

RECLAMATION

Managing Water in the West

Evaluation of Packaged Concrete Repair Materials - Scoping Study

Research and Development Office
Science and Technology Program
(Final Report) ST-2017-1796-01 (8530-2017-10)

Test Data		
PROPERTY	TEST METHOD	TYPICAL RESULTS
Fresh wet density	ASTM C 138	137-144 lb/ft ³ (2.2-2.3 kg/L)
Slump Flow* in (cm)	ASTM C1611	28.5 (72.5)
Visual Stability Index		0 (light)
J-Ring Slump Flow* in (cm)	ASTM C1621	28
Passing Ability, in (cm)		2"
Compressive strength 2 in (51 mm) cubes	ASTM C 109	1 day 7 days 28 days
Compressive strength 3 x 6 in (76 x 152 mm) cylinders		1 day 7 days 28 days
Flexural strength		1 day 7 days 28 days
Splitting tensile strength		1 day 7 days 28 days
Drying shrinkage		1 day 7 days 28 days
Rapid chloride test		1 day 7 days 28 days
TYPICAL PROPERTIES AT 70°F		
Compressive Strength, ASTM C 109	1 Day 7 Days 28 Days	3,500 psi (24.2 MPa) 5,000 psi (34.5 MPa) 6,500 psi (44.8 MPa) 8,000 psi (55.2 MPa)
Bond Strength, ASTM C 882	1 Day 7 Days 28 Days	3,500 psi (24.2 MPa) 5,000 psi (34.5 MPa) 6,500 psi (44.8 MPa) 8,000 psi (55.2 MPa)
Time of Set, ASTM C 266	Initial Set Final Set	5 Hours (approximately) 6 Hours (approximately)
Linear Length Change, ASTM C 157	28 Days Wet 28 Days Dry	+0.03% -0.05%
Chloride Ion Permeability, ASTM C 1202	Working Time at 70°F (21°C)	Very Low (<1,000 Coulombs) 60 minutes
Compressive Strength, psi	3 hours 1 day - 24 hours 7 days 28 days	> 2,300 > 3,000 > 4,000 > 7,000
Flexural Strength, psi	7 days 28 days	> 600 > 650
Splitting Tensile Strength, psi	28 days	> 300
Direct Tension Strength, psi	7 days 28 days	> 300 TBD
Bond Strength, psi	1 day - 24 hours 7 days	> 1,500 > 1,600
Scaling Resistance, lbs/ft ²	25 cycles	0
Modulus of Elasticity, ksi	28 days	3.17
Coefficient of Thermal Expansion, in/in/°F	28 days	2.01
Length Change, % of total length	28 days soak / 28 days dry	-0.001 / -0.001
	TBD - to be determined	ASTM C 157



Mission Statements

Protecting America's Great Outdoors and Powering Our Future

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Disclaimer:

Information in this report may not be used for advertising or promotional purposes. The data and findings should not be construed as an endorsement of any product or firm by the Bureau of Reclamation, Department of Interior, or Federal Government. The products evaluated in the report were evaluated for purposes specific to the Bureau of Reclamation mission. Reclamation gives no warranties or guarantees, expressed or implied, for the products evaluated in this report, including merchantability or fitness for a particular purpose.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188		
T1. REPORT DATE: SEPTEMBER 2017		T2. REPORT TYPE: RESEARCH		T3. DATES COVERED	
T4. TITLE AND SUBTITLE Evaluation of Packaged Concrete Repair Materials - Scoping Study			5a. CONTRACT NUMBER 17XR0680A1-RY15412017IS21796 (8)		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER 1541 (S&T)		
6. AUTHOR(S) Shannon Harrell, P.E. sharrell@usbr.gov 303-445-2370			5d. PROJECT NUMBER ST-2017-1796-01		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER 86-68530		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Shannon Harrell, P.E. Bureau of Reclamation Technical Services Center Concrete, Geotechnical, and Structural Laboratory (86-68530)			8. PERFORMING ORGANIZATION REPORT NUMBER 8530-2017-10		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Research and Development Office U.S. Department of the Interior, Bureau of Reclamation, PO Box 25007, Denver CO 80225-0007			10. SPONSOR/MONITOR'S ACRONYM(S) R&D: Research and Development Office BOR/USBR: Bureau of Reclamation DOI: Department of the Interior		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S) ST-2017-1796-01		
12. DISTRIBUTION / AVAILABILITY STATEMENT Final report can be downloaded from Reclamation's website: https://www.usbr.gov/research/					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT (Maximum 200 words) <i>The primary objective of this study was to research the importance of quality testing on packaged concrete repair materials. A literature review was performed which identified many quality issues leading to premature failure that have occurred over the last 10 years. The study also compared data sheets of typical repair products from different manufacturers that are frequently used in Reclamation structures to show how difficult it is to specify an "or equal" product when standard data sheet protocols are not followed. Some conclusions were developed based on recommendations from the literature review. Recommendations for next steps identify some recommended changes to specifications and future research topics.</i>					
15. SUBJECT TERMS concrete repair; test methods; repair material					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT U	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Shannon Harrell, P.E.
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER 303-445-2370

BUREAU OF RECLAMATION

Research and Development Office Science and Technology Program

Concrete, Geotechnical, and Structural Laboratory, 86-68530

(Final Report) ST-2017-1796-01 (8530-2017-10)

Evaluation of Packaged Concrete Repair Materials - Scoping Study

Prepared/Technical Approval by: Shannon Harrell, P.E.
Civil Engineer, Concrete, Geotechnical, and Structural Laboratory Group, 86-68530

Checked by: Westin Joy, P.E.
Civil Engineer, Concrete, Geotechnical, and Structural Laboratory Group, 86-68530

Peer Review: Kurt von Fay, BSCE, MBA
Civil Engineer, Concrete, Geotechnical, and Structural Laboratory Group, 86-68530

Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFRL	Air Force Research Laboratory
ASTM	American Society for Testing and Materials
DOT	Department of Transportation
ERDC	Engineer Research and Development Center
FDOT	Florida Department of Transportation
GSL	Geotechnical and Structure Laboratory
ICRI	International Concrete Repair Institute
NTPEP	National Transportation Product Evaluation Program
PT	Post-tensioned
PTI	Post-Tensioning Institute
SDC	Strategic Development Council
USACE	U.S. Army Corps of Engineers

Executive Summary

The primary objective of this study was to research the importance of quality testing on packaged concrete repair materials. A literature review was performed which identified many quality issues leading to premature failure that have occurred over the last 10 years. The study also compared data sheets of typical repair products from different manufacturers that are frequently used in Reclamation structures to show how difficult it is to specify an “or equal” product when standard data sheet protocols are not followed.

The concrete repair industry has grown to include a significant number of concrete repair material manufacturers, each producing numerous repair materials. Currently, each manufacturer produces their own material data sheets with properties (strength, durability, unit weight, air content, etc.), but they don't always use the same tests to determine the material properties for their various products, even though there is an industry approved data sheet protocol [1] that has been in existence for several years.

Many Reclamation concrete repair projects are located in remote places where delivering ready-mixed concrete to the site is a challenge. In these cases, some contractors request the use of a packaged concrete repair material that can be mixed on site. In other instances, the repair jobs only require a small quantity of concrete repair material, making the use of a packaged concrete repair material a more feasible alternative.

Some recommended next steps include the following:

- Reclamation should consider requiring packaged concrete repair materials be tested by third party programs similar to NTPEP.
- Reclamation specifications should consider requiring manufacturers to follow the data sheet protocol.
- Reclamation specifications should consider requiring field testing of packaged concrete repair materials.
- Reclamation specifications should consider requiring limited testing of packaged concrete repair materials sent to a job site for all projects using packaged concrete repair products. Materials supplied should be from the same batch plant and lot as supplied on the jobsite.
- Reclamation should consider an ongoing testing program that will test products from an approved list of repair materials. Although there are programs like NTPEP that has a database of test results for packaged repair products, many of the products Reclamation uses are not in that program.
 - Testing program would include testing products from the same batch plant and lot but also different lots and different batch plants to detect potential variation in products from the use of different local materials.
- Reclamation should consider seeing if NTPEP will broaden the program to evaluate repair materials that are more in line with Reclamation work (i.e. vertical and overhead packaged repair products or other concrete repair materials that are not necessarily rapid set.)

Contents

Executive Summary	vi
Abstract	8
Background	8
Conclusions	9
Discussion	9
Literature Review	10
U.S. Army Corps of Engineers - ERDC/GSL	11
U.S. Federal Highway Administration	12
Florida Department of Transportation (FDOT)	12
Strategic Development Council (SDC) Workshop	12
2013 - Establishing Standards of Care for Prepackaged Powdered Materials for Use in Construction	12
Results	14
Recommendations for Next Steps	25
References	26
Appendix A – Concrete Repair Material Data Sheets	A-1

Tables

Table 1. Material properties and test methods from the Data Sheet Protocol (ICRI 320.3R)	10
Table 2. Commonly Used Reclamation Repair Materials	15
Table 3. Strength and durability property test methods for self- consolidating repair materials	16
Table 4. Strength and durability property test methods for large structural repair materials	18
Table 5. Strength and durability property test methods for vertical and overhead repair materials	19
Table 6. Strength and durability property test methods for BASF repair materials	21
Table 7. Strength and durability property test methods for Ceratech Inc. repair materials	22
Table 8. Strength and durability property test methods for Sika repair materials	23
Table 9. Strength and durability property test methods for Five Star repair materials	24

Abstract

The primary objective of this study was to research the importance of quality testing on packaged concrete repair materials. A literature review was performed which identified many quality issues leading to premature failure that have occurred over the last 10 years. The study also compared data sheets of typical repair products from different manufacturers that are frequently used in Reclamation structures to show how difficult it is to specify an “or equal” product when standard data sheet protocols are not followed. Some conclusions were developed based on recommendations from the literature review. Recommendations for next steps identify some recommended changes to specifications and future research topics.

Background

The concrete repair industry has grown to include a significant number of concrete repair material manufacturers, each producing numerous repair materials. Currently, each manufacturer produces their own material data sheets with properties (strength, durability, unit weight, air content, etc.), but they don't always use the same tests to determine the material properties for their various products, even though there is an industry approved data sheet protocol [1] that has been in existence for several years. They may also manufacture the repair materials in different parts of the country and alter constituent materials slightly from batch to batch, depending on the costs and availability of constituents. Additionally, they may use different test methods from another manufacturer, which makes it difficult to determine if products are equal to one another.

Many Reclamation concrete repair projects are located in remote places where delivering ready-mixed concrete to the site is a challenge. In these cases, some contractors request the use of a packaged concrete repair material that can be mixed on site. In other instances, the repair jobs only require a small quantity of concrete repair material, making the use of a packaged concrete repair material a more feasible alternative. Lastly, many concrete repair products are rapid-setting, allowing the Reclamation structure to get back into service faster than traditional concrete solutions would allow. The Concrete, Geotechnical, and Structural Laboratory group is frequently called upon to recommend a packaged concrete repair material as an alternative to traditional concrete. In other cases, the contractor may request to substitute a different manufactured product for the one already specified. Testing commonly used manufactured packaged repair materials using the same industry standard test protocols will provide confidence regarding which products are comparable and what kind of performance should be expected.

Conclusions

- Several Government entities have acknowledged the need for quality verification through the use of their own testing programs.
 - USACE/ERDC
 - AASHTO/NTEP
- FHWA recommended trial batch testing of every manufactured lot of cementitious grout for chloride contamination after it was discovered that one manufacturer had varying levels of chloride in their packaged PT grout.
- The data sheet protocol has been hard to implement because:
 - Material manufacturers do not want to bare the additional cost of testing and additional testing won't equate to more product sold.
 - Specifiers have a hard time specifying something that none or only a very few manufacturers can provide. The additional cost of testing may be passed off onto the consumer, making the use of packaged materials more expensive.
- Current data sheets from manufacturers have numerous gaps in reporting that may mislead the specifier or consumer.
- Presenters at the SDC workshop recommended:
 - Standardized data sheet protocol and QA/QC procedures for manufacturers, specifiers, and owners.
 - Plant certification programs for cementitious grout and concrete repair material manufacturers be implemented.
 - Performance-based requirements and specifications.

Discussion

The International Concrete Repair Institute (ICRI) has developed a guideline, Guideline for Inorganic Repair Material Data Sheet Protocol (No. 320.3R-2012), to standardize the testing and reporting of data for inorganic repair materials (cement based repair materials). The guideline is known in the industry as the “Data Sheet Protocol” and will be referred to as such throughout the remainder of the report. ACI also has a guide for testing and reporting data for cementitious repair materials. This guide is ACI 364.3R-09, Guide for Cementitious Repair Material Data Sheet [2]. Table 1 lists the material properties and the recommended test methods from the data sheet protocol [1]. Unfortunately, not all manufacturers are using the data sheet protocol, so trying to specify equal products or evaluate contractor requests for substitutions is challenging.

