

Texas Specifications Related to the Use of Slag Cement

Slag Cement School

April 21, 2025



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ASTM Standards Referenced

- **ASTM C150** – *Standard Specification for Portland Cements*
- **ASTM C595** – *Standard Specification for Blended Hydraulic Cements*
- **ASTM C618** – *Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*
- **ASTM C989** - *Standard Specification for Slag Cement for Use in Concrete and Mortars*

Texas Specifications Related to the Use of Slag Cement – *TXDOT, Selected Cities/Counties*

- *Texas DOT*
- *City of Houston*
- *Harris County*
- *Dallas*
- *Dallas County*
- *Fort Worth*
- *Tarrant County*





Hydraulic Cement and Slag Cement Specifications

TXDOT Standard Specifications – *Item 421 Hydraulic Cement Concrete*

- **Section 2.1** - Cement
- **Section 2.2** - Cementitious Materials
- **Section 4.1** - Classification of Concrete Mix Designs



TXDOT Standard Specifications – *Item 421 Hydraulic Cement Concrete*

- **Section 2.1 - Cement**
 - DMS-4600 Hydraulic Cement - “All cements must meet the requirements of either ASTM C150 or **ASTM C595**”



QUICK REVIEW

- **ASTM C595** – *Standard Specification for Blended Hydraulic Cements*

Cement Types

- Binary blended cements
 - Type IL (clinker + limestone)
 - Type IP (clinker + pozzolan)
 - **Type IS** (clinker + slag cement)
- Ternary blended cements
 - Type IT (clinker + 2 of either limestone, pozzolan, **slag cement**)



QUICK REVIEW

Naming Practice - Cement Type (%), or Cement Type (X%) (X%)

Examples:

- Type IL limestone with 10% LS - **Type IL (10)**
- Type IP with 20% pozzolan – **Type IP (20)**
- **Type IS with 35% slag cement – Type IS (35)**
- Type IT with 20% pozzolan, **20% slag cement** – **Type IT (P20)(S20)**

- **Section 2.1 – Cement**
- **DMS-4600 Hydraulic Cement**

1. **ASTM C150 Portland Cements**

2. **ASTM C595 Blended Cements**

- **Type IL**
- **Type IP**
- **Type IS cement** – may contain up to 95% **slag cement**.
 - **TXDOT** – must have **>35% slag**
- **Type IT cement** – Ternary blend with Portland cement clinker, pozzolans, limestone, slag cement.
 - **TXDOT** – Maximum 35% - 50% total cementitious, silica fume not to exceed 10%.
 - **TXDOT** – If less than 35% total cementitious, must pass ASTM C1567 ASR test using an expansive sand.

- **Section 2.1 – Cement**
- **DMS-4600 Hydraulic Cement**

1. **ASTM C150 Portland Cements**

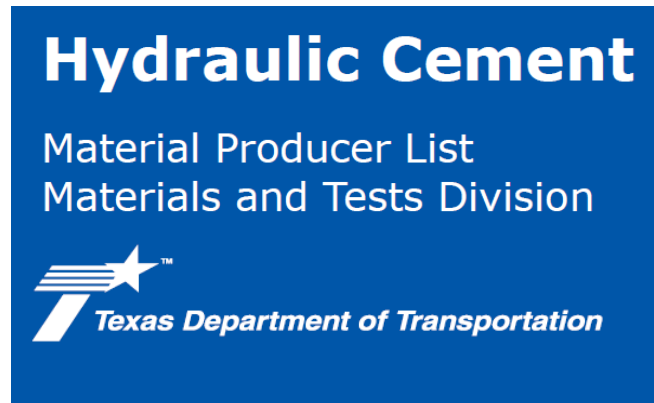
2. **ASTM C595 Blended Cements**

- **Type IL**
- **Type IP**
- **Type IS cement** – may contain up to 95% slag cement.
 - TXDOT – must have >35% slag
- **Type IT cement** – Ternary blend with Portland cement clinker, pozzolans, limestone, **slag cement**.
 - TXDOT – Maximum 35% - 50% total cementitious, silica fume not to exceed 10%.
 - TXDOT – If less than 35% total cementitious, must pass ASTM C1567 ASR test using an expansive sand.

- **Section 2.1 – Cement**
- DMS-4600 Hydraulic Cement

Blended cement currently listed on TXDOT approved Hydraulic Cements:

- Type IL - 26
- Type IP - 2
- Type IT - 1
- Type IS - 0



- **Section 2.1 – Cement**
- DMS-4600 Hydraulic Cement

Blended cement currently listed on TXDOT approved Hydraulic Cements:

- Type IL - 26
- Type IP - 2
- Type IT - 1
- Type IS - 0



Approved sources for blended cements other than Type IL will likely increase going forward as the demand for lower carbon cements increases.

