



# FLEX BASE PROPERTIES

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## Flexible Base Selection and Information Guide

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Geotechnical, Soils & Aggregates Branch  
Materials & Pavements Section  
Construction Division

August 2018

- Collaborative effort between Texas A&M Transportation Institute (TTI) and Materials & Tests Division (MTD).
- Provides a basic overview of Item 247, “Flexible Base,” from TxDOT’s 2014 Specification book.
- Provides personnel of all experience levels with enough information to designate and associate the appropriate type and grade of flexible base required for any project.

# Flexible Base Selection & Information Guide

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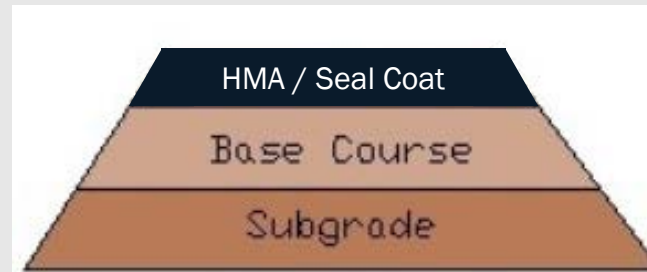
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- Short and concise, 6 pages of text and one appendix (total 12 pages).
- Does not include information about construction.
- The information in this document is relevant to both construction and maintenance projects using flexible base materials.

# Flex Base Properties

## What is a Flexible Base and it's function?

- Granular, unbound/untreated material as a base course within a flexible pavement structure.
- Foundation support and structural capacity to pavement.
- Provides support to minimize cracking of the surface layers.
- Dissipates stresses from traffic to subgrade to minimize potential for rutting.
- Economical less \$ than hot-mix asphalt.



# Flex Base Properties

## 2014 Specifications, Item 247 Flexible Base

### ➤ Item Code Bid Descriptions

- ✓ FL BS (CMP IN PLC) (TY A GR 1-2) (FNAL POS)
- ✓ FL BS (CMP IN PLC) (TY B GR 3) (FNAL POS)
- ✓ FL BS (CMP IN PLC) (TY A, B, OR D GR 4) (8")
- ✓ FL BS (CMP IN PLC) (TY D GR 5) (IN VEH)
- ✓ FL BS (STKPL DEL) (TY E GR3) (IN STKPL)
- ✓ FL BS (CIP) (TY D GR1-2 OR 5) (FNAL POS)

### ➤ Flex Base Material Properties

- ✓ TY – Types A, B, C, D, or E
- ✓ GR – Grades 1-2, 3, 4, or 5



## Item 247 Flexible Base

### ➤ *Material Types A, B, C, D, and E*

- ✓ Type A – Crushed stone, higher-quality base.
- ✓ Type B – Crushed or uncrushed gravel, areas with gravel as a local material.
- ✓ Type C – Crushed gravel, +60% with 2 or more crushed faces.
- ✓ Type D – Allows use of Type A or crushed concrete (where economically feasible).
- ✓ Type E – Caliche, iron ore, or for new materials as shown on plans.

# Flexible Base Material Types

Different physical properties, sizes, shapes, and color.



Type A - Crushed Limestone



Type A - Crushed Sandstone



Type B or C - Uncrushed Gravel



Type D - Crushed Concrete



Type E - Caliche



# Flexible Base Material Types

## FY 2018 Project Lettings

### ➤ 2014 Specifications, Item 247 Flexible Base

TYPE	# PROJECTS	PERCENT
A	128	51%
B	1	<1%
C	0	0
D	99	39%
E	21	8%
A OR B	2	<1%
A OR D	1	<1%

## Item 247 Flexible Base

### ➤ *Material Grades 1-2, 3, 4, and 5*

- ✓ Grades are differentiated by material requirements & properties determined from laboratory testing.
- ✓ Numbering sequence is not an order of quality. Grade 1-2 will not necessarily provide a higher quality performing base than a Grade 5.
- ✓ Grade selection should be dictated by the application of base for the typical section of the pavement structure.