Table 1. Material properties and test methods from the Data Sheet Protocol (ICRI 320.3R)

Material Property	Test Method
Compressive Strength	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Tensile Strength (Splitting)	ASTM C496/C496M
Tensile Strength (Direct)	CRD C164
Modulus of Elasticity	ASTM C469/C469M
Bond Strength	ICRI 210.3 ASTM C1583/C1583M
Length Change	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)
Coefficient of Thermal Expansion	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Resistance to Freezing-and-Thawing Cycles	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Scaling Resistance	ASTM C672/C672M
Rapid Chloride Ion Permeability	ASTM C1202
Sulfate Resistance	ASTM C1012/C1012M

Literature Review

The quality of packaged powdered materials has come into question in recent years. One of the main concerns is contamination of the materials. One of the main sources of contamination comes from improper cleanout of equipment between batches or during production of the raw materials. Mixing equipment, raw material trucks, and bagging line equipment can all lead to potential contamination of the final product if not carefully cleaned between loads. Other sources of potential contamination could come from storing raw materials in the wrong bins [2].

Variations in the weight of the material in the bags is also an issue. If the actual weight of the material in the bag varies from the weight identified on the packaging, the water-to-cementitious content of the mixed material will be variable, leading to potentially lower strength, segregation of the materials in the final product, or poor performance. Variations in the bagged weight can occur if the weighing systems at the batching plant are not properly calibrated [2].

Shelf life of packaged materials is also an issue. The listed shelf life can be influenced by moisture prematurely migrating into the dry ingredients. Moisture can be introduced if the bags are permeable or if the products are not stored in a facility that protects it from the elements [2].

U.S. Army Corps of Engineers - ERDC/GSL

The US Army Corps of Engineers are faced with problems similar to those that Reclamation faces. Specifying an appropriate repair material is challenging when there are a countless number of manufacturers on the market all claiming to have the better repair product. Many of these companies have several products that appear to be similar. The Army Corps of Engineers' (USACE) Engineer Research and Development Center (ERDC) Geotechnical and Structure Laboratory (GSL) had been testing cementitious repair materials through several different programs and funding years from 2006 to 2011.

2011 - Development of Laboratory Testing Criteria for Evaluating Cementitious, Rapid-Setting Pavement Repair Materials [3]

One of the primary objectives of this research was to identify cementitious, rapid-setting repair materials that could be used to repair airfield pavement. Each material was tested to determine the material properties that they felt were most important for achieving a durable, reliable, long lasting repair. Technical letters following research projects identified compressive strength, bond strength, thermal compatibility, shrinkage potential, and freeze-thaw resistance as the key characteristics used to evaluate airfield pavement repair material performance. The study incorporated numerous previous studies including:

- 2006-2010 ERDC laboratory and field tests
- 2007 Air Force Research Laboratory (AFRL) laboratory and field tests
- 2009-2010 Missouri University for Science and Technology (MST) lab studies

The study cited numerous instances where materials had to be retested because the repair material was reformulated. The report cited that Pavement SL was on a list of approved products because it had performed well in the field during previous investigations. The product had performed well in the 2007 field study, but did not perform well in 2008 after reformulation. Manufacturer's product formulations are proprietary, therefore it is unknown to the user when products change formulation. An ongoing testing program would be beneficial for determining how reformulations may affect field performance.

The American Association of State Highway and Transportation Officials (AASHTO) have a program called the National Transportation Product Evaluation Program (NTPEP) which is dedicated to testing manufactured products on a regular basis. NTPEP has a Technical Committee on Rapid Set Concrete Patch Materials which has defined a 2017 work plan to evaluate products every 5 years. The results of the program are posted to the NTPEP website and are intended to be used for product quality verification [4]. Although Reclamation typically does not use rapid set concrete patch materials, a program like this would be beneficial and their 5 year evaluation plan highlights the need for periodic evaluations of packaged concrete repair materials.

U.S. Federal Highway Administration

The U.S. Federal Highways Administration, Turner-Fairbank Highway Research Center has an ongoing laboratory study on corrosion of grouted post-tensioned (PT) bridges that are affected by chloride contamination of grouts. The study, which provides a review of historical chloride threshold values for metals in cementitious materials, was initiated after it was discovered that chloride-contaminated grout from packaged grout bags had led to corrosion of high-strength 7-wire strands in some post-tensioned bridges [5].

In February of 2012, a memorandum was sent out to Directors of Field Services updating them on the status of an evaluation of varying levels of chloride found in SikaGrout 300 PT cementitious grout, produced out of a specific Sika plant (Marion, OH plant). One of the outcomes from this incident was that the FHWA coordinated with the Post-Tensioning Institute (PTI) to make changes to specifications in an effort to increase quality assurance on future projects. Those changes were incorporated into the Third Edition of the PTI Specification for Grouting of Post-Tensioned Structures. A list of 35 bridges were identified in the report that potentially utilized grout with elevated chloride levels. The memorandum recommended chloride levels be tested on trial batches for every new project and any ongoing projects, prior to the release of the new PTI specification. In addition, the test should be performed at least once per manufactured lot [6].

Florida Department of Transportation (FDOT)

Florida's State Structures Maintenance Engineer developed a presentation outlining their findings following the failure of some PT tendons after packaged thixotropic grout came into use. This investigation also stemmed from the previously discussed excessive chloride level in SikaGrout 300 PT grout. The investigation found that other DOTs were reporting some SikaGrout 300 PT bag weights were 10% lighter than specified on the packaging. There were also wood chips found in packaged bags of thixotropic grout from various manufacturers [7].

Strategic Development Council (SDC) Workshop

The Strategic Development Council (SDC) is a council of the American Concrete Institute (ACI) Foundation. They were formed to "facilitate advancement in concrete technology". Every year, they have a fall and spring forum where experts in the concrete industry, including contractors, manufacturers, owners, private sector engineers, government, and academia come together to explore new technologies and to discuss issues in the concrete industry. The day preceding each forum is designated for a workshop to discuss issues in the concrete industry.

2013 - Establishing Standards of Care for Prepackaged Powdered Materials for Use in Construction

The workshop during the fall of 2013 discussed the quality issues related to packaged powder materials. Some of the issues that have been previously identified are unwanted chlorides, contamination of products from using the same blending equipment on several different products, bag weight variations, and other contamination issues (i.e. wood chips in the material) [8]. The following sections summarize some of the presentations from that meeting.

Manufacturing Overview [9]

Bagged products are made in the same way as traditional concrete. The concrete is batched by weight, mixed thoroughly, and then placed in bags for distribution. Specifications for these materials follow ASTM C387 which requires the aggregates be dried to less than 0.1% by mass. The quality control testing of these bagged products was described in the presentation as the following:

- Dried aggregate moisture content
- Aggregate gradations
- Sampling of raw materials
- Check computerized batch weight vs. mix design

The quality assurance testing described in the presentation included:

- Check bag weight
- Test package per ASTM C387
- Test packages for proportions vs. mix design

DOT Perspective [8]

This presentation described some of the issues DOTs face when using packaged materials. There were 14 issues listed by the presenter that were of concern to DOTs and their mission. The following list highlights those issues that are of greatest concern to Reclamation.

- Shelf Life - Packaged products usually have a shelf life. The package may be tested at the plant and be performing fine, but a package that has been sitting at a contractor's warehouse may have diminished properties if used after its use by date.
- Variability of products containing fly ash. There is variability in fly ash depending on where the fly ash is produced. Therefore, depending on where the product was packaged, the fly ash may be different.
- Properties not listed on data sheets. An example of this issue is that some products do not test for freeze-thaw resistance. If the product is to be used in a freeze-thaw prone area, it is unknown if the product will be durable.
- The presenter speculated that testing performed at the plant on the products are from fresh, controlled samples. However, the rest of the products may not follow the same strict batching and packaging measures.
- Vendors may change their ingredients without notifying the end user. Therefore, approved product lists may be out of date.

A few of the presenter's solutions to this problem are to perform trial batching to verify products, perform more testing on commonly used products, and perform annual or semi-annual testing of products that are on approved lists.

Existing Industry Quality Programs Perspective [10]

Some of the large manufacturers use multiple plants throughout the country to bring down distribution costs. Each plant uses local materials which may mean that there are different formulations for the same product depending on what is available in the area. There is concern as to whether there is equal performance for products produced in different parts of the country.

Data sheets produced by the manufacturer are used by specifiers to determine what the physical properties are of a given packaged product. However, there are some ways that were presented in which a manufacturer can mislead the specifier.

- Skip reporting the value
- Report values with unpublished test methods by either:
 - Not listing the test method
 - Calling the test “In-house”, “Modified”, or placing an “*” next to the method
- Use test methods not intended for use with the material
 - Use methods at a different time or temperature than standard
 - Change the curing procedure
- There is no independent data from a nonbiased laboratory
- What value is specified in the data sheet? Minimum, typical, average, or best ever?

The industry does support the use of the data sheet protocol. Material suppliers have additional costs related to testing their products per the protocol and they don’t see that sales would increase to cover the cost of the extra testing. Specifiers are hesitant to require the data sheet protocol because there are not many material suppliers that would perform the testing, thus reducing the number of products available for use. The manufacturers that do comply with the data sheet protocol will likely raise their prices.

Results

Table 2 below lists some of the packaged concrete repair products that are or have been commonly specified by Reclamation. The table contains a description of each product and their typical intended use.

Table 2. Commonly Used Reclamation Repair Materials

Company	Product	Description	Type of repair
BASF	MasterEmaco N 400 RS	Rapid-setting polymer-modified high-build repair mortar for vertical and overhead surfaces.	Vertical and Overhead
	MasterEmaco S 440	Pourable and Pumpable pre-extended self-consolidating repair mortar.	Self-consolidating
	MasterEmaco S 440Cl	Pourable and Pumpable pre-extended self-consolidating repair mortar with integral corrosion inhibitor.	Self-consolidating
	MasterEmaco S 466Cl	Flowable structural-repair concrete with integral corrosion inhibitor.	Large volume structural repairs
Ceratech Inc.	Pavemend SL Semi-Leveling	Rapid-setting, semi-leveling, cementitious structural repair concrete.	Self-consolidating
	VR Rapid Repair Vertical and Overhead Mortar	Cementitious, rapid setting, one step vertical and overhead structural repair mortar.	Vertical and Overhead
Five Star	Structural Concrete S300	Normal setting, one component, enhanced hydraulic cement mortar used for pourable and pumpable repairs.	Large volume structural repairs
	Structural Concrete V/O	High strength, rapid setting, one component, permanent concrete repair material for vertical and overhead structural repairs.	Vertical and Overhead
Sika	Sikacrete 211	One-component, cementitious, pumpable and pourable concrete mix.	Large volume structural repairs
	Sikacrete 211 SCC Plus	One-component, cementitious, polymer-modified, self-consolidating concrete mix with integral corrosion inhibitor.	Self-consolidating
	SikaRepair 224	One-component, cementitious, sprayable mortar for structural repairs.	Vertical and Overhead

Company	Product	Description	Type of repair
	SikaQuick VOH	Fast Setting, one component, ready-to-use repair mortar for vertical and overhead applications.	Vertical and Overhead

Table 3, Table 4, and Table 5 compare the test methods performed by different manufacturers for self-consolidating, large structural repairs, and vertical/overhead repair products, respectively. Red text indicates where different manufacturers use different test methods, which makes comparing those properties challenging for the specifier. The tables also note with bold text an extensive number of properties that had no values listed in the tables. The data sheet protocol test methods is also listed for reference and comparison.