TXDOT Standard Specifications – *Item 421*

Hydraulic Cement Concrete

- **Section 2.2** - Cementitious Materials
- DMS-4620 – Slag Cement

“All slag cement must meet the requirements of ASTM C989, Grade 100 or better.”



TXDOT Standard Specifications – *Item 421*

Hydraulic Cement Concrete

- **Section 2.2 - Cementitious Materials**
- DMS-4620 – Slag Cement

“All slag cement must meet the requirements of ASTM C989, Grade 100 or better.”

- **Currently, TXDOT has 8 sources of slag cement on their Material Producer List**

Slag Cement

Material Producer List
Materials and Tests Division



TXDOT Standard Specifications – *Item 421 Hydraulic Cement Concrete*

- **Section 4.0 - Construction**
 - Section 4.1 Classification of Concrete Mix Designs
 - Table 8 List Classes of Concrete



Section 4.1 Table 8 Lists:

- Class of Concrete
- Design Strength
- Max w/cm Ratio
- Allowable Cement Types
- Mix Design Option
- Exceptions
- General US

Class of Concrete	Design Strength ¹ , Min f _c (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use ²
A	3,000	0.60	I, II, III, IL, IP, IS, IT, V	1, 2, 4, and 7	When the cementitious material content does not exceed 520 lb. per cubic yard, any coal ash or natural pozzolan listed on the MPL may be used at a cement replacement of 20%–50%.	Curb, gutter, curb and gutter, concrete retards, sidewalks, driveways, backup walls, anchors, non-reinforced drilled shafts
B	2,000	0.60			Limit the alkali loading to 4.0 lb. per cubic yard or less when using Option 7.	Riprap, traffic signal controller foundations, small roadside signs, and anchors
C ³	3,600	0.45	I, II, III, IP, IL, IS, IT, V	1–8	–	Drilled shafts, bridge substructure, traffic rail, culverts except top slab of direct traffic culverts, headwalls, wing walls, inlets, manholes, traffic barrier
E	3,000	0.50	I, II, III, IL, IP, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb. per cubic yard, any coal ash or natural pozzolan listed on the MPL may be used at a cement replacement of 20%–50%.	Seal concrete
F ³	Note ⁴	0.45	I, II, III, IP, IL, IS, IT, V		Limit the alkali loading to 4.0 lb. per cubic yard or less when using Option 7.	Railroad structures; occasionally for bridge piers, columns, bents, post-tension members
H ³	Note ⁴	0.45	I, II, III, IP, IL, IS, IT, V	1–4, 8	Mix design Options 1–8 allowed for cast-in-place concrete and the following precast elements unless otherwise stated on the plans. <ul style="list-style-type: none"> ■ Bridge deck panels ■ Retaining wall systems ■ Coping ■ Sound walls ■ Wall columns ■ Traffic rail ■ Traffic barrier ■ Long/arch span culverts ■ Precast concrete 	Precast concrete, post-tension members

Section 4.1 Table 8 Lists:

- Class of Concrete
- Design Strength
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- Exceptions
- General US

The only Class of Concrete that does not allow Type IS is High Early Strength (HES) for early pavement release or repair

Class of Concrete	Design Strength ¹ , Min f _c (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use ²
					products included in Items 462, "Concrete Box Culverts and Drains"; 464, "Reinforced Concrete Pipe"; and 465, "Junction Boxes, Manholes, and Inlets" Do not use Type III cement in mass placement concrete.	
S ³	4,000	0.45	I, II, I/II, IP, IL, IS, IT, V	1-8	—	Bridge slabs, top slabs of direct traffic culverts, approach slabs
P	See Item 360, "Concrete Pavement."	0.50	I, II, I/II, IL, IP, IS, IT, V	1-8	When the cementitious material content does not exceed 520 lb. per cubic yard, any coal ash or natural pozzolan listed on the MPLs may be used at a cement replacement of 20%-50%.	Concrete pavement
CO ³	4,600	0.40	I, II, I/II, IP, IL, IS, IT, V	1-8	—	Bridge deck concrete overlay
LMC ³	4,000	0.40				Latex-modified concrete overlay
SS ³	3,600	0.45		1-8	Use a minimum cementitious material content of 658 lb. per cubic yard of concrete. Limit the alkali loading to 4.0 lb. per cubic yard or less when using Option 7.	Slurry displacement shafts, underwater drilled shafts
K ³	Note ⁴	0.40	I, II, I/II, III IP, IL, IS, IT, V	1-8	—	Bridge repair
HES	Note ⁴	0.45	I, IL, II, I/II, III	—	Mix design options do not apply. 700 lb. of cementitious material per cubic yard limit does not apply.	Concrete pavement, concrete pavement repair
"X" (HPC) ^{3,5,6}	Note ⁷	0.45	I, II, I/II, III IP, IL, IS, IT, V	1-4, and 8	—	—
"X" (SRC) ^{3,5,6}	Note ⁷	0.45	I/II, II, IP, IL (MS or HS), IS, IT (MS or HS), V	1-4, and 7	When using coal ash, only use coal ashes allowed for SRC as listed on the fly ash MPL. Type III-MS may be used where allowed.	—