# Flexible Base Material Grades

Property	Test Method	Grade 1-2	Grade 3	Grade 4	Grade 5
Master gradation sieve size (cumulative % retained)	Tex-110-E				
2½"		0	0	As shown on the plans	0
1¾"		0-10	0-10		0-5
¾"		10-35	-		10-35
⅝"		30-65	-		35-65
#4		45-75	45-75		45-75
#40		65-90	50-85		70-90
Liquid limit, % max <sup>1</sup>	Tex-104-E	40	40		As shown on the plans
Plasticity index, max <sup>1</sup>	Tex-106-E	10	12	As shown on the plans	10
Plasticity index, min <sup>1</sup>		As shown on the plans			
Wet ball mill, % max <sup>2</sup>	Tex-116-E	40	-	As shown on the plans	40
Wet ball mill, % max increase passing the #40 sieve		20	-	As shown on the plans	20
Compressive strength, psi, min	Tex-117-E	As shown on the plans			
Lateral pressure, 0 psi		35	-		-
Lateral pressure, 3 psi		-	-		90
Lateral pressure, 15 psi		175	-		175

*\*When using recycled materials, the final product, blended, is required to meet the material requirements listed in this table.*

# Flexible Base Material Grades

## ➤ Grade 1-2

- ✓ Pavements with moderate to high traffic.
- ✓ Low confinement with thin surfacing, such as seal coat or thin HMA.
- ✓ Low lateral support, such as with little or no shoulders.

## ➤ Grade 3

- ✓ Subbase, backfilling edges, or shoulder work.

## ➤ Grade 4

- ✓ Properties shown on plans, gives flexibility to customize a base specification.
- ✓ May be used to address local materials, recycled materials, and experimental sections.

## ➤ Grade 5

- ✓ Modification of Grade 1-2 with exception of no unconfined compressive strength requirement.
- ✓ Pavements with confinement from hot-mix asphalt on top and shoulders.
- ✓ Allows use of a harder aggregate with a lower fines content.
- ✓ Fines may be less cohesive.

# Flexible Base Material Grades

## FY 2018 Project Lettings

➤ *2014 Specifications, Item 247 Flexible Base*

GRADE	# PROJECTS	PERCENT
1-2	151	59%
3	7	3%
4	62	24%
5	34	13%
1-2 OR 5	4	2%

# Recycled Materials

- Recycled materials may be used when shown on the plans.
- Reclaimed Asphalt Pavement (RAP)
  - ✓ Maximum 20% RAP, unless otherwise shown on plans.
- Percentages for all other recycled materials will be shown on the plans.
- Crushed concrete used in flexible base.
- Crushed toilets and glass are other examples of recycled materials but have not been used in project lettings.



# Recycled Materials

- DMS-11000, Evaluating and Using Nonhazardous Recyclable Materials Guidelines.
- Compliance with this DMS is determined by the Environmental Affairs Division.

DEPARTMENTAL MATERIALS SPECIFICATION

EVALUATING AND USING NONHAZARDOUS  
RECYCLABLE MATERIALS GUIDELINES

## DMS - 11000

### EVALUATING AND USING NONHAZARDOUS RECYCLABLE MATERIALS GUIDELINES

EFFECTIVE DATE: OCTOBER 2008

**11000.1. Description.** This Specification governs the process for evaluating the environmental factors associated with nonhazardous recyclable materials (NRMs) not addressed in other Department specifications. Applicable Department engineering specifications govern the evaluation of engineering factors associated with the NRM product.

The Department's goal is to use materials with environmental qualities that do not necessitate short-term or long-term management (i.e., worker protection, deed restrictions, tracking, monitoring, or special handling after the project life) in Department specification items.

The Department prohibits the use of hazardous wastes in Department projects; therefore, the Department will reject the use of those wastes as outlined in Item 6, "Control of Materials," Article 6.9, "Recyclable Materials," of the Department's *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*.

Hazardous waste definitions are defined in the Department's Administrative Code (TAC), 30 TAC 335.1. Refer to 30 TAC 335.1 to determine if a material is a hazardous waste.