Table 3. Strength and durability property test methods for self-consolidating repair materials

	BASF		Sika	Ceratech Inc.	
Property	MasterEmaco S 440	MasterEmaco S 440CI	Sikacrete 211 SCC Plus	Pavemend SL Semi-Leveling	ICRI 320.3R
Compressive Strength	ASTM C109 ASTM C39	ASTM C109 ASTM C39	ASTM C39	ASTM C39	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	<i>ASTM C348</i>	<i>ASTM C348</i>	<i>ASTM C78</i>	<i>ASTM C78</i>	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	<i>ASTM C882 (modified)</i>	No Data	<i>ASTM C882 (modified)</i>	<i>ASTM C882</i>	None
Direct Tensile Bond Strength	No Data	No Data	<i>ACI 503</i>	No Data	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	No Data	No Data	No Data	No Data	None
Tensile Strength (Splitting)	ASTM C496	ASTM C496	ASTM C496	ASTM C496	ASTM C496/C496M
Tensile Strength (Direct)	No Data	No Data	No Data	No Data	CRD C164
Modulus of Elasticity	No Data	No Data	No Data	ASTM C469	ASTM C469/C469M
Drying Shrinkage	<i>ASTM C157 (modified)</i> <i>ASTM C157 (unmodified)</i>	<i>ASTM C157 (modified)</i>	<i>ASTM C157</i>	<i>ASTM C157</i>	ASTM C157/C157M (modified as described per ICRI 320.3R-

	BASF		Sika	Ceratech Inc.	ICRI 320.3R
Property	MasterEmaco S 440	MasterEmaco S 440CI	Sikacrete 211 SCC Plus	Pavemend SL Semi-Leveling	
					2012 section 5.13)
Freeze/thaw Resistance	<i>ASTM C666</i>	No Data	<i>ASTM C666</i>	<i>ASTM C666 Procedure A</i>	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	<i>CRD C 39</i>	No Data	No Data	<i>AASHTO T 336</i>	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	No Data	ASTM C1202	ASTM C1202	No Data	ASTM C1202
Scaling Resistance	No Data	No Data	ASTM C672	ASTM C672	ASTM C672/C672M
Sulfate Resistance	No Data	No Data	ASTM C1012	No Data	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

Table 4. Strength and durability property test methods for large structural repair materials

	BASF	Sika	Five Star	
Property	MasterEmaco S 466CI	Sikacrete 211	Structural Concrete S300	ICRI 320.3R
Compressive Strength	<i>ASTM C109</i>	<i>ASTM C39</i>	<i>ASTM C109</i>	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	<i>ASTM C348</i>	<i>ASTM C78</i>	No Data	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	<i>ASTM C882 (modified)</i>	<i>ASTM C882 (modified)</i>	<i>ASTM C882</i>	None
Direct Tensile Bond Strength	ACI 503R Appendix A	No Data	No Data	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	Michigan DOT	No Data	No Data	None
Tensile Strength (Splitting)	ASTM C496	ASTM C496	No Data	ASTM C496/C496M
Tensile Strength (Direct)	No Data	No Data	No Data	CRD C164
Modulus of Elasticity	ASTM C469	No Data	No Data	ASTM C469/C469M
Drying Shrinkage	<i>ASTM C157 (modified)</i>	<i>ASTM C157</i>	<i>ASTM C157</i>	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)
Freeze/thaw Resistance	ASTM C666 Procedure A	No Data	No Data	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	No Data	No Data	No Data	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	ASTM C1202 AASHTO T 277	ASTM C1202	ASTM C1202	ASTM C1202
Scaling Resistance	ASTM C672	No Data	No Data	ASTM C672/C672M
Sulfate Resistance	ASTM C1012	No Data	No Data	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

Table 5. Strength and durability property test methods for vertical and overhead repair materials

	BASF	Ceratech Inc.	Sika		Five Star	ICRI 320.3R
Property	MasterEmaco N 400 RS	VR Rapid Repair Vertical and Overhead Mortar	SikaQuick VOH	SikaRepair 224	Structural Concrete V/O	
Compressive Strength	ASTM C109 ASTM C39	ASTM C109	ASTM C109	ASTM C109	ASTM C109	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	ASTM C348	ASTM C78	ASTM C293	ASTM C348	No Data	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	ASTM C882 (modified)	ASTM C882	ASTM C882 (modified)	ASTM C882 (modified)	ASTM C882	None
Direct Tensile Bond Strength	No Data	ASTM C496	ICRI No. 210.3	ACI 503	No Data	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	No Data	No Data	No Data	No Data	No Data	None
Tensile Strength (Splitting)	ASTM C496	ASTM C496	ASTM C496	ASTM C496	No Data	ASTM C496/C496M
Tensile Strength (Direct)	No Data	ASTM C496 ²	No Data	No Data	No Data	CRD C164
Modulus of Elasticity	ASTM C469	ASTM C469	ASTM C469	No Data	No Data	ASTM C469/C469M
Drying Shrinkage	ASTM C157	ASTM C157	ASTM C157	No Data	ASTM C157	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)

Evaluation of Packaged Concrete Repair Materials - Scoping Study

	BASF	Ceratech Inc.	Sika		Five Star	ICRI 320.3R
Property	MasterEmaco N 400 RS	VR Rapid Repair Vertical and Overhead Mortar	SikaQuick VOH	SikaRepair 224	Structural Concrete V/O	
Freeze/thaw Resistance	ASTM C666	No Data	No Data	No Data	ASTM C666 Procedure A	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	CRD C 39	AASHTO TP 60	No Data	No Data	No Data	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	ASTM C1202	No Data	ASTM C1202	ASTM C1202 AASHTO T 277	ASTM C1202	ASTM C1202
Scaling Resistance	No Data	ASTM C672	No Data	No Data	No Data	ASTM C672/C672M
Sulfate Resistance	No Data	No Data	No Data	ASTM C1012	No Data	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

² Data Sheet says direct tension, but test method is split tension.

Table 6, Table 7, Table 8, and Table 9 compare the test methods used by the same manufacturer on different repair materials. As can be seen, even the same manufacturer does not use the same test method for certain material properties on all their products.

Table 6. Strength and durability property test methods for BASF repair materials

Property	Product				ICRI 320.3R
	MasterEmaco S 440	MasterEmaco S 440CI	MasterEmaco S 466CI	MasterEmaco N 400 RS	
Compressive Strength	ASTM C109 ASTM C39	ASTM C109 ASTM C39	ASTM C109	ASTM C109 ASTM C39	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	ASTM C348	ASTM C348	ASTM C348	ASTM C348	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	ASTM C882 (modified)	No Data	ASTM C882 (modified)	ASTM C882 (modified)	None
Direct Tensile Bond Strength	No Data	No Data	ACI 503R Appendix A	No Data	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	No Data	No Data	Michigan DOT	No Data	None
Tensile Strength (Splitting)	ASTM C496	ASTM C496	ASTM C496	ASTM C496	ASTM C496/C496M
Tensile Strength (Direct)	No Data	No Data	No Data	No Data	CRD C164
Modulus of Elasticity	No Data	No Data	ASTM C469	ASTM C469	ASTM C469/C469M
Drying Shrinkage	ASTM C157 (modified) ASTM C157 (unmodified)	ASTM C157 (modified)	ASTM C157 (modified)	ASTM C157	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)
Freeze/thaw Resistance	ASTM C666	No Data	ASTM C666 Procedure A	ASTM C666	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	CRD C 39	No Data	No Data	CRD C 39	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	No Data	ASTM C1202	ASTM C1202 AASHTO T 277	ASTM C1202	ASTM C1202
Scaling Resistance	No Data	No Data	ASTM C672	No Data	ASTM C672/C672M
Sulfate Resistance	No Data	No Data	ASTM C1012	No Data	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

Table 7. Strength and durability property test methods for Ceratech Inc. repair materials

Property	Product		ICRI 320.3R
	Pavemend SL Semi-Leveling	VR Rapid Repair Vertical and Overhead Mortar	
Compressive Strength	<i>ASTM C39</i>	<i>ASTM C109</i>	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	ASTM C78	ASTM C78	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	ASTM C882	ASTM C882	None
Direct Tensile Bond Strength	No Data	ASTM C496	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	No Data	No Data	None
Tensile Strength (Splitting)	ASTM C496	ASTM C496	ASTM C496/C496M
Tensile Strength (Direct)	ASTM C496	No Data	CRD C164
Modulus of Elasticity	ASTM C469	ASTM C469	ASTM C469/C469M
Drying Shrinkage	ASTM C157	ASTM C157	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)
Freeze/thaw Resistance	ASTM C666 Procedure A	No Data	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	<i>AASHTO T 336</i>	<i>AASHTO TP 60</i>	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	No Data	No Data	ASTM C1202
Scaling Resistance	ASTM C672	ASTM C672	ASTM C672/C672M
Sulfate Resistance	No Data	No Data	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

Table 8. Strength and durability property test methods for Sika repair materials

Property	Product				ICRI 320.3R
	Sikacrete 211	SikaQuick VOH	SikaRepair 224	Sikacrete 211 SCC Plus	
Compressive Strength	ASTM C39	ASTM C109	ASTM C109	ASTM C39	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	ASTM C78	ASTM C293	ASTM C348	ASTM C78	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	ASTM C882 (modified)	ASTM C882 (modified)	ASTM C882 (modified)	ASTM C882 (modified)	None
Direct Tensile Bond Strength	No Data	ICRI No. 210.3	ACI 503	ACI 503	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	No Data	No Data	No Data	No Data	None
Tensile Strength (Splitting)	ASTM C496	ASTM C496	ASTM C496	ASTM C496	ASTM C496/C496M
Tensile Strength (Direct)	No Data	No Data	No Data	No Data	CRD C164
Modulus of Elasticity	No Data	ASTM C469	No Data	No Data	ASTM C469/C469M
Drying Shrinkage	ASTM C157	ASTM C157	No Data	ASTM C157	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)
Freeze/thaw Resistance	No Data	No Data	No Data	ASTM C666	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	No Data	No Data	No Data	No Data	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	ASTM C1202	ASTM C1202	ASTM C1202 AASHTO T 277	ASTM C1202	ASTM C1202
Scaling Resistance	No Data	No Data	No Data	ASTM C672	ASTM C672/C672M
Sulfate Resistance	No Data	No Data	ASTM C1012	ASTM C1012	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

Table 9. Strength and durability property test methods for Five Star repair materials

Property	Product		ICRI 320.3R
	Structural Concrete S300	Structural Concrete V/O	
Compressive Strength	ASTM C109	ASTM C109	Mortar – ASTM C109/C109M Extended mortar and concrete – ASTM C39/C39M
Flexural Strength	No Data	No Data	Mortar – ASTM C348 Extended mortar and concrete – ASTM C78/C78M
Slant Shear Bond Strength ¹	ASTM C882	ASTM C882	None
Direct Tensile Bond Strength	No Data	No Data	ICRI 210.3 ASTM C1583/C1583M
Direct Shear Bond Strength ¹	No Data	No Data	None
Tensile Strength (Splitting)	No Data	No Data	ASTM C496/C496M
Tensile Strength (Direct)	No Data	No Data	CRD C164
Modulus of Elasticity	No Data	No Data	ASTM C469/C469M
Drying Shrinkage	ASTM C157	ASTM C157	ASTM C157/C157M (modified as described per ICRI 320.3R-2012 section 5.13)
Freeze/thaw Resistance	No Data	ASTM C666 Procedure A	ASTM C666/C666M, Procedure A (in addition to the procedure described in ICRI 320.3R-2012 section 5.15)
Coefficient of Thermal Expansion	No Data	No Data	CRD C 39-81 (modified as described per ICRI 320.3R-2012 section 5.14)
Rapid Chloride Permeability	ASTM C1202	ASTM C1202	ASTM C1202
Scaling Resistance	No Data	No Data	ASTM C672/C672M
Sulfate Resistance	No Data	No Data	ASTM C1012/C1012M

¹ ICRI 320.3R Guideline for Inorganic Repair Material Data Sheet Protocol does not have a recommended shear strength test.

Recommendations for Next Steps

- Reclamation should consider requiring packaged concrete repair materials be tested by third party programs similar to NTPEP.
- Reclamation specifications should consider requiring manufacturers to follow the data sheet protocol.
- Reclamation specifications should consider requiring field testing of packaged concrete repair materials.
- Reclamation specifications should consider requiring limited testing of packaged concrete repair materials sent to a job site for all projects using packaged concrete repair products. Materials supplied should be from the same batch plant and lot as supplied on the jobsite.
- Reclamation should consider an ongoing testing program that will test products from an approved list of repair materials. Although there are programs like NTPEP that has a database of test results for packaged repair products, many of the products Reclamation uses are not in that program.
 - Testing program would include testing products from the same batch plant and lot but also different lots and different batch plants to detect potential variation in products from the use of different local materials.
- Reclamation should consider seeing if NTPEP will broaden the program to evaluate repair materials that are more in line with Reclamation work (i.e. vertical and overhead packaged repair products or other concrete repair materials that are not necessarily rapid set.)