Class of Concrete	Design Strength ¹ , Min f _c (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use ²
					Type I, IL, and III cements may be used when natural pozzolans are used or when coal ashes allowed for SRC in conformance with the coal ash MPL are used, and with a maximum w/cm of 0.40. Use Option 7 for precast concrete where allowed.	

4. Design strength must be achieved within 60 days.

Section 4.2.6 Mix Design Options list 8 Options:

Options 2, 3, & 4 apply to slag cement

Mix Design Options.

Option 1. Replace cement with at least the minimum dosage listed on the MPL for the coal ash or natural pozzolan used in the mixture. Conduct Option 8 testing to determine the minimum replacement dosage as listed on the MPL. Do not replace more than 50% of the cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

Option 2. Replace 35–50% of the cement with slag cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

Option 3. Replace 35–50% of the cement with a combination of coal ash, slag cement, MFA, natural pozzolan, or at least 3% silica fume; however, no more than 10% may be silica fume. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

Option 4. Use Type IP, IS, or IT cement as allowed in Table 8 for each class of concrete. When replacing blended cements with additional SCMs, the replacement limits in Option 3 will apply to the final cementitious mixture. When using fly ash or natural pozzolans not having a minimum dosage listed on the MPL in the final cementitious mixture, perform Option 8 testing.

Option 5. Option 5 is left intentionally blank.

Option 6. Use a lithium nitrate admixture at a minimum dosage determined by testing conducted in accordance with Tex-471-A. Before use of the mix, provide an annual certified test report signed and sealed by a licensed professional engineer, from a laboratory on the MPL, certified by the Materials and Tests Division (MTD) as being capable of testing in accordance with Tex-471-A.

Option 7. Ensure the total alkali contribution from the cement in the concrete does not exceed 3.5 lb. per cubic yard of concrete when using hydraulic cement not containing SCMs calculated as follows.

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\% \text{ Na}_2\text{O equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

Option 8. Use Table 10 when deviating from Options 1–3 or when required by the coal ash MPL. Perform required testing annually and submit results to the Engineer. Laboratories performing ASTM C1260, C1567, and C1293 testing must be listed on the Department's MPL. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer demonstrating the proposed mixture conforms to the requirements of Table 10.

Option 2 - Slag cement may be used in all classes at 35%-50% replacement. Up to 70 for mass concrete placements.

Option 3 – Slag may be used in combination with coal ash, MFA, natural pozzolan, or silica fume (min. 3%) for replacement of 35%-50%.

Option 4 – If Type IS is replaced with additional SCM's, the limits in Option 3 will apply.

Section 4.2.6 Mix Design Options

list 8 Options:

Option 7 – Alkali loading – slag cement is not included in the calculation, just like fly ash.

Mix Design Options.

Option 1. Replace cement with at least the minimum dosage listed on the MPL for the coal ash or natural pozzolan used in the mixture. Conduct Option 8 testing to determine the minimum replacement dosage as listed on the MPL. Do not replace more than 50% of the cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

Option 2. Replace 35–50% of the cement with slag cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

Option 3. Replace 35–50% of the cement with a combination of coal ash, slag cement, MFA, natural pozzolan, or at least 3% silica fume; however, no more than 10% may be silica fume. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

Option 4. Use Type IP, IS, or IT cement as allowed in Table 8 for each class of concrete. When replacing blended cements with additional SCMs, the replacement limits in Option 3 will apply to the final cementitious mixture. When using fly ash or natural pozzolans not having a minimum dosage listed on the MPL in the final cementitious mixture, perform Option 8 testing.

Option 5. Option 5 is left intentionally blank.

