CHAPTER 660
BASE AND SUBBASE

Topic 661 - Engineering Considerations

Bases and subbases serve as a support for the surface layer and distribute the wheel load to subgrade material.

In addition to functioning as part of the pavement structure, bases and subbases serve the following functions:

- Slow down the intrusion of fines from the subgrade soil into pavement structural layers.
- Minimize the damage of frost action.
- Prevent the accumulation of free water within or below the pavement structure.
- Provide a working platform for construction equipment.

Topic 662 - Base and Subbase Categories

Index 662.1 Aggregate Base and Subbase

Aggregate bases and subbases consist of a combination of sand, gravel, crushed stone and recycled material. They are classified in accordance with their gradation and the amount of fines. The gradation of the aggregates can affect structural capacity, drainage, and frost susceptibility. The quality of aggregate base and subbase material affects the rate of load distribution and drainage.

662.2 Treated Base and Subbase

(1) Hot Mix Asphalt Base (HMAB). Depending on the quality of aggregate, HMAB is classified as dense graded Type A or Type B Hot Mix Asphalt, (HMA). Type A is primarily a crushed aggregate, which provides greater stability than Type B. When used with HMA pavement, the HMAB is to be considered as part of the pavement layer. The HMAB will be assigned the same gravel factor, G_f, as the remainder of the HMA in the pavement structure.

(2) Other Treated Bases and Subbases. Treated bases and subbases are materials mixed with asphalt, portland cement, or other stabilizing agents to improve the strength or stiffness of granular material. These materials include lean concrete base (LCB), cement treated base (CTB), asphalt treated base (ATB) and lime treated subbase (LTS). CTB has shown poor performance under rigid pavement in the past. CTB exhibit excessive pumping, faulting, and cracking. This is most likely due to impervious nature of the base, which traps moisture and yet can break down and contribute to the movement of fines beneath the slab.

662.3 Treated Permeable Base and Subbase

Treated permeable bases (TPB) provide a strong, highly permeable drainage layer within the pavement structure. The binder material may be either asphalt (ATPB) or portland cement (CTPB). Either of these TPB layers will generally provide greater drainage capacity than is needed. The standard thickness is based primarily on constructability with an added allowance to compensate for construction tolerances. If material other than ATPB and CTPB with a different permeability, it is necessary to check the permeability and adequacy of the layer thickness. TPB must be used in accordance with a positive sub-drainage system per Index 651.2.

Erosion and stripping (water washing away cement paste, binders, and fines) can be an issue for TPB. Research conducted in the 1990s at the University of California Pavement Research Center (UCPRC) indicates that the use of ATPB is highly susceptible to stripping. Because of this, the Department recommends use of standard aggregate base (AB), with a compaction of the HMA layer of at least 93 percent of theoretical Rice maximum, instead of ATPB for new pavement structures. When ATPB is needed, such as to ensure continuity of existing ATPB/CTPB layer and/or provide drainage through the

pavement structure, special provisions should be made to ensure that it is not subjected to conditions that will lead to premature structural failure. The following guidelines should be followed when using ATPB on State highway pavement projects.

(1) Considerations for using ATPB. The following two conditions warrant consideration to use ATPB layer in the pavement structure:

(a) When widening or adding lanes adjacent to an existing ATPB layer to ensure continuity of existing ATPB layer.

(b) Where there is need to drain excess water through the pavement, such as when the uphill side of pavement does not allow for drainage. However, when practical, it is better in such cases to use sub-surface drainage to carry water to the other side of the roadway rather than drain excess water through an ATPB layer just below the HMA.

(2) Added features when using ATPB. The following features are recommended when using ATPB:

(a) Use edge drains or daylight the edges (see Chapter 650).

(b) If using edge drains, be sure that Maintenance is informed and can budget funds for maintaining edge drains. Developing an estimate of maintenance costs to maintain edge drains and Budget Change Proposals may be required to assure edge drains can be maintained.

(c) Try to use permeable backfill in shoulders on sides of edge drain to avoid bathtub effect if edge drain becomes clogged.