References

- [1] ICRI Committee 320, Task Group, *Guideline for Inorganic Repair Material Data Sheet Protocol Guideline No. 320.3R-2012*, Rosemont, IL: International Concrete Repair Institute, 2012.
- [2] P. H. Emmons, F. R. Goodwin and M. M. Sprinkel, "Quality of Prepackaged Powdered Materials Used in Construction," *Concrete International*, pp. 43-47, 2014.
- [3] L. P. Priddy, "Development of Laboratory Testing Criteria for Evaluating Cementitious, Rapid-Setting Pavement Repair Materials," U.S. Army Engineer Research and Development Center, Vicksburg, MS, 2011.
- [4] NTPEP Technical Committee on Rapid Set Concrete Patching Materials, "NTPEP Committee Work Plan for Evaluation of Rapid Set Concrete Patching Materials for Portland Cement Concrete," National Transportation Product Evaluation Program, Washington, DC, 2016.
- [5] P. Y. Yirmani and H. Ghasemi, "Literature Review of Chloride Threshold Values for Grouted Post-Tensioned Tendons," Federal Highway Administration, McLean, VA, 2012.
- [6] J. Baxter, "Memorandum: ACTION: Elevated Chloride Levels in SikaGrout 300PT Cementitious Grout," Federal Highway Administration, 2012.
- [7] J. Pouliotte, *FDOT Grouted PT Inspection Findings and Future Direction*, unknown.
- [8] M. Sprinkel, "DOT Perspectives," in *Strategic Development Council Workshop*, Indianapolis, IN, 2013.
- [9] K. A. MacDonald, "How Bagged Products are Made," in *Strategic Development Council Workshop*, Indianapolis, IN, 2013.
- [10] F. Goodwin, "Existing Industry Quality Programs Perspective," in *Strategic Development Council Workshop*, Indianapolis, IN, 2013.

Appendix A – Concrete Repair Material Data Sheets

MasterEmaco® S 440CI

Pourable and pumpable pre-extended self-consolidating repair mortar with integral corrosion inhibitor

FORMERLY LA40 PMAC REPAIR MORTAR

PACKAGING

55 lb (25 kg) polyethylene-lined bags

YIELD

0.43 ft³ per 55 lb (0.012 m³/25 kg) bag

STORAGE

Store in unopened containers in cool, clean, dry conditions

SHELF LIFE

1 year when properly stored

VOC CONTENT

0 g/L less water and exempt solvents

DESCRIPTION

MasterEmaco S 440CI is a one-component, shrinkage-compensated, self-consolidating repair mortar that is polymer modified and contains an integral corrosion inhibitor. It is designed for large volume repairs, including structural elements in applications from 1.5" (38 mm) to full depth.

PRODUCT HIGHLIGHTS

- Dual expansion system compensates for shrinkage in plastic and hardened states
- High early strength allows early form removal
- Low permeability protects against carbon dioxide and chloride intrusion
- Excellent freeze/thaw resistance for durability in cold, wet environments
- Flowability makes it ideal for placement by pumping or pouring into congested locations
- Self-consolidation minimizes honeycombing without vibration
- Polymer modification improves adhesion and provides increased freeze/thaw stability
- Very low chloride permeability and an integral corrosion inhibitor protects reinforcing steel
- Only requires the addition of potable water

APPLICATIONS

- Interior and exterior
- Large volume structural repairs
- Repair or replacement of concrete elements

SUBSTRATE

- Concrete

HOW TO APPLY**SURFACE PREPARATION****CONCRETE**

1. Concrete must be structurally sound and fully cured (28 days).
2. Saw cut the perimeter of the area being repaired into a square with a minimum depth of ½" (13 mm).
3. Refer to current ICRI Guideline no. 310.2R for surface prep requirements to permit proper bond.

REINFORCING STEEL

1. Remove all oxidation and scale from the exposed reinforcing steel in accordance with ICRI Technical Guideline No. 310.1R.
2. For additional protection from future corrosion, coat the prepared reinforcing steel with MasterProtect P 8100 AP.

Technical Data

Test Data

PROPERTY	TEST METHOD	TYPICAL RESULTS
Fresh wet density	ASTM C 138	137–144 lb/ft ³ (2.2–2.3 kg/L)
Slump Flow* , in (cm) Visual Stability Index	ASTM C1611	28.5 (72.5) 0 (Highly Stable - No Bleeding)
J-Ring Slump Flow* , in (cm) Passing Ability , in (cm)	ASTM C1621	28 (71.5) 0.5 (1) No visible blocking
Compressive strength 2 in (51 mm) cubes	ASTM C 109	2,500 psi (17.2 MPa) @ 1 day 5,300 psi (36.5 MPa) @ 7 days 6,500 psi (44.8 MPa) @ 28 days
Compressive strength 3 x 6 in (76 x 152 mm) cylinders	ASTM C 39	5,700 psi (39.3 MPa) @ 28 days
Flexural strength	ASTM C 348	1,350 psi (9.3 MPa) @ 28 days
Splitting tensile strength	ASTM C 496	650 psi (4.5 MPa) @ 28 days
Drying shrinkage	ASTM C 157 (modified)	700 ustrains @ 28 days
Rapid chloride permeability	ASTM C 1202	Very low (less than 1,000 coulombs) @ 28 days

*2.75 qts water / 55 lb bag (Minimum water addition)

Results were obtained with a water/powder ratio of 2.7 qts per 55 lb (2.6 L per 25 kg) bag.

All application and performance values are typical for the material, but may vary with the test method, conditions, and configurations.

MIXING

1. Precondition material to 70° F \pm 5° (21° C \pm 3°) before mixing.
2. Ensure that MasterEmaco S 440CI is thoroughly mixed; a forced-action mixer is essential. Mixing in a suitably sized container using an appropriate paddle with a slow-speed (400–500 rpm) heavy-duty drill is acceptable. Do not use free-fall mixers.
3. Measure 2.7 quarts (2.6 L) of potable water and pour 2 quarts into the mixer. With the machine in operation, add 1 full 55 lb (25 kg) bag of MasterEmaco S 440CI and mix for 1 minute before adding the rest of the water. Always add powder into the water. The quantities mixed may be scaled up as required.
4. Mix for a further 2–3 minutes to obtain a smooth consistency.
5. When using the drill-and-paddle mixing method, place the complete 2.7 quarts (2.6 L) of water in the mixing drum. With the paddle rotating, add 1 full 55 lb (25 kg) bag of MasterEmaco S 440CI and mix 3 minutes to reach a smooth, even consistency.
6. Depending on the ambient temperatures and the desired consistency, additional water may be added. The total water content should not exceed 2.9 quarts (2.7 L) per 55 lb (25 kg) bag.

APPLICATION

1. Build forms in accordance with ACI 347R. Keep the unrestrained surface area of the repair to a minimum.
2. Saturate the prepared concrete substrate by filling the prepared formwork with clean water 24 hours before placement.
3. Immediately before the placement of MasterEmaco S 440CI, completely drain this water and seal the drainage outlets, leaving the substrate saturated surface-dry (SSD) with no ponded water remaining.
4. In jobsite circumstances where the formwork cannot be filled with water to achieve an SSD surface, the prepared concrete substrates must be thoroughly hosed down with clean water to achieve an equal level of saturation. Apply the repair material with sufficient pressure to ensure intimate contact with the substrate.
5. A long open-time bonding agent such as MasterEmaco P 124 may be used in place of a saturated substrate. In such a case, place the MasterEmaco S 440CI before the bonding agent becomes tack free.
6. Immediately after mixing, pump or pour the MasterEmaco S 440CI into the formed area. The material does not require vibrating.
7. The recommended application range of MasterEmaco S 440CI is from 40 to 85° F (4 to 29° C). Follow ACI 305 and 306 for hot or cold weather guidelines.

CURING

1. Leave the formwork in place until the compressive strength reaches 2,500 psi (17.2 MPa) or a strength specified by the engineer.
2. Cure with an approved curing compound compliant with ASTM C 309 or preferably ASTM C 1315. If the repair area will receive a coating, wet curing is recommended.

CLEAN UP

Clean tools and equipment with clean water immediately after use. Cured material must be removed mechanically.

FOR BEST PERFORMANCE

- Minimum ambient, surface, and material temperature is 45° F (7° C) and rising.
- Do not mix longer than 5 minutes.
- Minimum application thickness is 1.5" (38 mm).
- Do not mix partial bags.
- Do not use to make overlay repairs where the surface of fresh, wet MasterEmaco S 440CI will remain unrestrained during cure.
- Do not vibrate
- Do not add plasticizers, accelerators, retarders, or other additives.
- For professional use only; not for sale to or use by the general public.
- Make certain the most current versions of product data sheet and SDS are being used; visit www.master-builders-solutions.BASF.us to verify the most current versions.
- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

HEALTH, SAFETY AND ENVIRONMENTAL

Read, understand and follow all Safety Data Sheets and product label information for this product prior to use. The SDS can be obtained by visiting www.master-builders-solutions.basf.us, e-mailing your request to basfbscst@basf.com or calling 1(800)433-9517. Use only as directed.

**For medical emergencies only,
call ChemTrec® 1(800)424-9300.**

LIMITED WARRANTY NOTICE

BASF warrants this product to be free from manufacturing defects and to meet the technical properties on the current Technical Data Guide, if used as directed within shelf life. Satisfactory results depend not only on quality products but also upon many factors beyond our control. BASF MAKES NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ITS PRODUCTS. The sole and exclusive remedy of Purchaser for any claim concerning this product, including but not limited to, claims alleging breach of warranty, negligence, strict liability or otherwise, is the replacement of product or refund of the purchase price, at the sole option of BASF. Any claims concerning this product must be received in writing within one (1) year from the date of shipment and any claims not presented within that period are waived by Purchaser. BASF WILL NOT BE RESPONSIBLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFITS) OR PUNITIVE DAMAGES OF ANY KIND.

Purchaser must determine the suitability of the products for the intended use and assumes all risks and liabilities in connection therewith. This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights, nor shall any legal relationship be created by or arise from the provision of such information and advice. BASF reserves the right to make any changes according to technological progress or further developments. The Purchaser of the Product(s) must test the product(s) for suitability for the intended application and purpose before proceeding with a full application of the product(s). Performance of the product described herein should be verified by testing and carried out by qualified experts.

MasterEmaco® N 400 RS

Rapid-setting polymer-modified high-build repair mortar for vertical and overhead surfaces

FORMERLY HBA REPAIR MORTAR

PACKAGING

45 lb (20.4 kg) polyethylene bags
(MasterEmaco A 400 liquid sold
separately)
NO. 2 KIT: 225 lbs (102 kg) powder
and 5 gallon (18.9 L) liquid

YIELD

45 lbs (20.4 kg) of MasterEmaco N 400
mixed with 1 gallon (3.8 L)
of MasterEmaco A 400 yields
0.5 ft³ (0.015 m³)
NO. 2 KIT: 2.50 ft³ per 225 lb bag
(0.076 m³ per 102 kg bag)

STORAGE

Store and transport in unopened
containers in cool, clean, dry
conditions. Do not allow the liquid
component to freeze.

SHELF LIFE

12 months when properly stored

VOC CONTENT

0 g/L less water and exempt solvents

DESCRIPTION

MasterEmaco N 400 RS is a two-component polymer-modified rapid-setting mortar. It is used to repair vertical and overhead concrete surfaces in deep lifts.

PRODUCT HIGHLIGHTS

- Very rapid setting so repairs can be returned to service within hours
- Very high-build; up to 3" on vertical and 1½" on overhead surfaces
- Shrinkage compensation minimizes stresses on the bond line
- Low permeability provides protection against carbon dioxide and chloride intrusion
- Polymer modification improves adhesion and provides increased freeze/thaw stability
- Readily mixes with MasterEmaco A 400 to produce a workable consistency

APPLICATIONS

- Interior and exterior
- Vertical and overhead
- Above and below grade
- Spalls or holes in concrete
- Deteriorated edges

SUBSTRATES

- Concrete
- Masonry

HOW TO APPLY

SURFACE PREPARATION

1. Substrate must be structurally sound and fully cured (28 days).
2. Saw cut the perimeter of the area being repaired into a square with a minimum depth of ¼" (6 mm).
3. The surface to be repaired must be clean, free of laitance and saturated surface-dry (SSD) following ICRI Guideline no. 310.2 to permit proper bond.

REINFORCING STEEL

1. Remove all oxidation and scale from the exposed reinforcing steel in accordance with ICRI Technical Guideline No. 310.1R.
2. For additional protection from future corrosion, coat the prepared reinforcing steel with MasterProtect P 8100 AP.

Technical Data

Composition

MasterEmaco N 400 RS is a proprietary blend of cement, graded aggregate, shrinkage-compensating agents, additives, and latex.

Test Data

The following results were obtained with a liquid / powder ratio of 3.7 quarts per 45 lb (3.5 L per 20.5 kg) bag.