Option 6. Use a lithium nitrate admixture at a minimum dosage determined by testing conducted in accordance with Tex-471-A. Before use of the mix, provide an annual certified test report signed and sealed by a licensed professional engineer, from a laboratory on the MPL, certified by the Materials and Tests Division (MTD) as being capable of testing in accordance with Tex-471-A.

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City of Houston 2023 Specification



City of Houston, 2023 specification

Allows:

- ASTM C150 Portland Cements Type I and II
- ASTM C618 fly ash
- ASTM C595 Type IP



City of Houston, 2023 specification

Allows:

- ASTM C150 Portland Cements Type I and II
- ASTM C618 fly ash
- ASTM C595 Type IP

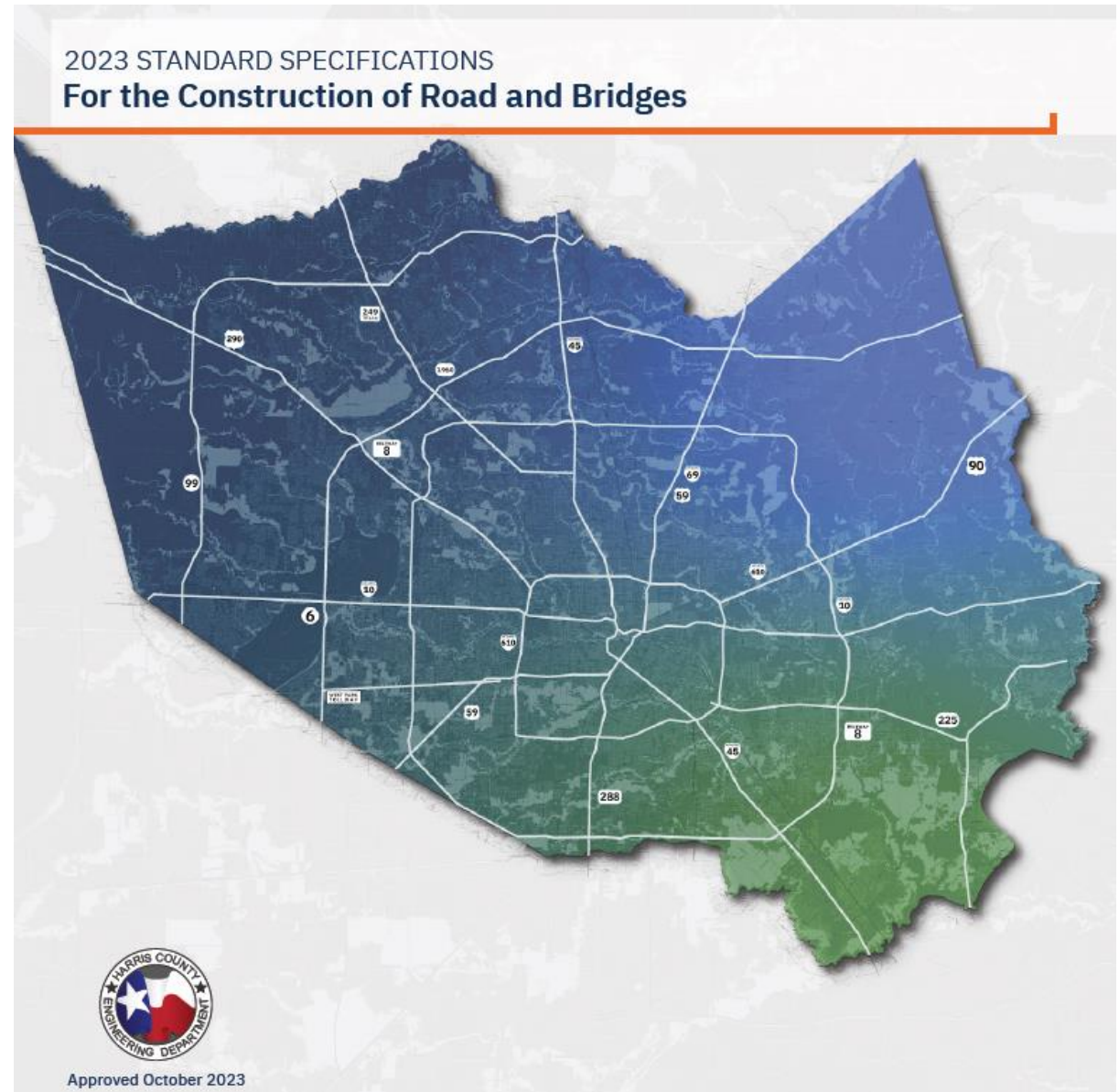
Does not include:

- ASTM C595 Type IL
- ASTM C595 Type IS
- ASTM C989 slag cement.



