

9290400 SUPPLEMENTARY CEMENTITIOUS MATERIALS
COMMENTS FROM INTERNAL/INDUSTRY REVIEW

Anonymous

Comments: (Industry 6-10-21)

Section 929-4.2: Defines SO₃ for two different items (sulfate sulfur and total sulfur as sulfate). Section 929-4.2.1: In item 2, sulfate sulfur is already defined so can only refer to as SO₃.

Response: Three quantities are addressed in the specification, 1) the amount of sulfur present in the slag granules as sulfide (S), 2) the amount of sulfate (SO₃) added to the slag cement (added, for example, as CaSO₄), and 3) the total amount of sulfur in the slag cement expressed as sulfate (SO₃). Due to the temperature and atmosphere at which slags are formed, the sulfur contained in slag granules is reduced to sulfide (S). Concrete mixes containing slag cement need extra sulfate to avoid long-term durability problems, so extra sulfate has to be included with the slag granules prior to grinding to produce slag cement. X-ray fluorescence spectroscopy (XRF) is an elemental analysis method for which the elemental quantities determined are converted to oxide equivalents for comparison. As such, XRF cannot distinguish between sulfide (S) and sulfate (SO₃), so the sulfate reported from XRF is the oxide equivalent of all the sulfur in the slag cement (total sulfate).

Action: No change is needed in the proposed specification.

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Comments: (Industry6-24-21)

Section 929-4.2: Defines SO₃ for two different items (sulfate sulfur and total sulfur as sulfate). Section 929-4.2.1: In item 2, sulfate sulfur is already defined so can only refer to as SO₃.

Response: Same as duplicate comment above.

Action: No change is needed in the proposed specification.

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Comments: (Industry 6-27-21)

Item 1) We have tested multiple Type I/II(MH) and Type IL cements in Florida and all meet the ASTM C1012 acceptance criteria without slag or other SCM. We have tested multiple slags with alumina up to 14% and blaine up to 670 m²/kg and performance in ASTM C1012 was always improved. Therefore, the requirement for ASTM C1012 testing is overly conservative and may needlessly interrupt FDOT projects while waiting for ASTM C1012 testing results.

Response: Initial ASTM testing of slag cement is done to establish an original sulfate durability profile that can be used for comparison if retesting is needed. For currently approved sources, there is no intention of disapproving the source unless the slag cement has failed at the end of the 12-month test. Failures are likely due to an inadequate sulfate balance, which is relatively simple to correct.

Action: No action is needed^[HD1].

Item 2) According to ASTM C989, Section X.2.3 “high alumina content can have a detrimental influence at low slag cement-replacement”. However, X.2.3.3 notes that this occurred with alumina contents of greater than 18% and slag contents 50% and less, but not all cements were Type II (<8% C3A). Since FDOT requires at least than 50% slag content, this should not be an issue. We would propose a higher alumina content of at least 16% to trigger ASTM C1012 testing and only if slag is used at less than 50% of the cementitious materials. FDOT is further protected by required surface resistivity testing, which corresponds to a low concrete permeability that reduces the ingress of sulfates from soil or seawater.

Response: The greater than 11% alumina content trigger was suggested by the Slag Cement Association. ACI 233R Guide to the Use of Slag Cement in Concrete and Mortar suggests that to avoid an undersulfated portland cement-slag cement system, slag cements with Al₂O₃ contents greater than 11% should be interground with enough sulfate to balance the system. For mixes that do not contain a highly reactive pozzolan, there is no minimum threshold for the surface resistivity value. Currently the surface resistivity requirement exists to build a database. The Department will continually review collected data and will adjust the Al₂O₃ content accordingly.

Action: No action is needed.

Item 3) In 929-4.2.1, clarify whether the two conditions of Al₂O₃ and blending are “and” or “or”.

Response: Agree that a distinction must be made.

Action: The existing language will be changed to “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:

Item 4) Clarify if the requirement on blending of two different slag granules applies if both sources are less than 11% alumina, if the average of the granules is less than 11% (e.g. a 50/50 blend of 9 and 12% alumina), if one of the granules is greater than 11%, the average is greater than 11%, or both a greater than 11%.

Response: Agree that this needs to be clarified.

Action: Modified the proposed language to read:

1. The Al_2O_3 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_2O_3 contents of both slag sources are equal to or greater than 12%.
 - b. The average Al_2O_3 content of the blend is equal to or greater than 12%.
 - c. One of the slag sources has an Al_2O_3 content that is equal to or greater than 14%.

Item 5) Clarify if blending means two granule sources interground at the same time or two granule sources at different times. We suggest the following alternative: "If two or more granule sources are blended together at the same time and any one granule source exceeds 11% alumina."

Response: This was clarified in the Action taken for Item 4.

Action: No action needed since the clarification has been made in the Action for Item 4..

Item 6) In 929-4.2.1, define provisional acceptance. If the slag has expansion at 6 months of less than 0.05% and is given provisional acceptance, but exceeds 0.1% at 12 months, indicate what action will be taken by FDOT. Clarify how provisional acceptance affect the slag supplier and concrete producer.

Response: The progress of the ASTM C1012 testing should be monitored so that if it looks like the slag cement will fail the test, adjustments to the sulfate content of the slag cement could be made and ASTM C1012 testing could be started on the modified slag cement. Work on projects should not be interrupted if the ASTM C1012 data is tracked closely so that solutions can be implemented prior to any failure.

Action: No action is needed.

Item 7) For the retesting criteria in 929-4.2.1, wider criteria are needed because slag is a byproduct and suppliers may need to make changes to ensure consistent performance. Suppliers of granules typically cannot commit to +/-1% alumina. We suggest the change in alumina should be at least 2%, the blaine at least 100 m²/kg, and the SO₃ at least 1%.

Response: These numbers are based on analyses of 3-year spans of data obtained from slag manufacturers and are default numbers. Actual values will be determined from analyses of each manufacturers data. Much like a process control chart, these values may change over time due to changes in the composition of the slag granules.

Action: No action is needed.

Item 8) Also, clarify that the retesting only applies when any of these changes occur and alumina

is above the 11% threshold.

Response: Agree that this needs to be clarified.

Action: Modified the proposed language to read “For any slag cements with Al₂O₃ content equal to or greater than 12%, perform a retest of ASTM C1012 if the monthly test report indicates that any of the following have occurred:

Item 9) Clarify that the retesting requires if “any” or “all” conditions change.

Response: This was resolved in the Action for Item 8).

Action: No action is needed.

Item 10) Concrete producers are not able to substitute slag sources without retesting all concrete mixtures in the lab and in some cases the field. If a slag source changes and does not have ASTM C1012 data, a concrete producer may not be able to change mixes in sufficient time to avoid delays on FDOT projects. Consider a slag substitution process similar to that in the Materials Manual for fly ash and aggregate.

Response: Due to the numerous factors that can affect the durability of portland cement-slag cement combinations, it is not feasible to allow a slag cement substitution procedure. The Department will work with concrete producers to avoid any work stoppages.

Action: No action is needed.
