Layer Coefficient Values for Cracked and Seated Concrete

Prepared for
Bureau of Technical Services

Prepared by
CTC & Associates LLC
WisDOT Research & Library Unit
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Request for Report

The Bureau of Technical Services is interested in identifying layer coefficient values used by state DOTs nationwide for cracked and seated concrete, in comparison with values used for rubblized concrete.

Summary

We distributed a survey to members of the AASHTO Research Advisory Committee for completion by appropriate staff at their agencies. The survey consisted of the following questions:

1. Does your state use a specific value, or range of values, for the layer coefficient of cracked and seated concrete? If so, how does it compare to your value(s) for rubblized concrete?
2. Who in your agency can WisDOT contact for more information?

Staff at 14 state DOTs responded to this survey. Key findings from the survey include:

- Almost half of states (43 percent) use crack and seat methods, with layer coefficients ranging from 0.25 to 0.40, with a mean of 0.30 and a median of 0.28.
- Values for rubblized concrete range from 0.14 to 0.29, with a mean of 0.21 and a median of 0.20.

The following chart summarizes these results. See **Survey Results** beginning on page 3 of this report for the full text of these survey responses.

State	Crack and Seat Layer Coefficient	Rubblized Concrete Layer Coefficient	Notes
Maryland	0.25	0.20	*Ranges of 0.20 to 0.35 and 0.15 to 0.30, respectively.*
Ohio	0.27	0.14	*Based on deflection data; currently evaluating rubblization performance and considering use of coarse rubblization.*

South Dakota	0.28	0.24	
North Dakota	0.29	N/A	*Does not use rubblization; 0.25 for break and seat.*
Arkansas	0.30	0.29	
Kansas	0.40	0.20	*Uses rubblization for reinforced pavements, crack and seat only for non-reinforced.*
Maine	N/A	0.20	*Has not used the crack and seat method in many years. Rubblized value from literature, not testing.*
Indiana	N/A	None given	*Has conducted a few research projects related to both methods; no structural number determined for crack and seat.*
California	N/A	N/A	*Does not use layer coefficients.*
Montana	N/A	None given	*Does not use layer coefficients. 0.4' overlay for crack and seat pavements.*
Georgia	N/A	N/A	*Has not used crack and seat or rubblization methods.*
Minnesota	N/A	GE of 1.5	*Uses a Gravel Equivalence (GE) of 1.5 for rubblized concrete; has done very little crack and seat.*
Illinois	N/A	N/A	*Does not use layer coefficients or crack and seat. Uses mechanistic-empirical approaches for rubblization.*
Mississippi	N/A	None given	*Has not used crack and seat (no answer with regard to rubblization).*
Mean	**0.30**	**0.21**	
Median	**0.28**	**0.20**	

Survey Results

The full text of each survey response is provided below. For reference, we have included an abbreviated version of each question before the response; for the full question text, please see the Summary on page 1 of this report.

Maryland

1. Layer Coefficient Values

Our range is 0.20 to 0.35, with a “desired” value of 0.25. For rubblized, the range is 0.15 to 0.30, with a “desired” value of 0.20.

2. Contact Information

Geoff Hall, P.E.
Chief, Pavement & Geotechnical Division
Office of Materials Technology
Maryland State Highway Administration
(443) 572-5067

Kansas

1. Layer Coefficient Values

The Kansas Department of Transportation uses the rubblization technique because we are primarily dealing with reinforced pavements. We would use crack and seat only on non-reinforced pavements. The layer coefficient for crack and seat is 0.40 and the layer coefficient for rubblized concrete is 0.20.

2. Contact Information

Andrew Gisi
Kansas DOT
(785) 291-3856
agisi@ksdot.org

Indiana

1. Layer Coefficient Values

We did a few research projects in the past related to cracked-and-seated and rubblized concrete. We did cracked-and-seated evaluation using Dynaflect equipment. There is no structural number determined from the research; we have only deflections. We have a rubblized concrete structural number that we determined from falling weight deflectomer.

2. Contact Information

Tommy E. Nantung
Section Manager
Indiana Department of Transportation
Division of Research and Development
(765) 463-1521, ext. 248
tnantung@indot.in.gov

California

1. Layer Coefficient Values

California does not use a layer coefficient for cracked and seated concrete or rubblized concrete. California uses a predetermined overlay design over cracked and seated pavement that is based on the truck traffic expected. Design is based on experience with reflective cracking. Rubblized concrete is treated as a high quality granular base and overlay above that is designed accordingly using Hveem design method for asphalt, and predetermined concrete tables for concrete.