*...process for evaluating the environmental factors associated with nonhazardous recyclable materials (NRMs) not addressed in other Department specifications.*



# Recycled Materials

The following NRMs have established histories of use in Department construction projects and are administered by other Department specifications:

- aluminum;
- compost;
- glass beads;
- ground granulated blast furnace slag;
- shredded brush;
- steel;
- tire rubber;

TEXAS DEPARTMENT OF TRANSPORTATION

2-7

LAST REVIEWED: SEPTEMBER 2014

DEPARTMENTAL MATERIALS SPECIFICATION

EVALUATING AND USING NONHAZARDOUS  
RECYCLABLE MATERIALS GUIDELINES

- ceramics, glass cullet, plastics, and crushed concrete from non-industrial sources;
- reclaimed asphalt pavement;
- fly and bottom ash from electrical utility plants, and
- Department-owned materials.

➤ List of Nonhazardous Recycled Materials (NRM) in compliance with DMS (grandfathered).

➤ Testing is only required per TxDOT specifications.

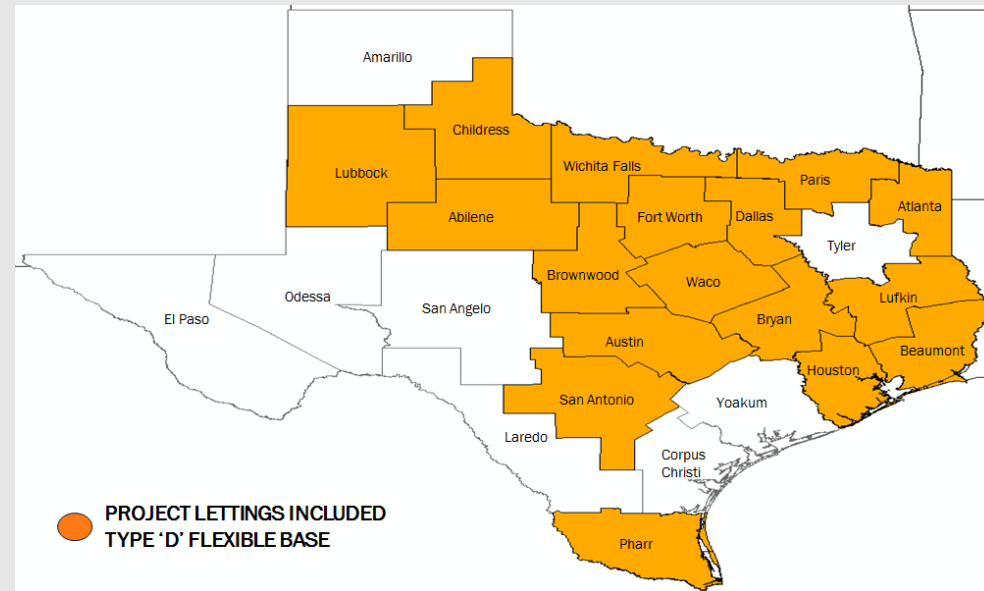
# Recycled Materials

- Maximum sulfate content of 3,000 ppm (not for RAP).
- Free from reinforcing steel and other objectionable material having at most 1.5% deleterious material (Tex-413-A).
- Maximum decantation for RAP is 5.0% (Tex-406-A).



# Recycled Materials

- Use of RAP, crushed concrete, and any other recycled materials in flexible base are difficult to quantify.
- Item bid description codes do not include information about recycled materials.
- Type D flexible base allows the use of crushed concrete.
- A majority of Districts specify Type D, thus allowing the use of crushed concrete.



# Flexible Base Material Properties

Property	Test Method	Grade 1-2	Grade 3	Grade 4	Grade 5
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2½"		0	0	As shown on the plans	0
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# Flexible Base Material Properties



- Plasticity Index (PI)
  - ✓ Consistency & cohesion of fines for bonding and stability
  - ✓ Indication of high clay content for low strength and moisture susceptibility