PROPERTY	RESULTS	TEST METHODS
Fresh wet density , lb/ft ³ (kg/m ³)	112 (1,794)	ASTM C 138
Set time , min, at 72° F (22° C), 50% relative humidity		ASTM C 191
Initial	15	
Final	30	
Compressive strength , psi (MPa), 2" (51 mm) cubes		ASTM C 109
1 day	1,700 (11.7)	
7 days	3,000 (20.7)	
28 days	5,000 (34.5)	
Compressive strength , psi (MPa), 3 by 6" (76 by 152 mm) cylinders, at 28 days	4,000 (27.6)	ASTM C 39
Flexural strength , psi (MPa) at 28 days	750 (5.2)	ASTM C 348
Slant shear bond strength , psi (MPa)		ASTM C 882, modified ¹
7 days	1,100 (7.6)	
at 28 days	1,250 (8.6)	
Splitting tensile strength , psi (MPa)		ASTM C 496
7 days	300 (2.1)	
28 days	360 (2.5)	
Elastic modulus , psi (GPa)	1.9×10^6 (13.3)	ASTM C 469
Coefficient of thermal expansion ² 1" (25 mm) prisms, in/in/° F (cm/cm/° C)	4.8×10^{-6} (8.6×10^{-6})	CRD C 39
Drying shrinkage , µstrain, at 28 days	350	ASTM C 157
Freeze/thaw resistance , % RDM ³ , at 300 cycles	96	ASTM C 666
Rapid chloride permeability , coulombs	670 (very low)	ASTM C 1202

All application and performance values are typical for the material, but may vary with test methods, conditions, and configurations.

¹No bonding agent scrubbed into prepared surface.

²Portland cement concrete, typical range is $4.0\text{--}8.0 \times 10^{-6}$ in/in/° F ($7.2\text{--}14.4 \times 10^{-6}$ cm/cm/° C), according to American Concrete Institute.

³Relative dynamic modulus

MIXING

1. Precondition material to 70° F \pm 5° (21° C \pm 3°) before mixing.
2. For the occasional 1 bag mix, mechanically mix at slow speed with a ¾" drill and mixing paddle.
3. Add approximately 3 quarts (2.8 L) of MasterEmaco A 400 into a clean mixing container. Gradually sift in powder ½ at a time while mixing continuously at slow speed (high speeds may entrain air). Mix for a minimum of 3 minutes to ensure a uniform, lump-free consistency. Do not exceed a total of 1 gallon (3.8 L) of mixing liquid per 43 lb (19.8 kg) bag.
4. For normal applications, place 3 quarts (2.8 L) of MasterEmaco A 400 into the clean mixer for each complete 45 lb (20.5 kg) bag of MasterEmaco N 400 RS. The powder should always be added to the liquid.
5. Ensure that MasterEmaco N 400 RS is thoroughly mixed; a forced-action mixer is essential. Do not use free-fall mixers.
6. Mix 3 minutes until fully homogeneous. Do not overmix. Never retemper MasterEmaco N 400 RS.
7. Depending on the ambient temperature and the desired consistency, additional MasterEmaco A 400 may be added, but the maximum liquid content should not exceed 1 gallon (3.8 L) per 45 lb (20.5 kg) bag of MasterEmaco N 400 RS.

APPLICATION

1. Dampen the surface with potable water; it must be saturated surface-dry (SSD) with no standing water.
2. With a gloved hand, scrub a small quantity of mixed material into the SSD substrate. Thoroughly key in and work the material throughout the cavity to promote bond. Do not apply more of the bond coat than can be covered with mortar before the bond coat dries.
3. MasterEmaco N 400 RS can be applied in single lifts up to 3" (76 mm) in thickness on vertical surfaces and up to 1½" (38 mm) in thickness on overhead surfaces (without the use of form work). Placement time is approximately 10 minutes at 70° F (21° C) and 50% relative humidity.
4. Trowel, shave or shape material to the desired finish after initial set.
5. The recommended application range of MasterEmaco N 400 RS is from 40 to 90° F (4 to 32° C). Follow ACI 305 and 306 for hot or cold weather guidelines.

CURING

Cure with an approved water based curing compound compliant with ASTM C 309 or preferably ASTM C 1315. If the repair area will receive a coating, wet curing is recommended.

CLEAN UP

Clean tools and equipment with clean water immediately after use. Cured material must be removed mechanically.

FOR BEST PERFORMANCE

- Do not mix partial bags.
- Do not overwork material
- Do not add plasticizers, accelerators, retarders, or other additives.
- Do not add any admixtures or extend with aggregate.
- Bonding agents are recommended for large areas as well as permanently damp areas.
- Protect from freezing for 24 hours after application.
- For warm-weather applications, consider using MasterEmaco N 400.
- For professional use only; not for sale to or use by the general public.
- Make certain the most current versions of product data sheet and SDS are being used; visit www.master-builders-solutions.basf.us to verify the most current versions.
- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

HEALTH, SAFETY AND ENVIRONMENTAL

Read, understand and follow all Safety Data Sheets and product label information for this product prior to use. The SDS can be obtained by visiting www.master-builders-solutions.basf.us, e-mailing your request to basfbcsct@basf.com or calling 1(800)433-9517. Use only as directed.

**For medical emergencies only,
call ChemTrec® 1(800)424-9300.**

LIMITED WARRANTY NOTICE

BASF warrants this product to be free from manufacturing defects and to meet the technical properties on the current Technical Data Guide, if used as directed within shelf life. Satisfactory results depend not only on quality products but also upon many factors beyond our control. BASF MAKES NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ITS PRODUCTS. The sole and exclusive remedy of Purchaser for any claim concerning this product, including but not limited to, claims alleging breach of warranty, negligence, strict liability or otherwise, is the replacement of product or refund of the purchase price, at the sole option of BASF. Any claims concerning this product must be received in writing within one (1) year from the date of shipment and any claims not presented within that period are waived by Purchaser. BASF WILL NOT BE RESPONSIBLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFITS) OR PUNITIVE DAMAGES OF ANY KIND.

Purchaser must determine the suitability of the products for the intended use and assumes all risks and liabilities in connection therewith. This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights, nor shall any legal relationship be created by or arise from the provision of such information and advice. BASF reserves the right to make any changes according to technological progress or further developments. The Purchaser of the Product(s) must test the product(s) for suitability for the intended application and purpose before proceeding with a full application of the product(s). Performance of the product described herein should be verified by testing and carried out by qualified experts.



We create chemistry

Technical Data Guide

3

03 01 00
Maintenance of
Concrete

MasterEmaco® S 440

Pourable and pumpable pre-extended
self-consolidating repair mortar

FORMERLY LA40 REPAIR MORTAR

PACKAGING

55 lb (25 kg) polyethylene-lined bags

YIELD

0.43 ft³ (0.012 m³) per 55 lb (25 kg) bag

STORAGE

Store in unopened containers in cool,
clean, dry conditions

SHELF LIFE

1 year when properly stored

VOC CONTENT

0 g/L less water and exempt solvents

DESCRIPTION

MasterEmaco S 440 is a one-component, shrinkage-compensated, self-consolidating repair mortar. It is designed for large volume repairs, including structural elements in applications from 1.5" (38 mm) to full depth.

PRODUCT HIGHLIGHTS

- Dual expansion system compensates for shrinkage in plastic and hardened states
- High early strength allows early form removal
- Low permeability protects against carbon dioxide and chloride intrusion
- Excellent freeze/thaw resistance for durability in cold, wet environments
- Flowability makes it ideal for placement by pumping or pouring into congested locations
- Self-consolidation minimizes honeycombing without vibration

APPLICATIONS

- Interior and exterior
- Large volume structural repairs
- Repair or replacement of concrete elements

SUBSTRATES

- Concrete

HOW TO APPLY

SURFACE PREPARATION

CONCRETE

1. Concrete must be structurally sound and fully cured (28 days).
2. Saw cut the perimeter of the area being repaired into a square with a minimum depth of ½" (13 mm).
3. Refer to current ICRI Guideline no. 310.2R for surface prep requirements to permit proper bond.

REINFORCING STEEL

1. Remove all oxidation and scale from the exposed reinforcing steel in accordance with ICRI Technical Guideline No. 310.1R.
2. For additional protection from future corrosion, coat the prepared reinforcing steel with MasterProtect P 8100 AP.

Technical Data

Composition

MasterEmaco S 440 is a proprietary blend of cement, graded aggregate, shrinkage-compensating agents, and additives.

Test Data

PROPERTY	RESULTS	TEST METHOD
Fresh wet density , lb/ft ³ (kg/m ³)	142 (2,275)	ASTM C 138
Slump Flow* , in (cm) Visual Stability Index	25 (63.5) 0 (Highly Stable - No Bleeding)	ASTM C1611
J-Ring Slump Flow* , in (cm) Passing Ability , in (cm)	24.5 (62.5) 0.5 (1) No visible blocking	ASTM C1621
Compressive strength , psi (MPa); 2" (51 mm) cubes 1 day 7 days 28 days	 2,500 (17.2) 5,000 (34.5) 6,000 (41.4)	ASTM C 109
Compressive strength , psi (MPa); 3 by 6" (76 by 152 mm) cylinders, at 28 days	5,000 (34.5)	ASTM C 39
Flexural strength , psi (MPa), at 28 days	1,150 (7.9)	ASTM C 348
Slant shear bond strength , psi (MPa), at 28 days	3,000 (20.7)	ASTM C 882, (modified ¹)
Splitting tensile strength , psi (MPa), at 28 days	500 (3.4)	ASTM C 496
Drying shrinkage , μ strain, at 28 days	350	ASTM C 157, (unmodified)
Drying shrinkage , μ strain, at 21 days	611	ASTM C 157, (modified)
Freeze/thaw resistance , % RDM ²	100	ASTM C 666
Coefficient of thermal expansion , in/in/° F (cm/cm/° C)	5.5 x 10 ⁻⁶ (9.9 x 10 ⁻⁶)	CRD C 39

¹No bonding agent

²RDM = Relative Dynamic Modulus

*2.75 qts water / 55 lb bag (Minimum water addition)

Results were obtained with a water per powder ratio of 2.7 qts per 55 lb (2.6 L per 25 kg) bag.

All application and performance values are typical for the material, but may vary with test methods, conditions, and configurations.

MIXING

1. Ensure that MasterEmaco S 440 is thoroughly mixed; a forced-action mixer is essential. Mixing in a suitably sized container using an appropriate paddle with a slow-speed (400–500 rpm) heavy-duty drill is acceptable. Do not use free-fall mixers.
2. Measure 2.7 quarts (2.6 L) of potable water and pour 2 quarts into the mixer. With the machine in operation, add 1 full 55 lb (25 kg) bag of MasterEmaco S 440 and mix for 1 minute before adding the rest of the water. Always add powder into the water. The quantities mixed may be scaled up as required.
3. Mix for a further 2–3 minutes to obtain a smooth consistency.
4. When using the drill-and-paddle mixing method, place the complete 2.7 quarts (2.6 L) of water in the mixing drum. With the paddle rotating, add 1 full 55 lb (25 kg) bag of MasterEmaco S 440 and mix 3 minutes to reach a smooth, even consistency.
5. Depending on the ambient temperatures and the desired consistency, additional water may be added. The total water content should not exceed 2.9 quarts (2.7 L) per 55 lb (25 kg) bag.

APPLICATION

1. Build forms in accordance with ACI 347R. Keep the unrestrained surface area of the repair to a minimum.
2. Saturate the prepared concrete substrate by filling the prepared formwork with clean water 24 hours before placement.
3. Immediately before the placement of MasterEmaco S 440, completely drain this water and seal the drainage outlets, leaving the substrate saturated surface-dry (SSD) with no ponded water remaining.
4. In jobsite circumstances where the formwork cannot be filled with water to achieve an SSD surface, the prepared concrete substrates must be thoroughly hosed down with clean water to achieve an equal level of saturation. Apply the repair material with sufficient pressure to ensure intimate contact with the substrate.
5. A long open-time bonding agent such as MasterEmaco P 124 may be used in place of a saturated substrate. In such a case, place the MasterEmaco S 440 before the bonding agent becomes tack free.
6. Immediately after mixing, pump or pour the MasterEmaco S 440 into the formed area. The material does not require vibrating.
7. The recommended application range of MasterEmaco S 440 is from 40 to 85° F (4 to 29° C). Follow ACI 305 and 306 for hot or cold weather guidelines.

CURING

1. Leave the formwork in place until the compressive strength reaches 2,500 psi (17.2 MPa) or a strength specified by the engineer.
2. Cure with an approved curing compound compliant with ASTM C 309 or preferably ASTM C 1315. If the repair area will receive a coating, wet curing is recommended.

CLEAN UP

Clean tools and equipment with clean water immediately after use. Cured material must be removed mechanically.