2. Contact Information

Bill Farnbach
Caltrans
(916) 274-6188
bill_farnbach@dot.ca.gov

Imad Basheer
Caltrans
(916) 274-6176

Ohio

1. Layer Coefficient Values

We use a structural coefficient of 0.27 for cracked and seated pavement and a coefficient of 0.14 for rubblized pavement. See Table 401-1 in the Pavement Design & Rehabilitation Manual (http://www.dot.state.oh.us/Divisions/HighwayOps/Pavement/Pages/Publications.aspx).

The 0.27 for crack and seat came from an analysis of deflection data from some of our initial break and seat projects (18" pattern). The crack and seat pattern we are looking for is 4' x 4'.

The 0.14 for rubblization came from a comparison of the deflection on initial rubblization projects and the deflection on aggregate bases constructed at the same time. For rubblization, we are looking for pieces to not exceed 6".

We are currently evaluating the performance of our rubblized projects and considering an increase in the max size (called coarse rubblization by some states). I would be interested in seeing the results of your survey, please send a copy when completed.

2. Contact Information

Roger Green
Ohio DOT
(614) 995-5993

Maine

1. Layer Coefficient Values

MaineDOT has not used the crack and seat method in many years. We recently rubblized I-295, but used the MEPDG for the pavement design. I did a comparison using the AASHTO 1993 guide and I used a layer coefficient of 0.20 for the rubblized concrete, but this was taken from literature and not determined by MaineDOT through testing.

2. Contact Information

Karen Gross
Geotechnical/Pavement Engineer
Highway Program—Production Team
Bureau of Project Development
Maine Department of Transportation
(207) 624-3352

Montana

1. Layer Coefficient Values

In Montana we haven’t assigned a layer coefficient to cracked and seated concrete. Rather than use the AASHTO Pavement Design method, we typically place a 0.4' overlay over the cracked and seated pavement. We chose the 0.4' based on past experience and it has performed well on our Interstate pavements. If you have any more questions please contact me.

2. Contact Information
Dan Hill, P.E.
Montana Department of Transportation
Pavement Design Engineer
Pavement Analysis Section
(406) 444-3424
dahill@mt.gov

Georgia

1. Layer Coefficient Values
GDOT has not used crack and seat or rubblization

2. Contact Information
Georgene M. Geary, P.E.
State Materials and Research Engineer
Georgia DOT
(404) 363-7512
ggeary@dot.ga.gov

Arkansas

1. Layer Coefficient Values
Arkansas uses a layer coefficient of 0.3 for cracked or seated concrete, and we use a value of 0.29 for Rubblized Concrete.

2. Contact Information
Charles D. Clements, P.E.
Roadway Design Division Head
Arkansas State Highway and Transportation Department
(501) 569-2336

Minnesota

1. Layer Coefficient Values
Mn/DOT uses a Gravel Equivalence (GE) of 1.5 for rubblized PCC. We have done very little crack and seat.

2. Contact Information
Jerry Geib
Pavement Design Engineer
Materials & Road Research
(651) 366-5496
gerard.geib@dot.state.mn.us

Illinois

1. Layer Coefficient Values
Illinois does not use layer coefficients for pavement design. Based on research conducted for us in the early 1980s (http://ict.illinois.edu/Publications/report%20files/TES-038.pdf), it became apparent that structural layer coefficients were not constant values. Illinois instead began to explore mechanistic-empirical based methods of pavement design. We currently are using a mechanistic-empirical based approach to designing HMA overlays for rubblized concrete pavements as outlined in the attachment. [See Appendix A of this TSR.] We do not allow the use of the crack and seat method of pavement rehabilitation due to issues with not adequately breaking the bond between any reinforcing steel and the concrete pavement.

2. Contact Information
Amy M. Schutzbach, P.E.
Engineer of Physical Research
Illinois Department of Transportation
Bureau of Materials and Physical Research
(217) 782-2631

Mississippi

1. Layer Coefficient Values
Mississippi has not performed crack and seat on concrete pavements.

2. Contact Information
James C. Watkins, P.E.
State Research Engineer
Mississippi Department of Transportation
(601) 359-7650

North Dakota

1. Layer Coefficient Values
NDDOT does not use the rubblizing process. Crack and seat is used on non-reinforced PCC (layer coefficient: 0.29). Break and seat is used on wire mesh reinforced PCC (layer coefficient: 0.25).