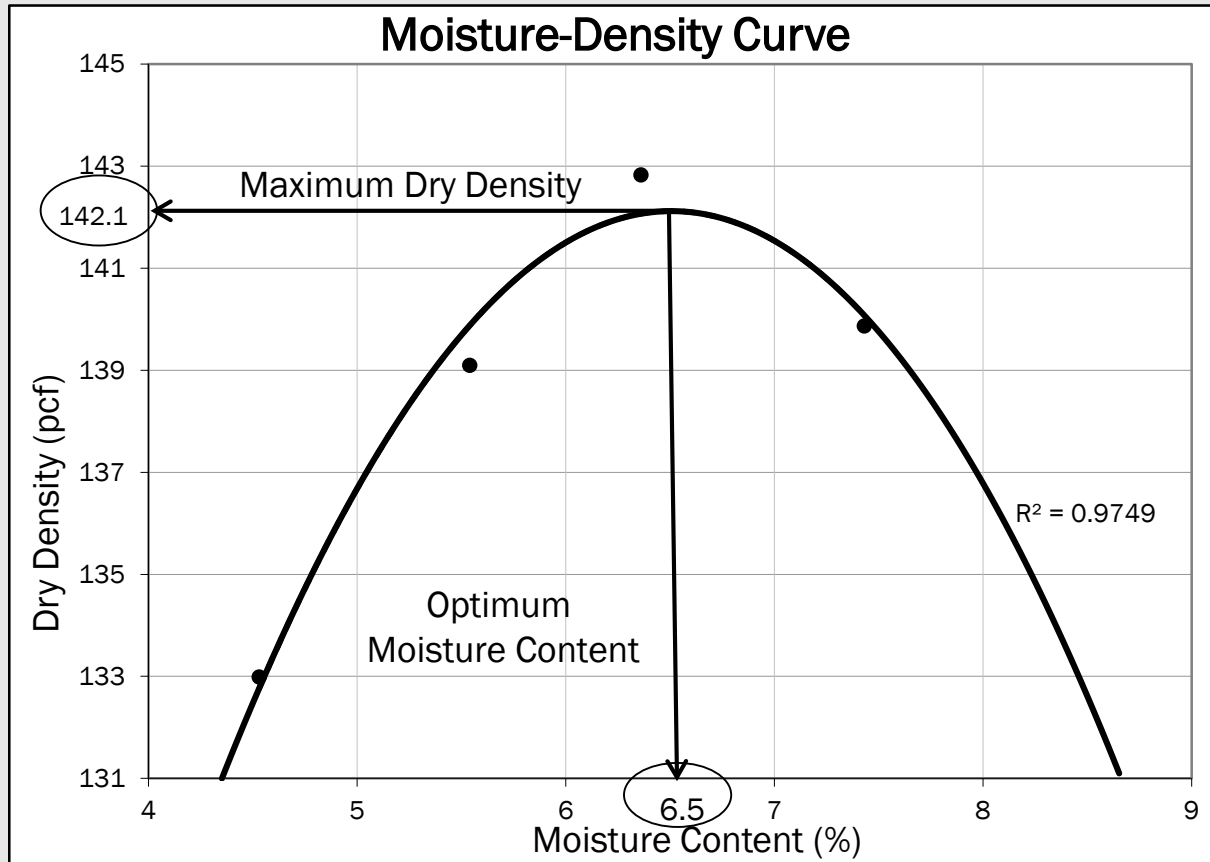


- Sieve Analysis (Gradation)
  - ✓ Separation of aggregate particles into different sizes from 1-3/4" to material passing #40 sieve (0.02").
  - ✓ Proportions deviating from specifications may effect stability and segregation.



- Wet Ball Mill
  - ✓ Sample, 6 steel spheres 2" diameter, & water into bucket and rotated 600 revolutions at 60 rpm.
  - ✓ Potential degradation during hauling, spreading, and construction.

# Flexible Base Material Properties



## ➤ *Density Control*

- ✓ 100% of maximum dry density
- ✓ Moisture content within  $\pm 2$  percent of optimum.

## ➤ *Curing*

- ✓ Finished section until moisture content is at least 2 percent below optimum.

## ➤ *Ride Quality*

- ✓ Only applicable to final travel lanes receiving 1 or 2 course seal coat.
- ✓ IRI value of 100.0 in. per mile or less for each wheelpath.

- *Use local materials where feasible and justified to minimize the demand of higher quality materials to save resources and money.*