They are due for a specification update in 2025

Harris County 2023 Specification



Harris County, 2023 specification

- Mirrors TXDOT Specifications
- Allows ASTM C989 Slag Cement and Type IS (>35% slag)
- Has a minimum concrete temperature requirement of 60 degrees F. for use in bridge substructures, box culverts, precast and prestressed concrete.



City of Dallas

Last Updated in 2021

Allows:

- ASTM C150 Type I or II cement
- ASTM C618 Fly ash
- ASTM C595 Type IP



City of Dallas

Last Updated in 2021

Allows:

- ASTM C150 Type I or II cement
- ASTM C618 Fly ash
- ASTM C595 Type IP

Dallas County conforms to
City of Dallas construction
specifications.



City of Fort Worth

Latest Specification 2021

Allows:

- ASTM C150 Type I or II
- ASTM C595 Type IL
- ASMT C618 Fly ash
- **ASTM C989 Slag cement** – up to 50% replacement by itself, or in combination with fly ash and/or silica fume



Tarrant County Differs to TXDOT Standards

Section 3. Roadway Construction and Design Standards

3.01. Construction Standards

A. General

1. Minimum Standards

- a. The standards established by Section 3 are the minimum specifications for the preparation and construction of streets dedicated to the public.
- b. Any work, methods, materials, and equipment not addressed in this Section 3 shall conform to the current edition of TxDOT's Roadway Design Manual and Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. With approval by The Department, the most current version of the Public Works Construction Standards manual published by the North Central Texas Council of Governments may be used as an alternative.



Slag Cement in Private Work

- Inclusion of slag cement varies specifier to specifier.
- Some may only include slag only as cementitious material under ASTM C989.
- Some may include Type IS under ASTM C595 Blended Cements.

Slag Cement in Private Work

- Inclusion of slag varies specifier to specifier.
- Some may only include slag only as cementitious material under ASTM C989.
- Some may include Type IS under ASTM C595 Blended Cements.
- Some make no mention of slag cement, or even ASTM C595 Blended Cements, no Type IL.
- Specifiers are slow to update specifications.

Specification Examples

ederal, state and local volatile organic compound regulations.

4.5.2 Cementitious Materials

4.5.2.1 Portland cement shall be in accordance with *ASTM C150/C150M*, Type I or Type II unless otherwise specified in contract documents.

4.5.2.2 Only one brand of cement shall be used.

4.5.2.3 Fly ash may be used in accordance with *ACI 301 / ACI 301M* and shall be in accordance with *ASTM C618*, Class F unless otherwise specified in contract documents. Class C fly ash may be used if Class F is not available.

4.5.2.4 Ground Granular Blast Furnace Slag (GGBFS) in accordance with *ASTM C989/C989M* may be used if available.

4.5.2.5 Cementitious materials used for mass concrete applications shall be in accordance with *ACI 301 / ACI 301M* Section 8.2.1.1. For applications designated as environmental engineering concrete structures in contract documents, cementitious materials used for mass concrete applications shall also be in accordance with *ACI 350.5 / ACI 350.5M* Section 8.2.1.1.

As a cementitious material, ASTM C989

As both cementitious material, ASTM C989, and ASTM C595 Blended Cement Type IS

VII. CONCRETE SPECIFICATION:

A. Materials:

The following list of materials is descriptive. Application and usage of these materials are stipulated elsewhere in this specification.

1. Cementitious – For slab-on-grade shall be Portland Cement, Type I, II, I/II and IL (less than 8% in tricalcium aluminate content). Blended cementitious materials except Type IL are unacceptable. Only cement light in color and derived from a single source shall be used throughout the work, to achieve uniformity of quality and consistency in color and appearance. Type II cement is preferred but if unavailable, Type I, I/II or IL shall be acceptable. Cements prone to false set and high alkali content shall be rejected. Submit manufacturer's mill reports covering this material. For Type IL Cement, additional laboratory testing shall be performed as specified below.

ASTM C595 Type IL, but no other blended cements

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete General: ACI 301 and ACI 117.

B. Cementitious Materials:

1. Portland Cement: ASTM C150, Type I or Type III.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS or Type IP.
5. Silica fume.
6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: Type GU, general use or Type HE, high early strength.
7. Aggregate: ASTM C 33, Normal weight.
8. Water.



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Thank You!
Questions?