2. Contact Information
Clayton Schumaker
NDDOT
(701) 328-6906

Tom Bold
NDDOT
(701) 328-6921

South Dakota

1. Layer Coefficient Values
South Dakota's layer coefficient values for the following Rehabilitated PCC Pavements:

- Cracked and Seated PCCP: 0.28 per inch.
- Rubblized PCCP: 0.24 per inch.

2. Contact Information
Gill L. Hedman
South Dakota DOT
Pavement Design Engineer
(605) 773-5503
gill.hedman@state.sd.us

SUBJECT: **Guidelines for Rubblizing PCC Pavement and Designing a Bituminous Concrete Overlay**

DATE: **June 1, 2001**

Applicability

These guidelines are to be followed to: (a) review the existing pavement structure, (b) identify design considerations, and (c) prepare a request for review and approval, for rubblizing PCC pavement and designing a bituminous concrete overlay.

Background

With many pavements nearing the end of their design lives, and extensive patching sometimes needed to rehabilitate a pavement section; rubblizing may result in both cost and time savings over standard techniques.

Rubblization is part of a rehabilitation process in which existing portland cement concrete (PCC) pavement is broken (in-place) into small pieces and compacted to create a uniform base. Rubblization should be considered as an alternative to extensive pavement patching with a standard bituminous concrete overlay or a thick, structural bituminous concrete overlay for PCC pavements with severe distresses.

The benefits of rubblization are: most patching of the existing PCC pavement is eliminated; a more uniform base is provided; reflective cracking of the bituminous concrete overlay, caused by rocking and thermal movement of PCC panels and poor load transfer, is minimized; and a moderately drainable base is produced.

These guidelines encompass the evaluation of an existing pavement structure to determine if the section can support the rubblizing construction process, and design and construction steps needed to successfully use this option. The use of rubblizing requires close attention to subgrade support. This technique requires sufficient thickness of the rubblized pavement and subbase structure to protect the subgrade during construction operations.

Procedures

The selection of rubblization with a bituminous concrete overlay should be the result of a thorough review of the existing pavement structure, design issues, and examination of other alternatives.

(a) Review of the Existing Pavement Structure

A thorough investigation of the existing pavement and subsurface should be conducted. The purpose of the investigation is to determine if the pavement section can be successfully rubblized. It is essential, that only constructible sections be selected for this rehabilitation option. This requires adequate support from the subgrade, subbase, and rubblized pavement section for construction activities. If conditions exist that would result in extensive removal and replacement of the existing pavement, or the subgrade is weak and would result in severe construction problems, the designer should consider other rehabilitation options.

(1) Preliminary Soils Review

Before ordering an extensive subgrade investigation, the designer should contact the District's Geotechnical Engineer to discuss the proposed rubblizing section. From the pavement cross section, soil maps, and typical Immediate Bearing Values (IBVs) of soils in the area; the designer and Geotechnical Engineer should determine if the rubblized section will protect the subgrade, as outlined in the Department's Subgrade Stability Manual.

If the rubblized pavement will not provide adequate cover for potentially soft subgrades, rubblizing should not be considered as an option. Rubblizing destroys the slab action of the PCC pavement; and if an unstable subgrade is encountered during construction, the pavement section may require expensive change orders to reconstruct.

If it appears that the pavement can be rubblized, then a detailed pavement and subsurface investigation is needed to verify constructability of the pavement.

(2) Detailed Pavement and Subsurface Investigation

After passing a preliminary review, the District may request Falling Weight Deflectometer (FWD) testing from the Bureau of Materials and Physical Research to assist in planning coring locations. A detailed pavement and subsurface investigation should be conducted and a report prepared to specifically address the following points:

- AC overlay thickness (if present).
- Subbase condition and thickness (if present).
- Subgrade IBV from Dynamic Cone Penetrometer (DCP) test.
- Subgrade soil samples (if needed for further evaluation).
- Survey of existing drainage conditions.
- All shoulders' ability to carry traffic while under construction.
- Identification of locations where pavement removal and replacement, or alternative rehabilitation is recommended.
- Subgrade stability during rubblization.