FOR BEST PERFORMANCE

- Minimum ambient, surface, and material temperature is 40° F (4° C) and rising.
- Do not mix longer than 5 minutes.
- Minimum application thickness is 1.5" (38 mm). When the depth is less than 1.5", use MasterEmaco S 440 MC.
- Do not mix partial bags.
- Do not use to make overlay repairs where the surface of fresh, wet MasterEmaco S 440 will remain unrestrained during cure.
- Do not vibrate
- Do not add plasticizers, accelerators, retarders, or other additives.
- For professional use only; not for sale to or use by the general public.
- Make certain the most current versions of product data sheet and SDS are being used; visit www.master-builders-solutions.BASF.us to verify the most current versions.
- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

HEALTH, SAFETY AND ENVIRONMENTAL

Read, understand and follow all Safety Data Sheets and product label information for this product prior to use. The SDS can be obtained by visiting www.master-builders-solutions.basf.us, e-mailing your request to basfbscst@basf.com or calling 1(800)433-9517. Use only as directed.

**For medical emergencies only,
call ChemTrec® 1(800)424-9300.**

LIMITED WARRANTY NOTICE

BASF warrants this product to be free from manufacturing defects and to meet the technical properties on the current Technical Data Guide, if used as directed within shelf life. Satisfactory results depend not only on quality products but also upon many factors beyond our control. BASF MAKES NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ITS PRODUCTS. The sole and exclusive remedy of Purchaser for any claim concerning this product, including but not limited to, claims alleging breach of warranty, negligence, strict liability or otherwise, is the replacement of product or refund of the purchase price, at the sole option of BASF. Any claims concerning this product must be received in writing within one (1) year from the date of shipment and any claims not presented within that period are waived by Purchaser. BASF WILL NOT BE RESPONSIBLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFITS) OR PUNITIVE DAMAGES OF ANY KIND.

Purchaser must determine the suitability of the products for the intended use and assumes all risks and liabilities in connection therewith. This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights, nor shall any legal relationship be created by or arise from the provision of such information and advice. BASF reserves the right to make any changes according to technological progress or further developments. The Purchaser of the Product(s) must test the product(s) for suitability for the intended application and purpose before proceeding with a full application of the product(s). Performance of the product described herein should be verified by testing and carried out by qualified experts.



We create chemistry

Technical Data Guide

3 | 03 01 00
Maintenance of
Concrete

MasterEmaco® S 466CI

Flowable structural-repair concrete with
integral corrosion inhibitor

FORMERLY EMACO® S66 CI

PACKAGING

55 lb (25 kg) polyethylene-lined bags
3,300 lb (1,500 kg) bulk bags

YIELD

0.43 ft³ (0.012 m³) per 55 lb bag (25 kg)

STORAGE

Store in unopened containers in a
cool, clean, dry area

SHELF LIFE

55 LB BAGS: 12 months
when properly stored
3,300 LB BAGS: 3 months
when properly stored

VOC CONTENT

0 g/L less water and exempt solvents

DESCRIPTION

MasterEmaco S 466CI is a flowable, shrinkage-compensated repair concrete. It is designed for large volume repairs, including structural elements in applications from 1" (50 mm) to full depth. It has a unique formulation that provides excellent bond, resistance to sulfates and chlorides, high electrical resistivity, low permeability, high-compressive strengths, and protection from corrosion.

PRODUCT HIGHLIGHTS

- Very low chloride permeability and an integral corrosion inhibitor protects reinforcing steel
- Only requires the addition of potable water
- High compressive strength
- Excellent freeze/thaw resistance for durability in cold, wet environments
- Abrasion resistant for repairs requiring protection from vehicular traffic
- Flowability makes it ideal for placement by pumping or pouring into congested locations
- Shrinkage compensated, minimizing cracking from drying shrinkage reducing stress at the bond line

APPLICATIONS

- Interior and exterior
- Large volume structural repairs
- Repair or replacement of concrete elements

SUBSTRATES

- Concrete

HOW TO APPLY

SURFACE PREPARATION CONCRETE

1. Substrate must be structurally sound and fully cured (28 days).
2. Saw cut the perimeter of the area being repaired into a square with a minimum depth of 1" (25 mm).
3. Refer to current ICRI Guideline no. 310.2R for surface prep requirements to permit proper bond.

REINFORCING STEEL

1. Remove all oxidation and scale from the exposed reinforcing steel in accordance with ICRI Technical Guideline No. 310.1R.
2. For additional protection from future corrosion, coat the prepared reinforcing steel with MasterProtect P 8100 AP.

Technical Data

Composition

MasterEmaco S 466CI is a rheoplastic cement-based silica-fume-modified flowable repair concrete.

Typical Properties

PROPERTY	VALUE
Unit weight, lb/ft ³ (kg/m ³)	142 (2,275)
Working time, min	90
Set times, hours (ASTM C 266)	
Initial set	4
Final set	6

Test Data

PROPERTY	RESULTS			TEST METHODS
	1 Day Psi (MPa)	7 Day Psi (MPa)	28 Day Psi (MPa)	
Splitting tensile strength	300 (2.1)	550 (3.8)	700 (4.8)	ASTM C 496
Flexural strength	— —	— —	770 (5.3)	ASTM C 348
Compressive strength	2,500 (17.2)	6,000 (41.4)	8,000 (55.2)	ASTM C 109
Direct tensile bond strength	— —	260 (1.8)	340 (2.3)	ACI 503R, Appendix A
Direct shear bond strength	350 (2.4)	500 (3.4)	600 (4.1)	Michigan DOT
Slant shear bond strength	— —	2,150 (14.8)	3,300 (22.8)	ASTM C 882, modified ¹
Drying shrinkage, %, at 28 days	0.06			ASTM C 157, modified ²
Modulus of elasticity, psi (GPa), at 28 days	5.90 x 10 ⁶ (40.7)			ASTM C 469
Rapid chloride permeability, coulombs, at 28 days	650			ASTM C 1202 / AASHTO T 277
Freeze/thaw resistance, % RDM, at 300 cycles	97.0			ASTM C 666, Procedure A
Scaling resistance, 50 cycles	2; slight to moderate			ASTM C 672
Sulfate resistance, %, length change at 6 months	+0.006			ASTM C 1012

¹No epoxy-bonding agent used

²CRI Guideline No. 03733, 3 by 3 by 10" (75 by 75 by 250 mm) prism, air cured

Results were obtained when material was mixed with 0.6 gallons (2.3 L) of water per bag and cured at 70° F (21° C).
Expect reasonable variations depending upon application methods, test methods, and curing conditions.

MIXING

1. Precondition material to 70° F \pm 5° (21° C \pm 3°) before mixing.
2. Add 0.40–0.60 gallons (1.5–2.3 L) of potable water for each 55 lb (25 kg) bag of MasterEmaco S 466CI. Mix mechanically using a slow-speed drill (400–600 rpm) and a Jiffy paddle or mix in an appropriately sized mortar mixer.
3. Pour approximately 90% of the mix water into the mixing container, and then charge the mixer with the MasterEmaco S 466CI. Add the remaining mix water as required to obtain desired consistency. Add enough water to the mixing container to obtain a slump of 4–6" (102–152 mm), approximately 0.6 gallons (2.3 L) per bag. Maximum recommended slump is 7" (175 mm).
4. Mix until a homogeneous consistency is achieved, approximately 3–5 minutes. Do not mix longer than 5 minutes.
5. For applications greater than 8" (203 mm), add up to 25 lbs (11.3 kg) of ½–¾" rounded, high-density, washed, SSD coarse aggregate for each 55 lbs (25 kg) of MasterEmaco S 466CI.
6. Aggregate must comply with the requirements of ASTM C 33.

APPLICATION

FORMED APPLICATIONS

1. Build forms in accordance with ACI 347R. Keep the unrestrained surface area of the repair to a minimum.
2. Saturate the prepared concrete substrate by filling the prepared formwork with clean water 24 hours before placement.
3. Immediately before the placement of MasterEmaco S 466CI, completely drain this water and seal the drainage outlets, leaving the substrate saturated surface-dry (SSD) with no ponded water remaining.
4. In jobsite circumstances where the formwork cannot be filled with water to achieve an SSD surface, the prepared concrete substrates must be thoroughly hosed down with clean water to achieve an equal level of saturation. Apply the repair material with sufficient pressure to ensure intimate contact with the substrate.
5. A long open-time bonding agent such as MasterEmaco P 124 may be used in place of a saturated substrate. In such a case, place the MasterEmaco S 466CI before the bonding agent becomes tack free.
6. Immediately after mixing, pump or pour the MasterEmaco S 466CI into the formed area. The material does not require vibrating.
7. The recommended application range of MasterEmaco S 466CI is from 45 to 85° F (7 to 29° C). Follow ACI 305 and 306 for hot or cold weather guidelines.

HORIZONTAL APPLICATIONS

1. After removing all standing water, thoroughly scrub a thin layer of bond coat into the saturated surface with a stiff-bristled broom or brush. Do not dilute the bond coat with water. Do not apply more of this bond coat than can be covered with mortar before the bond coat dries. Do not retemper the bond coat.
2. Immediately place the repair mortar from one side of the prepared area to the other. Work the material firmly into the bottom and sides of the patch to ensure good bond. Level the MasterEmaco S 466CI and screed it to the elevation of the existing concrete. Apply the appropriate finish.
3. Finish the completed repair, as required, taking care not to overwork the surface.
4. The recommended application range of MasterEmaco S 466CI is from 45 to 85° F (7 to 29° C). Follow ACI 305 and 306 for hot or cold weather.
5. A maximum of 90 minutes should be allowed to mix, place, and finish MasterEmaco S 466CI at 70° F (21° C).

CURING

1. Leave the formwork in place until the compressive strength reaches 2,500 psi (17.2 MPa) or a strength specified by the engineer.
2. Cure with an approved curing compound compliant with ASTM C 309 or preferably ASTM C 1315. If the repair area will receive a coating, wet curing is recommended.

CLEAN UP

Clean tools and equipment with clean water immediately after use. Cured material must be removed mechanically.

FOR BEST PERFORMANCE

- Do not mix partial bags.
- Do not add plasticizers, accelerators, retarders, or other additives.
- For professional use only; not for sale to or use by the general public.
- Make certain the most current versions of product data sheet and SDS are being used; visit www.master-builders-solutions.BASF.us to verify the most current versions.
- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

HEALTH, SAFETY AND ENVIRONMENTAL

Read, understand and follow all Safety Data Sheets and product label information for this product prior to use. The SDS can be obtained by visiting www.master-builders-solutions.basf.us, e-mailing your request to basfbscst@basf.com or calling 1(800)433-9517. Use only as directed.

**For medical emergencies only,
call ChemTrec® 1(800)424-9300.**

LIMITED WARRANTY NOTICE

BASF warrants this product to be free from manufacturing defects and to meet the technical properties on the current Technical Data Guide, if used as directed within shelf life. Satisfactory results depend not only on quality products but also upon many factors beyond our control. BASF MAKES NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ITS PRODUCTS. The sole and exclusive remedy of Purchaser for any claim concerning this product, including but not limited to, claims alleging breach of warranty, negligence, strict liability or otherwise, is the replacement of product or refund of the purchase price, at the sole option of BASF. Any claims concerning this product must be received in writing within one (1) year from the date of shipment and any claims not presented within that period are waived by Purchaser. BASF WILL NOT BE RESPONSIBLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFITS) OR PUNITIVE DAMAGES OF ANY KIND.

Purchaser must determine the suitability of the products for the intended use and assumes all risks and liabilities in connection therewith. This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights, nor shall any legal relationship be created by or arise from the provision of such information and advice. BASF reserves the right to make any changes according to technological progress or further developments. The Purchaser of the Product(s) must test the product(s) for suitability for the intended application and purpose before proceeding with a full application of the product(s). Performance of the product described herein should be verified by testing and carried out by qualified experts.



STRUCTURAL CONCRETE® S300

Long Working Time, Permanent Repair

PRODUCT DESCRIPTION

Five Star Structural Concrete® S300 is a normal setting, one component, enhanced hydraulic cement mortar used for pourable and pumpable repairs of concrete structures. Five Star Structural Concrete® S300 may be extended with coarse aggregate for large volume repairs and foundation upgrades. Five Star Structural Concrete® S300 provides increased corrosion protection of steel reinforced structures with migrating corrosion inhibitor technology and very low chloride ion permeability.

ADVANTAGES

- Large volume repairs
- 60 minute working time
- Very low chloride ion permeability
- Pumpable
- Available in 3,000 lb bulk bag packaging
- Coarse aggregate extension up to 100%
- One-day turnaround
- Outstanding corrosion resistance for protection and rehabilitation

USES

- Repair of concrete structures
- Industrial floors, slabs and overlays
- Equipment foundations
- Repair of tanks, sumps and curbs
- Ready-mix concrete truck batching
- Structural fortifications

PACKAGING AND YIELD

Five Star Structural Concrete® S300 is packaged in heavy-duty polyethylene lined bags and is available in 50 lb. (22.7 kg) units yielding approximately 0.40 cubic feet (11.3 liters) at maximum water, or 0.60 cubic feet (17.0 liters) with a 70% extension using 3/8" pea gravel. Five Star Structural Concrete® S300 is also available in 3,000 lb. (1,360 kg) bulk bags.