(d) Increase binder content to 3 percent (maybe higher)

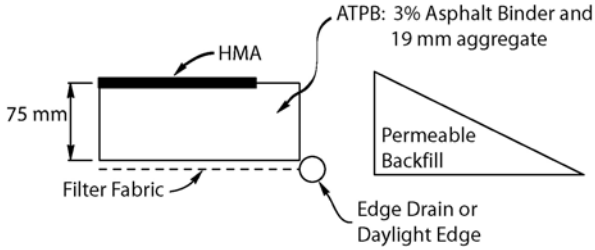
(e) Tack coat each layer.

(f) Perform moisture sensitivity testing on ATPB.

(g) Compaction of the HMA layer should be at least 93 percent of theoretical Rice maximum.

Figure 662.3

Typical Cross Section of ATPB Application



Topic 663 - Engineering Criteria

Because different types of treated and untreated aggregates have different capacities for resisting the forces imposed by traffic loads, this factor must be considered when determining the thickness of the pavement elements. For rigid pavement, this is considered in the design catalogs found in Topic 623. Table 663.1A provides the base and subbase material properties used for the Rigid Pavement Catalog. For flexible pavement, it is accomplished with California R-value and the gravel factor, G_f, which expresses the relative stiffness of various materials when compared to gravel. Table 663.1B provides the California R-values and G_f used for engineering flexible pavements.

The final selection of the bases and subbases for a given project depends on specific factors relative to the available materials, terrain, climate, economics, and past performance of the pavement under similar project or climatic conditions and travel patterns.

Since pavement engineering is a continually evolving field, the District Materials Engineer should be contacted for the latest guidance in base and subbase materials among other related engineering considerations.

Table 663.1A

Base and Subbase Material Properties for Rigid Pavement Catalog

HMA Type A Properties	
Aggregate gradation	0% retained 19 mm sieve 32% retained 9.5 mm 52% retained 4.75 mm sieve 5.5% passing 75 *u*m sieve
Asphalt binder type	See Index 632.1(2) and Table 632.1
Reference temperature	21 °C
Poisson's ratio	0.35
Effective binder content	11.662%
Air voids	8%
Total unit weight	2390 kg/m^3
Thermal conductivity asphalt	1.16 w/m.k
Heat capacity asphalt	0.96 kj/kg.k
Base erodibility index (1)	2
LCB Properties	
Unit weight	2400 kg/m^3
Poisson's ratio	0.20
Elastic Modulus	13,800 MPa
Thermal conductivity	2.16 w/m k
Heat capacity	1.17 kj/kg.k
Base erodibility index (1)	1
AB / AS Properties	
Poisson's ratio	0.40
Coefficient of lateral pressure, K_0	0.5
Resilient Modulus	300/200 MPa
Plasticity Index	1
Passing 75 *u*m	3%
Passing 4.75 mm	20%
D60	8 mm
Base erodibility index(1)	4

Note:

(1) Base erodibility index is classified as a number from 1 to 5 as follows:

1 = Extremely erosion resistant material

2 = Very erosion resistant material

3 = Erosion resistant material

4 = Fairly erodible material

5 = Very erodible material

Table 663.1B
Gravel Factor and California R-values for Bases and Subbases

Type of Material	Abbreviation	California R-value	Gravel Factor (G_f)
Aggregate Subbase	AS-Class 1	60	1.0
	AS-Class 2	50	1.0
	AS-Class 3	40	1.0
	AS-Class 4	specify	1.0
	AS-Class 5	specify	1.0
Aggregate Base	AB-Class 2	78	1.1
	AB-Class 3	specify	1.1(1)
Asphalt Treated Permeable Base	ATPB	NA	1.4
Cement Treated Base	CTB-Class A	NA	1.7
	CTB-Class B	80	1.2
Cement Treated Permeable Base	CTPB	NA	1.7
Lean Concrete Base	LCB	NA	1.9
Hot Mix Asphalt Base	HMAB	NA	(2)
Lime Treated Subbase	LTS	NA	0.9+UCS/6.9

Notes:

(1) Must conform to the quality requirements of AB-Class 2.

(2) When used with HMA, the HMAB is to be considered as part of the pavement layer. The HMAB will be assigned the same G_f as the remainder of the HMA in the pavement structure.

Legend:

NA = Not Applicable

UCS = Unconfined Compressive Strength in MPa (minimum 2.07 MPa per California Test 373)