The District's Geotechnical Engineer should develop a coring, DCP, and soil sampling plan for the section. In general, a minimum of 1 core per lane every 0.8 km (2 cores per lane-mile) should be taken. If FWD testing is not obtained, a minimum of 1 core per lane every 0.4 km (4 cores per lane-mile) should be taken. Core locations should be in representative cut and fill locations, and staggered between lanes. Additional coring and testing may be needed to define limits of weak subgrade areas.

The condition of any recovered stabilized material should be noted as being sound (intact and like new), slightly deteriorated (20% or less unsound or missing material), or deteriorated (more than 20% unsound or missing material). The overall condition of the subbase should be reported as a percentage of cores in each of these groups (i.e. 60% - sound, 30% - slightly deteriorated, and 10% - unsound).

After the core is removed, the DCP should be run in the hole for subgrade IBV. It is preferable to record single blow increments, to a depth of approximately 750 mm (30 in.) below the bottom of the pavement. If a granular base exists, the DCP may be driven through it and the depth determined from the change in IBV. A 3- to 4-kg (6- to 8-pound) soil sample should be taken and stored in an air-tight container for later testing if required. Forms BC 435 and Mat 508A shall be used for documentation.

After the field survey is complete, typical IBVs should be developed, along with cross section data and condition of each layer. The data from each test location should be presented in table form including depth, penetration, and calculated IBV.

For the 300 mm (12 in.) of subgrade directly below the pavement, additional analysis is required. The top of the subgrade is broken into two layers, from 0 to 150 mm (0 to 6 in.), and 150 to 300 mm (6 to 12 in.). The average IBV is determined for each layer and plotted on Figure 1, using the pavement cross-section information. Once the data is plotted, a determination should be made as to what type of Rubblizing Method should be specified.

For very limited areas of very soft subgrades, the designer may remove and replace the pavement, omit rubblizing, or perform a cracking and seating operation (Bureau of Design and Environment Manual, Chapter 53) so the pavement can bridge weak subgrade areas where undercutting is not cost-effective. These areas should be identified on the plans. If it is found that several short or a few substantial segments of the project require omissions, or removal and replacement of the pavement; then other rehabilitations should be considered.

The pavement and subsurface report should include the following:

- Cross section of pavement section(s).
- Core soundness and condition.
- Summarized results of Subsurface Investigation.
- Data plotted on Subgrade Rubblizing Guide.
- Number and locations of transitions to meet mainline structures.
- Clearances for overheads.
- Utilities and culverts.
- Location of any buildings or structures within 15 m (50 ft) of the rubblization.
- Location and condition of underdrains.

(b) Design Issues

There are many design issues that must be considered before the project can be submitted for review and approval. These include equipment selection, drainage considerations, priming, bituminous concrete overlay thickness design, traffic control, and specification of material transfer devices (MTDs).

(1) Equipment Selection

A pavement breaker and self-propelled rollers are the major equipment necessary to rubblize a PCC pavement. The pavement breaker should be selected to meet the project's needs with respect to traffic control, staging, and subgrade support limitations. The following equipment characteristics should be considered when making a decision on breaker selection:

a. Method I - Multi-Head Breaker (MHB)

The MHB is a self-propelled unit with multiple drop-hammers mounted at the rear of the machine. The hammers are set in two rows, and strike the pavement approximately every 115 mm (4.5 in.). The hammers have variable drop heights and variable cycling speeds. The Model MHB Badger Breaker, manufactured by Badger State Highway Equipment, Inc., Antigo, Wisconsin (*http://www.antigoconstruction.com/*) is acceptable.

The equipment has the ability to break pavement up to 4 m (13 ft) wide, in one pass. The rate of production depends on the type of base/subbase material, and is approximately 1.6 lane-km (1.0 lane-mi) per day.

The Z-pattern steel grid roller, a vibratory roller with a grid pattern, must be used in conjunction with the MHB to complete the breaking process. A Z-pattern grid is attached transversely to the drum surface. This roller further breaks flat and elongated material into more uniform pieces. The vibratory roller is self-propelled, with a minimum gross weight of 9 metric tons (10 tons).

