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Committee C09 on Concrete and Concrete Aggregates
Subcommittee C09.27 on Ground Slag

Research Report: C09-1048

Interlaboratory Study to Establish Precision Statements for ASTM C0989-16, Specification for Slag Cement for Use in Concrete and Mortars

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1. Introduction:

Interlaboratory Study 1113 was conducted to establish a precision statement for C0989, Specification for Slag Cement for Use in Concrete and Mortars.

2. Test Method:

The Test Method used for this ILS is C0989-16. To obtain a copy of C0989, go to ASTM's website, www.astm.org, or contact ASTM Customer Service by phone at 610-832-9585 (8:30 a.m. - 4:30 p.m. Eastern U.S. Standard Time, Monday through Friday) or by email at service@astm.org.

3. Participating Laboratories:

The following laboratories participated in this interlaboratory study:

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4. **Description of Samples:**
The slag sample used in this study was provided by Holicum. The slag sample was prepared and distributed by CCRL.

ASTM C150-12 Common Reference Type I Portland Cement for use in ASTM C989-12 Slag Activity Testing

Production Date: August 2013 **LOT #2**

STANDARD REQUIREMENTS
ASTM C 150 Tables 1 and 3 and ASTM C989 Section 10.1

CHEMICAL

Item	Spec. Limit	Test Result
SiO_2 (%)	[A]	20.2
Al_2O_3 (%)	[A]	4.3
Fe_2O_3 (%)	[A]	2.6
CaO (%)	[A]	62.8
MgO (%)	6.0 max	3.5
SO_3 (%)	3.0 max	3.2
Ignition loss (%)	3.0 max	2.5
Na_2O (%)	[A]	0.18
K_2O (%)	[A]	0.9
$Na_2O+0.658K_2O$ (min.-max, %)	0.60-0.90[B]	0.77
Insol. residue (%)	0.75 max	0.60[C]
Potential phase composition(%)[D]		
C_3S	[A]	60
C_2S	[A]	12.4
C_3A	[A]	7
C_4AF	[A]	8

PHYSICAL

Item	Spec. Limit	Test Result
Air content of mortar (volume %)	12 max	7.3[C]
Blaine fineness (m^2/kg)	260 min	361
Autoclave expansion (%)	0.80 max	0.03[C]
Min. compressive strength (psi)		
7 days	2760	4640
28 days	5000[B]	5886
Initial Set Time, Vicat (min.-max, minutes)	45-375	160

NOTES:
[A]No limit.
[B]Limit from ASTM C989.
[C]Test result represents data from one laboratory.
[D]Un-adjusted per Annex A1.5 of ASTM C150.

The chemical composition and physical test results listed above are the average from three laboratories unless otherwise noted (See Note C). Limits are from ASTM C150 unless otherwise noted (See Note B).

Tests were conducted on split samples obtained from a composite of grab samples representative of a blend of two portland cements meeting the requirements of ASTM C150.

5. **Interlaboratory Study Instructions**
Laboratory participants were emailed the test program instructions. For a copy of the instructions, please see Annex A.

6. **Description of Equipment/Apparatus[1]:**
For information on the equipment/apparatus used by each laboratory, please see Annex B.

7. **Data Report Forms:**
Each laboratory was provided with a data report form for the collection of data. A copy of the data is provided in Annex C.

Please note: The laboratories have been randomly coded and cannot be identified herein.

8. **Statistical Data Summary:**
A summary of the statistics calculated from the data returned by the participating laboratories is provided in Annex D.

9. **Precision and Bias Statement:**

9.1 The precision of this test method is based on an interlaboratory study of C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars, conducted in 2015. As part of this study, three properties were measured, each by as many as 22 laboratories. Every "test result" represents an individual determination, and all labs were asked to report results in duplicate. Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. C09-1048. [i]

9.1.1 Repeatability (r) - The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

9.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

9.1.1.2 Repeatability limits are listed in Table 1below.

[1] The equipment listed was used to develop a precision statement for C989-16. This listing is not an endorsement or certification by ASTM International.

9.1.2 Reproducibility (R) - The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

9.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

9.1.2.2 Reproducibility limits are listed in Table 1 below.

9.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E 177.

9.1.4 Any judgment in accordance with statements 9.1.1 and 9.1.2 would have an approximate 95% probability of being correct.

Table 1. Slag SAI (%)

Material	Average[ii]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	s_r	s_R	r	R
7 day	83.83	1.65	6.88	4.63	19.25
28 Day	118.0	2.62	4.78	7.33	13.38

9.2 Bias— No certified reference material was included in the test specimens distributed as part of this ILS, therefore no statement on bias is being made.

9.3 The precision statement was determined through statistical examination of all usable data, from 22 laboratories, on a single slag material, and a single common reference cement.