SHELF LIFE

One year in original unopened packaging when stored in dry conditions; high relative humidity will reduce shelf life.

TYPICAL PROPERTIES AT 70°F (21°C)	
Compressive Strength, ASTM C 109	
1 Day	3,500 psi (24.2 MPa)
3 Days	5,000 psi (34.2 MPa)
7 Days	6,500 psi (44.8 MPa)
28 Days	8,000 psi (55.2 MPa)
Bond Strength, ASTM C 882	
7 Days	2,300 psi (15.9 MPa)
Time of Set, ASTM C 266	
Initial Set	5 Hours (approximately)
Final Set	6 Hours (approximately)
Linear Length Change, ASTM C 157	
28 Days Wet	+0.03%
28 Days Dry	-0.05%
Chloride Ion Permeability, ASTM C 1202	
28 Days	Very Low (<1,000 Coulombs)
Working Time at 70°F (21°C)	60 minutes

**The data shown above reflects typical results based on laboratory testing under controlled conditions. Reasonable variations from the data shown above may result. Test methods are modified where applicable.*

PLACEMENT GUIDELINES

- SURFACE PREPARATION:** All horizontal and vertical concrete surfaces in contact with Five Star Structural Concrete® S300 shall be free of oil, grease, laitance, and other contaminants. All horizontal and vertical concrete surfaces must be clean, sound and rough to ensure a good bond. Mechanically roughen concrete surfaces in accordance with ICRI Technical Guideline 03732 to a minimum concrete surface profile roughness (CSP) 6 or greater. Remove all oxidation from exposed reinforcing steel. A perimeter edge and minimum depth of one inch (25 mm) should be provided for a durable repair. Feather edging is not desirable. Soak concrete surfaces prior to application with liberal quantities of potable water, leaving the concrete saturated and free of standing water, or use Five Star® Bonding Adhesive. Surfaces shall be conditioned to between 40°F and 90°F (5°C and 32°C) at the time of placement.
- FORMWORK:** Formwork shall be constructed of rigid non-absorbent materials, securely anchored, liquid-tight and strong enough to resist forces developed during placement. Areas where bond is not desired must be treated with form oil, paste wax or similar material. Joints may be necessary depending on pour dimensions. Any existing joints within the repair area should be maintained. Contact the Five Star Products' Engineering and Technical Service Center for further information.
- MIXING:** Wet down mortar mixer (stationary barrel with moving blades) before using and drain excess water. A drill and paddle mixer is acceptable for single bag mixes. With the mixer running add approximately 80% of the pre-measured potable water (total water content is 2¼ to 3 quarts potable water per 50 lb. unit) to the mixer. While mixing, slowly add Five Star Structural Concrete® S300 and mix to a uniform consistency for three to four minutes. Adjust consistency if necessary, but do not exceed maximum water content stated on the package or an amount that will cause segregation. Add clean, damp course aggregate meeting ASTM C 33 before final water adjustment. Do not mix more material than can be placed within 60 minutes.
- PLACEMENT PROCEDURES:** Whenever possible, place Five Star Structural Concrete® S300 full depth from one side of the repair to the other. To ensure optimal bond development, firmly work material into substrate. Placement should be continuous to prevent cold joints between pours. Finish as necessary.
SPECIAL CONDITIONS: For use in cold temperatures, Five Star Structural Concrete® S300 must be maintained at a temperature of at least 45°F (7°C). Protect from freezing until a compressive strength of at least 1,000 psi (6.9 MPa) is obtained. Faster strength gain will occur when the Five Star Structural Concrete® S300 and mixing water have been conditioned to a higher temperature prior to placement. In hot temperatures, Five Star Structural Concrete® S300 should be kept as cool as possible, but not exceeding 90°F (32°C).
- POST-PLACEMENT PROCEDURES:** Five Star Structural Concrete® S300 shall be protected from moisture loss until initial set, then immediately coated with an approved curing compound meeting water retention properties of ASTM C 309 or continuously wet cured for a minimum of three days. In-service operation may begin immediately after the required strength has been reached.

NOTE: PRIOR TO APPLICATION, READ ALL PRODUCT PACKAGING THOROUGHLY. For more detailed placement procedures, refer to the Five Star® Design-A-Spec™ installation guidelines or call the Five Star Products' Engineering and Technical Service Center at 1-800-243-2206.

- Never exceed the maximum recommended amount of mixing water as stated on the package or add an amount that will cause segregation.
- Under high evaporative conditions, an evaporation retarder or water fogging must be used prior to curing.
- For ready-mix truck mixing guidelines, contact the Five Star Products' Engineering and Technical Service Center at 1-800-243-2206.

CONSIDERATIONS

CAUTION Contains cementitious material and crystalline silica. International Agency for Research on Cancer has determined that there is sufficient evidence for the carcinogenicity of inhaled crystalline silica to humans. Take appropriate measures to avoid breathing dust. Avoid contact with eyes and contact with skin. In case of contact with eyes, immediately flush with plenty of water for at least 15 minutes. Immediately call a physician. Wash skin thoroughly after handling. Keep product out of reach of children. **PRIOR TO USE, REFER TO MATERIAL SAFETY DATA SHEET.**

For worldwide availability, additional product information and technical support, contact your local Five Star® distributor, local sales representative, or you may call the Five Star Products' Engineering and Technical Service Center at 1-800-243-2206.

SKU / PRODUCT CODE	DESCRIPTION	UNIT SIZE
28810	Structural Concrete® S300	50 lb. Bag

WARRANTY: "FIVE STAR PRODUCTS, INC. (FSP) PRODUCTS ARE MANUFACTURED TO BE FREE OF MANUFACTURING DEFECTS AND TO MEET FSP'S CURRENT PUBLISHED PHYSICAL PROPERTIES WHEN APPLIED IN ACCORDANCE WITH FSP'S DIRECTIONS AND TESTED IN ACCORDANCE WITH ASTM AND FSP STANDARDS. HOWEVER, SHOULD THERE BE DEFECTS OF MANUFACTURING OF ANY KIND, THE SOLE RIGHT OF THE USER WILL BE TO RETURN ALL MATERIALS ALLEGED TO BE DEFECTIVE, FREIGHT PREPAID TO FSP, FOR REPLACEMENT. THERE ARE NO OTHER WARRANTIES BY FSP OF ANY NATURE WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IN CONNECTION WITH THIS PRODUCT. FSP SHALL NOT BE LIABLE FOR DAMAGES OF ANY SORT, INCLUDING PUNITIVE, ACTUAL, REMOTE, OR CONSEQUENTIAL DAMAGES, RESULTING FROM ANY CLAIMS OF BREACH OF CONTRACT, BREACH OF ANY WARRANTY, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR FROM ANY OTHER CAUSE WHATSOEVER. FSP SHALL ALSO NOT BE RESPONSIBLE FOR USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT HELD BY OTHERS."

Five Star Products, Inc.
Corporate Headquarters
750 Commerce Drive
Fairfield, CT 06825 USA
Tel: 203-336-7900 • Fax: 203-336-7930
www.FiveStarProducts.com



© 2011 Five Star Products, Inc. | 11-08-2011
American Owned & Operated



STRUCTURAL CONCRETE® V/O

Vertical/Overhead Permanent Repair

PRODUCT DESCRIPTION

Five Star Structural Concrete® V/O is a high strength, rapid setting, one component, permanent concrete repair material for vertical and overhead structural repairs. Five Star Structural Concrete® V/O produces a repair which is dimensionally stable, develops an integral bond to existing concrete, and restores structural integrity within hours of placement. Five Star Structural Concrete® V/O provides increased corrosion protection to steel reinforced structures with migrating corrosion inhibitor technology and very low chloride ion permeability. Moisture sensitive coatings can be applied in 8 to 24 hours.

ADVANTAGES

- Can be troweled vertically or overhead
- Very low chloride ion permeability
- High 3-hour strength gains
- Can be coated in 8 to 24 hours
- One product for thin and thick placement
- Excellent freeze/thaw resistance
- Outstanding corrosion resistance for protection and rehabilitation

USES

- Rapid repair of load bearing walls, ceilings and other structural members
- Rapid repairs during shutdown
- Marine and hydraulic structure repairs

PACKAGING AND YIELD

Five Star Structural Concrete® V/O is packaged in heavy-duty polyethylene lined bags or plastic pails and is available in 50 lb. (22.7 kg) units yielding approximately 0.44 cubic feet (12.5 liters) at maximum water.

SHELF LIFE

One year (packaged in bags) or two years (packaged in pails) in original unopened packaging when stored in dry conditions; high relative humidity will reduce shelf life.

TYPICAL PROPERTIES AT 70°F (21°C)

Compressive Strength, ASTM C 109

3 Hours	2,500 psi (17.2 MPa)
1 Day	3,500 psi (24.2 MPa)
7 Days	4,000 psi (27.6 MPa)
28 Days	5,000 psi (34.5 MPa)

Bond Strength, ASTM C 882

1 Days	1,500 psi (10.4 MPa)
7 Days	2,200 psi (15.2 MPa)

Length Change, ASTM C 157

28 Days Wet	+ 0.04%
28 Days Dry	- 0.13%

Freeze/Thaw Resistance, ASTM C 666A

Relative Durability Modulus	95%
-----------------------------	-----

Chloride Ion Permeability, ASTM C 1202

28 Days	Very Low (<1,000 Coulombs)
---------	----------------------------

Working Time at 70°F (21°C)

15 minutes

**The data shown above reflects typical results based on laboratory testing under controlled conditions. Reasonable variations from the data shown above may result. Test methods are modified where applicable.*

PLACEMENT GUIDELINES

- 1. SURFACE PREPARATION:** All concrete surfaces in contact with Five Star Structural Concrete® V/O shall be free of oil, grease, laitance, and other contaminants. All concrete surfaces must be clean, sound and rough to ensure a good bond. Mechanically roughen concrete surfaces in accordance with ICRI Technical Guideline 03732 to a minimum concrete surface profile roughness (CSP) 6 or greater. Remove all oxidation from exposed reinforcing steel. A perimeter edge and minimum depth of 1/4 inch (6 mm) should be provided for a durable repair. Featheredging is not desirable. Soak concrete surfaces prior to application with liberal quantities of potable water, leaving the concrete saturated and free of standing water. Surfaces shall be conditioned to between 40°F and 90°F (5°C and 32°C) at time of placement.
- 2. MIXING:** Mix Five Star Structural Concrete® V/O thoroughly for approximately three to four minutes to a uniform consistency with a mortar mixer (stationary barrel with moving blades). A drill and paddle mixer is acceptable for single bag mixes. Mix Five Star Structural Concrete® V/O with 3 to 4 quarts potable water per 50 lb. unit. Working time is approximately 15 minutes at 70°F (21°C). Follow printed instructions on the package. Start by adding the minimum amount of pre-measured water to mixer and, after mixing for three to four minutes, adjust consistency as required to achieve non-sag consistency.
- 3. PLACEMENT PROCEDURES:** Firmly work a small amount of Five Star Structural Concrete® V/O into concrete surface with a trowel, taking care not to leave air pockets. Application is from one side of the repair to the other, filling the repair to the desired level. For multiple lift applications, contact Five Star Products' Engineering and Technical Service Center at 1-800-243-2206. Finish as necessary.
- 4. POST-PLACEMENT PROCEDURES:** Five Star Structural Concrete® V/O shall be kept continuously wet for at least 30 minutes after final set. Protect from freezing until a compressive strength of at least 1,000 psi (6.9 MPa) is reached.

NOTE: PRIOR TO APPLICATION, READ ALL PRODUCT PACKAGING THOROUGHLY. For more detailed placement procedures, refer to Design-A-Spec™ installation guidelines or call Five Star Products' Engineering and Technical Service Center at 1-800-243-2206.

CONSIDERATIONS

- Never exceed the maximum water content stated on the package.
- Temperature of materials, equipment and surfaces must be between 40°F and 90°F (5°C and 32°C) at time of placement. For cold and hot weather placement, consult the Five Star® Design-A-Spec™ installation guidelines.
- Substrate shall be free of frost and ice.