Method I should be specified if there is any question of the rubblized section's ability to support construction equipment. The rubblized section and subgrade still must be able to support compaction equipment and loaded trucks without rutting or dislodging the rubblized PCC pavement.

The MHB should be specified if the roadway is to remain open to traffic and encroachment into the adjacent lane cannot be accommodated. Encroachment of the MHB into the adjacent lane is similar to the rolling operation of bituminous paving.

The paving operation may work directly behind the breaking operation, in such a manner that the lane may be rubblized and overlaid for opening to traffic at the end of the day.

Caution should be used if buildings are within 15 m (50 ft) of the rubblizing operation, especially in an urban setting. Buildings which may be sensitive to vibration should be identified in the project report, with an alternate method of localized pavement breaking recommended. Alternate breaking methods, such as a skid steer mounted jack hammer, should be considered or pavement rubblizing omitted near vibration sensitive buildings.

Underground utilities and drainage structures must be identified for protection. An omission in the breaking operation may be required, over utilities and drainage structures. These omitted areas shall be broken with an alternate breaking method.

b. Method II - Resonant Frequency Breaker with High Flotation Tires

This method utilizes a resonant frequency breaker with tires, which have pressures below 415 MPa (60 psi). This allows operation on pavement sections that are thinner or have soft subgrades.

A resonant frequency breaker is a self-propelled unit that utilizes high frequency, low amplitude impacts with a shoe force of 8,880 N (2,000 lb) to fracture the PCC pavement. The shoe, or hammer, is located at the end of a pedestal, which is attached to a beam and counter weight. The breaking principle is that a low amplitude, high frequency resonant energy is delivered to the concrete slab, resulting in high tension at the top. This causes the slab to fracture on a shear plane, inclined at about 35 degrees from the pavement surface. The shoe, beam size, operating frequency, loading pressure and speed of the machine can all be varied.

The breaking begins at the centerline and proceeds to the outside edge of the pavement. The breaking pattern is approximately 200 mm (8 in.) wide, and requires 18 to 20 passes to break a 3.6 m (12 ft) lane width. The rate of production depends on the type of base/subbase material, and is about 1.0 lane-mi. (1.6 lane-km) per day.

The Resonant Breaker has very heavy wheel loads of 89,000 N (20,000 lb). The broken pavement, shoulder, and subgrade must be adequate to support multiple passes of the equipment. The Resonant Breaker encroaches 1.0 to 1.5 m (3 to 5 ft) into the adjacent lane to rubblize pavement near the center line. The pavement section/shoulder must be structurally adequate for traffic to be moved 2.0 to 2.5 m (7 to 8 ft) from the centerline and onto the shoulder. The use of the Resonant Breaker is best suited on roads that can be closed to traffic, and support the breaker's weight.

The Resonant Breaker produces limited vibrations. Caution should be used with vibration sensitive buildings that are within 3 m (10 ft) of the rubblizing operation.

Utilities or culverts within 150 mm (6 in.) of the PCC pavement bottom need to be protected, as described in Method I.

c. Method III - Resonant Frequency Breaker

This is the same basic machine as in Method II. However, it does not utilize the high flotation tires. This results in limiting usage as shown in Figure 1.

d. Method IV (Breaking device not specified)

This method can be specified if Methods I, II, and III could be used without restrictions to subgrade support, traffic, staging, or structures as noted above.

(2) Drainage Considerations

The Department's longitudinal underdrain policy (Design Manual, Chapter 53) should be followed. Underdrains are recommended, at a minimum, in sag areas of vertical curves. French drains, which are capable of draining the entire depth of the section, are acceptable for isolated areas. For sections where underdrains will not be installed, the designer should consider limiting the amount of time the rubblized pavement may be left without an overlay, to minimize delays from rain saturation. If existing underdrains are functioning, no additional drainage features are necessary.

(3) Priming

The rubblized surface should be overlaid without priming. Priming adds an extra step and curing period, which delays construction with no benefit to the finished product.

(4) Bituminous Concrete Overlay Thickness Design

a. Overlay Thickness Design Based on Actual Traffic

The designer should determine the required Traffic Factor (TF) needed for the design period [as noted in Section 54-5.01(g) of the Design Manual], using a recommended design period of 20 years. Design periods less than 10 years should not be considered. The bituminous overlay needed on top of the rubblized section is determined using attached Figure 2. All designs are rounded up to the next 5 mm (0.25 in.). The design thickness, as a function of district location and traffic factor, is determined as follows:

1. Districts 1 and 2

Use the thickness line for "Districts 1 and 2."

