



*Florida Department of Transportation*

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KEVIN J. THIBAUT, P.E.  
SECRETARY

July 22, 2021

Khoa Nguyen  
Director, Office of Technical Services  
Federal Highway Administration  
3500 Financial Plaza, Suite 400  
Tallahassee, Florida 32312

Re: State Specifications Office  
Section: **929**  
Proposed Specification: **9290400 SUPPLEMENTARY CEMENTITIOUS MATERIALS.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Thomas Frank to address concrete durability concerns related to the alumina content of slag cement in the Standard Specification.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to [daniel.strickland@dot.state.fl.us](mailto:daniel.strickland@dot.state.fl.us).

If you have any questions relating to this specification change, please call me at 850-414-4130.

Sincerely,

Signature on file

Daniel Strickland, P.E.  
State Specifications Engineer

DS/dh

Attachment

cc: Florida Transportation Builders' Assoc.  
State Construction Engineer

**SUPPLEMENTARY CEMENTITIOUS MATERIALS.****(REV 5-67-20-21)**

ARTICLE 929-4 is deleted and the following substituted:

**929-4 Slag Cement.**

Slag cement (ground granulated blast furnace slag, GGBFS) is the quenched, ground by-product of the iron ore refinement process conducted in blast furnaces. It is primarily an amorphous material of calcium aluminosilicate constituents.

**929-4.1 General:** Slag cement and reference cement used for determination of slag activity tests shall meet the requirements of ASTM C989. Sampling and testing procedures shall follow the requirements of ASTM C989.

**929-4.2 Acceptance Testing of Slag Cement:** Acceptance of slag cement from sources operating under an accepted QC Plan shall be based on the monthly test reports meeting the chemical and physical requirements of ASTM C989 and this Section. The test report shall include:

1. For slag granules, provide X-ray Fluorescence (XRF) elemental analysis of the granules, presented in oxide form. Include CaO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO, Mn<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, and sulfur (as sulfide).

2. For slag cement, provide XRF elemental analysis, presented in oxide form. Include CaO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO, Mn<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, sulfur as sulfide (S), sulfate sulfur (SO<sub>3</sub>), and total sulfur as sulfate (SO<sub>3</sub>).

3. The results of all testing listed under Test Methods section of ASTM C989.

4. Indicate the amount of any additions introduced during grinding of the slag granules and report compliance with Section 6 of ASTM C989.

a. Amount of limestone added and its CaCO<sub>3</sub> content.

b. Amount of other inorganic processing addition.

5. For calcium sulfate additions, indicate:

a. Amount of calcium sulfate added.

b. Form of calcium sulfate.

c. SO<sub>3</sub> content.

d. Method used to determine the amount of calcium sulfate that was added.

**929-4.2.1 Assessment of Sulfate Resistance:** Following guidance in ACI 233R-17 Guide to the Use of Slag Cement in Concrete and Mortar, slag cements with Al<sub>2</sub>O<sub>3</sub> contents greater than 11% should be interground with calcium sulfate to avoid an undersulfated cementitious system. Provide ASTM C1012 data with a 50:50 portland cement-slag cement blend, using a Type II (MH) portland cement on the Department's Production Facility Listing, with an alkali content of no more than 0.6%, when any of the following conditions occur:

1. The Al<sub>2</sub>O<sub>3</sub> content of the slag cement is equal to or greater than 12%.

2. The slag cement is a blend of slag granules from more than one source that are interground during production of the slag cement and for which one or more of the following are true:

a. The Al<sub>2</sub>O<sub>3</sub> contents of both slag sources are equal to or greater than 12%.

b. The average  $\text{Al}_2\text{O}_3$  content of the blend is equal to or greater than 12%.

c. One of the slag sources has an  $\text{Al}_2\text{O}_3$  content that is equal to or greater than 14%.

The Department will consider the ASTM C1012 data acceptable when the results indicate no more than 0.10% expansion at 12 months.

The Department may grant provisional acceptance if the expansion does not exceed 0.05% at 6 months.

For any slag cements with  $\text{Al}_2\text{O}_3$  content equal to or greater than 12%, perform a retest of ASTM C1012 if the monthly test report indicates that any of the following conditions have occurred:

1. The  $\text{Al}_2\text{O}_3$  content increases by greater than or equal to 1.0% of the content measured during qualification of the sulfate resistance.

