribution. Typically distributor bar height varies between 200 and 350 mm [8 to 14 in.].

NOTE 6—When high gusting winds or dusty conditions (or both) prevent or adversely affect binder or aggregate spreading application

³ Caltrans, Maintenance Technical Advisory Guide (MTAG), State of California Department of Transportation, Office of Pavement Preservation, Division of Maintenance, Sacramento, California, October, 2003.

operations, the work should be suspended and rescheduled.

5.1.5 All necessary equipment should be in position and ready to commence placement operations before starting the work.

5.1.6 The asphalt rubber binder is applied to the pavement surface after mixing and reacting, consistent with the requirements of Specification **D6114**. The binder should be applied at a material temperature not less than 195°C [385°F] or more than 215°C [415°F].

5.1.7 Following the asphalt-rubber binder application, the binder should be promptly covered with the pre-coated aggregate.

NOTE 7—Experience has shown that if more than 2 minutes elapse before the covering of the asphalt-rubber binder, the cover aggregate may not properly embed into the binder. This could lead to premature raveling or unsuitable bleeding or flushing (or both) of the pavement surface. Pre-coated aggregate as described in 5.3.1 is preferred in order to ensure a good bond to the asphalt-rubber binder and avoid aggregate chip loss.

5.2 *Workmanship, Finish, and Appearance:*

5.2.1 When joining edges against areas with aggregate, the joints should be swept clean of excess aggregate prior to the adjacent application of asphalt rubber binder. Transverse joints of this type are constructed by placing roofing paper or equivalent across and over the end of the previous asphalt rubber seal coat application. Once spraying has progressed beyond the paper, it should be removed immediately.

5.2.2 The longitudinal joint between adjacent applications of aggregate should coincide with the line between designated traffic lanes. Longitudinal joints are overlapped for complete coverage.

NOTE 8—Overlapping of longitudinal joints is recommended to ensure complete aggregate coverage. Lack of overlapping may result in exposed asphalt-rubber binder without aggregate, which may cause excessive tracking of the asphalt-rubber binder. Generally, overlapping is between 100 mm and 200 mm [4 to 8 in.].

5.2.3 At longitudinal joints with aggregate, the edges should be broomed back and blended to minimize differences in elevation, in order to provide a uniform appearance consistent with the adjacent sealed surface. Care should be taken to minimize ridges and depressions in order to enhance uniformity of appearance.

5.2.4 The application of asphalt rubber binder to areas not accessible with the distributor bar on the distributor truck is generally accomplished by using pressurized hand wands or by other appropriate means.

5.3 *Spreading Pre-Coated Aggregate:*

5.3.1 Following the application of the asphalt rubber binder, the pre-coated aggregate is placed over areas receiving asphalt rubber binder. The aggregate should be pre-coated using 0.5 to 1.0 % asphalt cement by weight of aggregate, conforming to Specifications **D946**, **D3381**, or **D6373**.

5.3.2 Aggregate for the asphalt rubber seal coat should be pre-coated at the hot plant at a temperature between 135°C and 165°C [275 to 325°F] and then applied at a temperature not less than 105°C (225°F) after applying the asphalt rubber binder.

5.3.3 No vehicle, including construction equipment, should be driven over the asphalt rubber binder prior to the application of the pre-coated aggregate.

5.3.4 The pre-coated aggregate is generally applied at a rate of 10.5 to 16.0 kg/m² [23 to 34 lbs/yd²] depending on the pavement condition. For pavement in fair condition with a PCI rating of 40 to 55 in accordance with Practice **D6433**, the finer 9.5 mm [$\frac{3}{8}$ in.] aggregate gradation (or a similar gradation) is recommended, with a spread rate of 10.5 to 13.5 kg/m² [23–30 lbs/yd²]. For pavement in poor condition with a PCI rating of 25 to 40 in accordance with Practice **D6433**, the coarser 12.5 mm [$\frac{1}{2}$ in.] aggregate gradation (or a similar gradation) is recommended with an spread rate of 12.0 to 16.0 kg/m² [27 to 34 lbs/yd²].

NOTE 9—Although an asphalt-rubber cape seal has been used on pavements in poor condition, the designer should consider many factors before such a surface treatment is employed on such a pavement. In particular, the poor pavement condition should be related to pavement aging and weathering, not traffic loads and fatigue cracking. All underlying subgrade or base failures (or both) should be corrected and any drainage problems should be rectified.

5.3.5 The spread rate is generally limited to any value within ± 10 percent of the selected application rate during spreading to provide a uniform appearance.

NOTE 10—The term “uniform appearance” refers to a surface that is generally free of gaps, ridges, depressions, or other irregularities caused by the application of the asphalt rubber seal coat.

5.4 *Finishing of the Asphalt-Rubber Seal Coat:*

5.4.1 The first pass of the rollers over the new asphalt rubber seal coat consists of a minimum of one complete coverage (covering the entire width of the seal, moving forward), using the necessary number of pneumatic tired rollers. Rolling should be completed as soon as practical using three complete passes, which is defined as the first rolling pass moving forward, a second pass moving backward, and a final third pass moving forward again to the next section thus covering each point on the pavement surface three times (up, back, and up).

NOTE 11—Rolling should occur immediately after the spreading of the pre-coated aggregate and should be concluded as rapidly as practical to ensure good aggregate embedment and bonding. The distance between the rollers and the aggregate spreader generally should not exceed 60 m [200 ft] at any time during spreading operations. Rollers should be staggered in such a manner so full-width rolling coverage is ensured.

5.4.2 In addition to the pneumatic tired rolling described in Section 5.4.1, one additional roller coverage with one steel wheel roller may be needed to properly seat the aggregate. Steel wheel rolling coverage may be beneficial in reducing the amount of loose aggregate during sweeping operations. If a steel wheel roller is used, the roller should be operated in the static mode only.

NOTE 12—The purpose of rolling the pre-coated aggregate is to ensure proper aggregate embedment into the asphalt-rubber binder. Rolling needs to take place as promptly as possible since, as the asphalt-rubber cools, it becomes increasingly more difficult to embed the pre-coated aggregate. If rolling is not done promptly, there is considerable risk that the pre-coated aggregate will not embed and adhere to the asphalt-rubber. This may in turn cause premature aggregate loss with its many attendant problems. Typically, the steel wheel roller weighs between 7.25 and 9 tonnes [8 to 10 tons].

5.4.3 Sweeping is generally carried out as a multi-step operation following final rolling of the aggregate. Loose aggregate should be removed from the roadway surface and abutting adjacent areas and should be properly disposed of.