2. Districts 7, 8 and 9

Use the thickness line for "Districts 7, 8, and 9."

3. Districts 3, 4, 5 and 6

Interpolate the pavement thickness based on the location of the proposed pavement section, in relation to the thickness lines for "Districts 1 and 2", and "Districts 7, 8, and 9".

b. Minimum Bituminous Concrete Overlay and Lift Thicknesses

The minimum bituminous concrete overlay thickness for rubblized pavement is 150 mm (6 in.). The first lift of the overlay should be 75 to 100 mm (3 to 4 in.). This thickness allows good compaction on and minimizes dislodging of the rubblized base. The surface lift should be 50 mm (2 in.). For pavement overlays which are 175 mm (7 in.) or less, surface lifts of 38 mm (1.5 in.) are allowable. Contact the Bureau of Materials and Physical Research if first lifts less than 75 mm (3 in.) are desired.

(5) Traffic Control

Traffic may be maintained during much of the rehabilitation operation. The road may be used after the installation of underdrains and the milling of any existing bituminous concrete overlay. The safety of open trenches, lane to lane drop-offs, high shoulders, and the condition of the exposed pavement surface should be considered when determining if the road can be reopened to traffic.

No traffic (including unnecessary construction traffic) should be allowed on the fractured pavement surface once the breaking operation begins. All bituminous concrete binder lifts should be paved before traffic is allowed onto the section. If staging requires that the pavement be opened to traffic before all the binder layers are in place, contact the Bureau of Materials and Physical Research to review the structural impacts.

Edge differentials in elevation of rubblized pavements can be substantially greater than standard overlays, and may require additional traffic control measures. The designer should evaluate the overall design and traffic staging to determine if any additional traffic control may be required. The designer should also evaluate differentials in elevation if milling to bare pavement is needed.

(6) Specification of Material Transfer Devices (MTDs)

The use of MTDs on the rubblized base must be evaluated on a case by case basis, due to the weights and axle configurations of the equipment. Contact the Bureau of Materials and Physical Research to perform an analysis.

(7) Construction Sequence

The general sequence of construction should be as follows:

- Install underdrains or French drains, as required.
- Remove any existing bituminous concrete overlay to the staged width.
- Remove and replace any existing unsound bituminous repair materials.
- Rubblize the pavement.
- Compact the broken pavement.
- Pave the binder lifts of the bituminous concrete overlay.
- Allow traffic on sections which have adequate thickness, as shown on the plans (if needed).
- Pave the surface of the bituminous concrete overlay.

(8) Other Design Issues

Any bituminous material on the pavement from pothole patching may be left in place. If there are any full-depth bituminous concrete patches in the section, soundness of the patch material should be determined. Bituminous concrete patches should be rated in the same manner as subbase in Section (a)(2). Visually indeterminate patches may be investigated with a limited coring program. If a bituminous concrete patch is unsound, the material should be removed. When traffic is maintained during the patching operation, the replacement material should be a Class C or D patch. If concrete is the replacement material, it shall be rubblized.

If the unsound patch is greater than 1 sq m (10 sq ft), bituminous concrete binder mixture shall be used. When the road is closed to traffic and the unsound patch is less than or equal to 1 sq m (10 sq ft), the replacement material may otherwise be aggregate. The aggregate shall be a Class D Quality (or better) crushed stone, crushed slag, crushed concrete, or crushed gravel meeting a CA 6 or CA 10 gradation; according to Section 1004 of the Standard Specifications.

Partial-depth bituminous concrete patches may be left in place during rubblization. If partial-depth patches prevent proper breaking of the PCC pavement, a skid steer loader (with a jack hammer attachment or similar device) may be used to complete breaking in these areas.

The rubblizing process will increase the pavement width 25 to 75 mm (1 to 3 in.) per 2-lane width, and encroach slightly into the underdrain trench. This has not caused performance problems with sand trench and pipe type underdrains to date. If the Resonant Breaker is used, the driving of heavy wheel loads directly over the underdrain trench should be avoided as much as possible. Wheel loads directly over the underdrain trench are of less concern if the existing shoulder is in sound condition.