2. The sulfate sulfur ( $\text{SO}_3$ ) content decreases by 0.25% less than that measured during qualification of the sulfate resistance.

3. The Blaine fineness increases by 50  $\text{m}^2/\text{kg}$  greater than that measured during qualification of the sulfate resistance.

The Department may grant provisional acceptance of the slag cement source if ASTM C1012 data is required for any of the above retesting conditions.

**SUPPLEMENTARY CEMENTITIOUS MATERIALS.****(REV 7-20-21)**

ARTICLE 929-4 is deleted and the following substituted:

**929-4 Slag Cement.**

Slag cement (ground granulated blast furnace slag, GGBFS) is the quenched, ground by-product of the iron ore refinement process conducted in blast furnaces. It is primarily an amorphous material of calcium aluminosilicate constituents.

**929-4.1 General:** Slag cement and reference cement used for determination of slag activity tests shall meet the requirements of ASTM C989. Sampling and testing procedures shall follow the requirements of ASTM C989.

**929-4.2 Acceptance Testing of Slag Cement:** Acceptance of slag cement from sources operating under an accepted QC Plan shall be based on the monthly test reports meeting the chemical and physical requirements of ASTM C989 and this Section. The test report shall include:

1. For slag granules, provide X-ray Fluorescence (XRF) elemental analysis of the granules, presented in oxide form. Include CaO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO, Mn<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, and sulfur (as sulfide).

2. For slag cement, provide XRF elemental analysis, presented in oxide form. Include CaO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO, Mn<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, sulfur as sulfide (S), sulfate sulfur (SO<sub>3</sub>), and total sulfur as sulfate (SO<sub>3</sub>).

3. The results of all testing listed under Test Methods section of ASTM C989.

4. Indicate the amount of any additions introduced during grinding of the slag granules and report compliance with Section 6 of ASTM C989.

a. Amount of limestone added and its CaCO<sub>3</sub> content.

b. Amount of other inorganic processing addition.

5. For calcium sulfate additions, indicate:

a. Amount of calcium sulfate added.

b. Form of calcium sulfate.

c. SO<sub>3</sub> content.

d. Method used to determine the amount of calcium sulfate that was added.

**929-4.2.1 Assessment of Sulfate Resistance:** Following guidance in ACI 233R-17 Guide to the Use of Slag Cement in Concrete and Mortar, slag cements with Al<sub>2</sub>O<sub>3</sub> contents greater than 11% should be interground with calcium sulfate to avoid an undersulfated cementitious system. Provide ASTM C1012 data with a 50:50 portland cement-slag cement blend, using a Type II (MH) portland cement on the Department's Production Facility Listing, with an alkali content of no more than 0.6%, when any of the following conditions occur:

1. The Al<sub>2</sub>O<sub>3</sub> content of the slag cement is equal to or greater than 12%.

2. The slag cement is a blend of slag granules from more than one source that are interground during production of the slag cement and for which one or more of the following are true:

a. The Al<sub>2</sub>O<sub>3</sub> contents of both slag sources are equal to or greater than 12%.

b. The average Al<sub>2</sub>O<sub>3</sub> content of the blend is equal to or greater than 12%.

c. One of the slag sources has an  $\text{Al}_2\text{O}_3$  content that is equal to or greater than 14%.

The Department will consider the ASTM C1012 data acceptable when the results indicate no more than 0.10% expansion at 12 months.

The Department may grant provisional acceptance if the expansion does not exceed 0.05% at 6 months.

For any slag cements with  $\text{Al}_2\text{O}_3$  content equal to or greater than 12%, perform a retest of ASTM C1012 if the monthly test report indicates that any of the following conditions have occurred:

1. The  $\text{Al}_2\text{O}_3$  content increases by greater than or equal to 1.0% of the content measured during qualification of the sulfate resistance.
2. The sulfate sulfur ( $\text{SO}_3$ ) content decreases by 0.25% less than that measured during qualification of the sulfate resistance.
3. The Blaine fineness increases by 50  $\text{m}^2/\text{kg}$  greater than that measured during qualification of the sulfate resistance.

The Department may grant provisional acceptance of the slag cement source if ASTM C1012 data is required for any of the above retesting conditions.