(c) Review and Approval

All proposed rubblizing projects must be submitted for approval to the Bureau of Design and Environment. At a minimum, the submittal should include the following: 1) detailed pavement and subsurface investigation report, 2) selection of breaking equipment method, 3) existing and proposed cross sections, 4) traffic information, and 5) discussion on why rubblization is the preferred method of rehabilitation over other alternatives. Submitting a copy simultaneously to the Bureau of Materials and Physical Research will facilitate a timely review.

Attachments

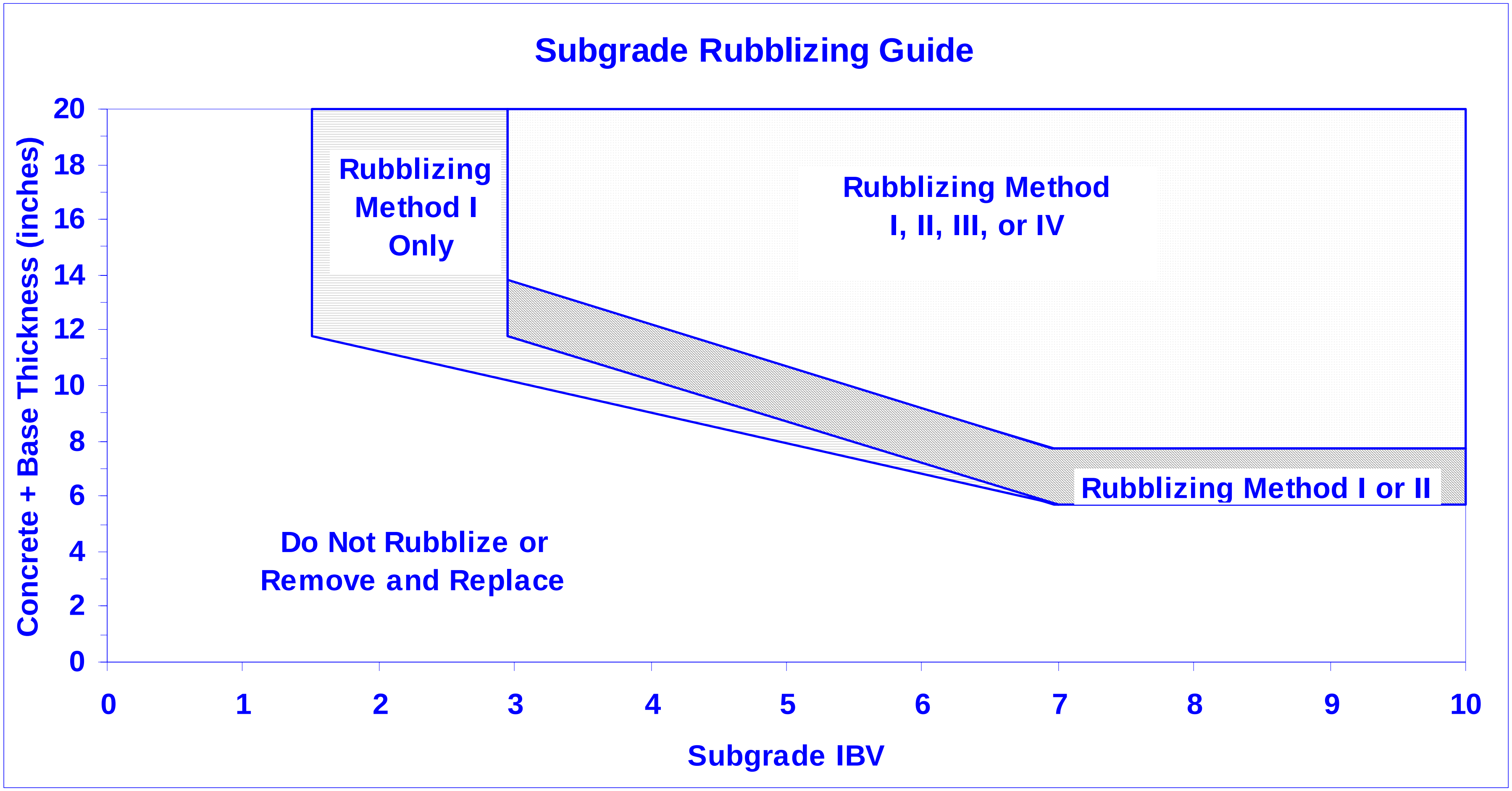
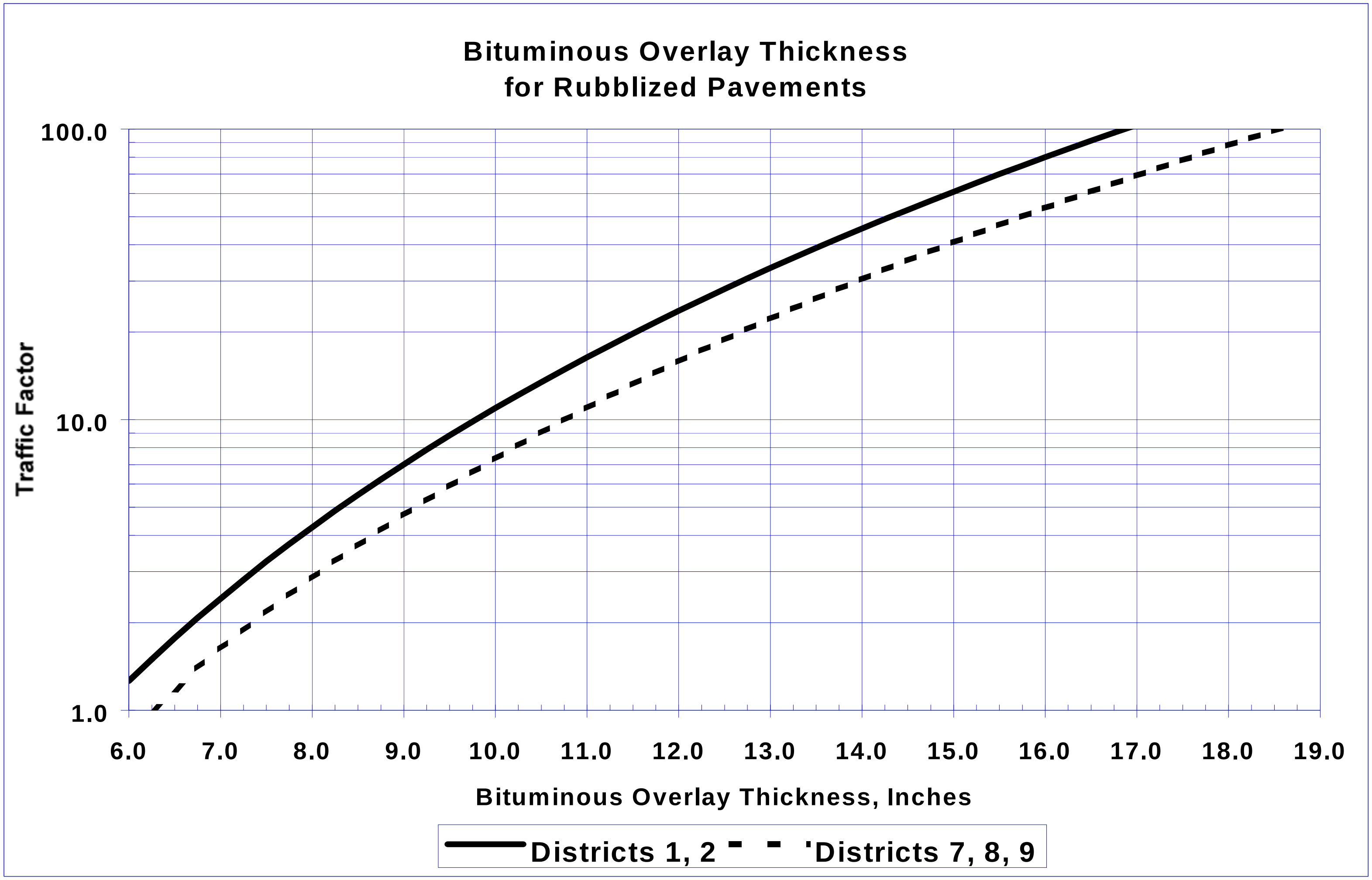


Figure 1

Figure 1



Bituminous Overlay Thickness
for Rubblized Pavements
100.0
10.0
1.0
Traffic Factor
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
Bituminous Overlay Thickness, Inches
Districts 1, 2
'Districts 7, 8, 9

Figure 2