CAUTION

Contains cementitious material and crystalline silica. The International Agency for Research on Cancer has determined that there is sufficient evidence for the carcinogenicity of inhaled crystalline silica to humans. Take appropriate measures to avoid breathing dust. Avoid contact with eyes and contact with skin. In case of contact with eyes, immediately flush with plenty of water for at least 15 minutes. Immediately call a physician. Wash skin thoroughly after handling. Keep product out of reach of children. **PRIOR TO USE, REFER TO SAFETY DATA SHEET.**

For worldwide availability, additional product information and technical support, contact your local Five Star® distributor, local sales representative, or call Five Star Products' Engineering and Technical Service Center at 1-800-243-2206.

SKU/PRODUCT CODE	DESCRIPTION	#UNITS/PALLET	WEIGHT
29600	Structural Concrete® V/O	56	50 lbs. (22.68 Kg)
29500	Structural Concrete® V/O	36	53 lbs. (24.04 Kg)

WARRANTY: "FIVE STAR PRODUCTS, INC. (FSP) PRODUCTS ARE MANUFACTURED TO BE FREE OF MANUFACTURING DEFECTS AND TO MEET FSP'S CURRENT PUBLISHED PHYSICAL PROPERTIES WHEN APPLIED IN ACCORDANCE WITH FSP'S DIRECTIONS AND TESTED IN ACCORDANCE WITH ASTM AND FSP STANDARDS. HOWEVER, SHOULD THERE BE DEFECTS OF MANUFACTURING OF ANY KIND, THE SOLE RIGHT OF THE USER WILL BE TO RETURN ALL MATERIALS ALLEGED TO BE DEFECTIVE, FREIGHT PREPAID TO FSP, FOR REPLACEMENT. THERE ARE NO OTHER WARRANTIES BY FSP OF ANY NATURE WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IN CONNECTION WITH THIS PRODUCT. FSP SHALL NOT BE LIABLE FOR DAMAGES OF ANY SORT, INCLUDING PUNITIVE, ACTUAL, REMOTE, OR CONSEQUENTIAL DAMAGES, RESULTING FROM ANY CLAIMS OF BREACH OF CONTRACT, BREACH OF ANY WARRANTY, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR FROM ANY OTHER CAUSE WHATSOEVER. FSP SHALL ALSO NOT BE RESPONSIBLE FOR USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT HELD BY OTHERS."

Specifications Subject to Change.

For most current version of datasheet, go to FiveStarProducts.com

Five Star Products, Inc.
Corporate Headquarters
60 Parrott Drive
Shelton, CT 06484 USA
Tel: +1 203-336-7900 • Fax: +1 203-336-7913
FiveStarProducts.com



© 2017 Five Star Products, Inc. | 02-01-2017
12518 Rev. B | American Owned & Operated





**Semi-Leveling,
Pre-Extended (1/8")
RAPID REPAIR
FLOWABLE CONCRETE**



Updated 8.19.14

1 General Characteristics

SL® is a rapid setting, **semi-leveling**, cementitious structural repair concrete. It is a single component powder that is water activated. **SL**® has 15 to 20 minutes of working time and will reach compressive strengths of greater than 2,500 psi within 2 hours and more than 7,000 psi at 28 days. Designed for use in horizontal, sloped, or form and pour repair applications, **SL**® can be applied in ambient temperatures from 40 to 110 degrees Fahrenheit.

RECOMMENDED USES: **SL**® is an ideal rapid repair material for roads and bridges, airport runways, warehouse or manufacturing facility floors, post-tension cable repairs and form and pour projects. Can be used as a temporary repair for asphalt pavement.

2 Additional Physical Properties

UNIT WEIGHT (with water, sand & aggregate)
138 lb/ft³

SETTING TIME

Set Times at 72°F/22°C at 1" (2.54 cm) material depth

Initial set: 15 - 20 minutes

Final set: 25 - 35 minutes

VOLUME YIELD

0.38 ft³ (0.010 m³) per 51.8 lb. (23.2 kg) unit

3 Material Specifications

Results provided by licensed engineering test laboratory and represent typical results from production materials. Actual results may vary from third party testing results; however, CERATECH's materials *meet and/or exceed* **ASTM C928**, and *exceed* established internal quality control standards, (available upon request). All samples were air cured.

Property	As Packaged 4 in. x 8 in. cylinders	Test Method
Compressive Strengths, psi		
2 hours	> 2,500	ASTM C 39
1 day - 24 hours	> 5,000	ASTM C 39
7 days	> 6,000	ASTM C 39
28 days	> 7,000	ASTM C 39
Flexural Strength, psi		
1 day- 24 hours	> 850	ASTM C 78
7 days	> 875	ASTM C 78
28 days	> 900	ASTM C 78
Splitting Tensile Strength, psi		
28 days	> 500	ASTM C 496
Bond Strength, psi		
1 day- 24 hours	> 1,500	ASTM C 882
7 days	> 2,000	ASTM C 882
28 days	> 3,000	ASTM C 882
Rapid Freeze Thaw Resistance (Durability Factor - Retained percentage of Dynamic Modulus)		
300 cycles	98%	ASTM C 666A
Scaling Resistance, lbs/ft²		
50 cycles	Complies with ASTM C928	ASTM C 672
Modulus of Elasticity, psi		
28 days	5.2 X 10 ⁶	ASTM C 469
Coefficient of Thermal Expansion, in/in/°F		
28 days	5.83 X 10 ⁻⁶ /°F	AASHTO T 336
Length Change, % of total length		
28 days air cure	< -0.02	ASTM C 157





**Semi-Leveling,
Pre-Extended (1/8")
RAPID REPAIR
FLOWABLE CONCRETE**



Updated 8.19.14

4 Site Preparation

Surfaces should be prepared in accordance with ICRI 03730, "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion" and / or ACI 546R-96 "Concrete Repair Guide". Concrete surfaces should be prepared by appropriate mechanical methods to obtain an exposed aggregate surface with a minimum surface profile of +/- 1/16" (1.5 mm) in accordance with ICRI 03732. Pre-existing coatings or surface treatments should be completely removed. Dry, clean, stable surfaces are required. Remove all standing water. Reinforcing steel should have no loose scale. **Surfaces of host concrete must be damp.**

5 Mixing Instructions

Standard Mixing Procedures (Bucket Mixing with Drill & Paddle)

- Loosen material by tumbling bucket & dry mixing **before** adding water.
- To ensure product performance, **DO NOT divide or separate individual units into smaller portions. MIX ENTIRE CONTENTS AT ONE TIME.**
- A drill (6 amp minimum) with a mixer blade turning at least 500 to 800 rpm is required. Drills with speeds greater than 800 RPMs may entrain air in the mix.
- DO NOT HAND MIX**
- To begin the mixing process, add the proper amount of water:

For Each:	Add:
51 lb (23.2 kg) 5 gallon (18.9 L) bucket or bag	2 U.S. quarts (1.9 L) of water

- For application temps near 72°F/22°C, the ideal water temperature is between 65°F/18°C and 75°F/24°C.
- After adding the water, it is very important to rapidly incorporate all of the dry SL® powders into water to achieve a uniform wet mixture within the first 30 seconds of mixing. Mix for 3 1/2 minutes**

Standard Mixing Procedures for: Rotating Drum Concrete Mixer or Mortar Mixer

- Pre-wet cement mixer with water then drain all water from mixer (away from repair area).
- Start mixer - SL® requires a total of 2 quarts of water per 51 lb. unit. Initially, add 50% of total mix water to concrete mixer.**
- Add pre-determined units of SL®.
- Add in remaining **mix water**.

- Mix for 5 minutes total.
- Pour all contents into repair area.
- Clean mixer or repeat process for next batch.

NOTES:

- In ambient temperatures, < 50°F / 10°C, use warm water (70°F/22°C to 85°F/29°C).
- In ambient temperatures > 85°F/ 29°C, use cooler water (50°F/ 10°C to 60°F/16°C).
- Working times will vary when mix water temperature's are outside of these recommendations.
- Minimum recommended batch size is 2 units (Use 4 quarts of water for 2 bag batches).**

6 Packaging & Shelf Life

PACKAGING

51.8 lb (23.2 kg) 5 gallon (18.9 L) bucket
GSA P/N: C600
51.8 lb (23.2 kg) bag
GSA P/N: C650

SHELF LIFE

Buckets - 2 years (when stored in original unopened bucket)
Bags - 1 year

STORAGE

Buckets are environmentally sealed and require no special storage requirements
Bags must be kept dry and out of direct sunlight.

7 Limitations

- Not recommended for surface temperatures above **110°F/43°C** or below **40°F/10°C**. (Contact CERATECH Tech support for temperatures below 50°F).
- Can be mixed with drill and paddle, rotating drum concrete mixer or mortar mixer.





Semi-Leveling,
Pre-Extended (1/8")
**RAPID REPAIR
FLOWABLE CONCRETE**



Product Data Sheet



Updated 8.19.14

8 Application & Finish

- Surfaces of host concrete must be damp with no standing water.
- Working times are influenced by surface temperature and repair profile.
Working time can be extended by adding CERATECH's Set Retarder Admixture to mix water. (See Set Retardant product data sheet for more information).
- Minimum profile thickness is 0.38" (0.9 cm) as packaged. There are no restrictions to the depth of the repair profile.
- For best results, CERATECH recommends monolithic placement of repair materials. Maintain a minimum thickness of 1.00 inch if repair material must be layered. Subsequent placements must be placed before final set of underlying layer has been reached.
- Upon initial set, a broom finish can be applied. Upon final set, the material can be saw-cut, drilled, sanded and/or polished.
- Do not re-temper. The addition of water to the surface of the repair will negatively affect the materials final properties.
- **Self-curing, wet curing not required or recommended.**
- **General loading in 1.5 hours for wheeled traffic and 45 minutes for foot traffic after addition of water @70°F**
! Add 30 minutes for every 10°F drop in temperature.
Contact CERATECH Field Engineering for Cold Weather Applications (50°F / 10°C and below).
- **All previously existing joints must be re-established within 2-3 hours of final set.**
- Clean all tools and equipment with water prior to the material reaching final set.

9 Safety

- See **Material Safety Data Sheet (MSDS)**.
- This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.
- Dispose of water and materials in accordance with Federal, State and Local regulations.
- The use of a dust mask, safety goggles and gloves is recommended.
- Keep out of the reach of children.

WARRANTY:

CERATECH, Inc. ("CERATECH") warrants that its products are free from defects in materials and workmanship. If any CERATECH product fails to conform to this warranty, CERATECH will replace the product at no cost to the buyer or refund the purchase price, at CERATECH's election. Any warranty claim must be made within one (1) year from the date of the shipment of the product to the buyer. In no event shall CERATECH be liable to the buyer for any consequential or incidental damages of any nature. CERATECH MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WRITTEN OR ORAL AS TO THE MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF ITS PRODUCTS AND EXCLUDES THE SAME. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.





**Vertical, Overhead & Precast
RAPID REPAIR VERTICAL
& OVERHEAD MORTAR**



Updated 2.4.14

1 General Characteristics

Pavemend VR™ is a cementitious, rapid setting, one step vertical and overhead structural repair mortar with parging mortar consistency. It is a single component powder that is water activated. **Pavemend VR™** has 10 to 15 minutes of working time, **plus an additional 10 to 15 minutes to shape and shave the repair to match the existing contours of the host concrete.** **Pavemend VR™** will exceed compressive strengths of **2,500 psi in 3 hours from final set** and 6,000 psi at 28 days. **Pavemend VR™ can be applied in a single lift from 1/16" to over 4" without bonding agents and can be easily sculpted and shaped to match the existing concrete.** **Pavemend VR™** can be applied in ambient temperature ranges of 40 to 100 degrees Fahrenheit and **can be re-animated to a gel state prior to final set without additional water, providing ease of use and reduced material waste.**

RECOMMENDED USES: **Pavemend VR™** has been designed specifically for use in vertical and overhead applications such as spall repair and impact damage on beams, columns, pile and pile caps, tendon grouting, pressure bearing pre-cast pipe, curbs, steps, pre-stressed panels, tunnels, sewers, loading docks, silos, retaining walls, culverts, catch basins, decorative moldings, parapet walls, septic tanks, cold storage vaults and other pre-cast product repair applications.

2 Additional Physical Properties

UNIT WEIGHT (NEAT)

115 lb/ft³ (1842 kg/m³)

SETTING TIME

Set Times at 72°F/22°C at 1" (2.54 cm) material depth

Initial set: 15 - 20 minutes

Final set: 25 - 35 minutes

VOLUME YIELD

0.14ft³ (0.004 m³) per 17 lb (7.7 kg) 2 gallon unit

COVERAGE (Approximate / 2 gallon bucket)

1/16" (1.5mm)	26.9 ft ²
1/8" (3.0 mm)	13.4 ft ²
1/4" (6.0 mm)	6.7 ft ²
1/2" (12.0 mm)	3.7 ft ²
3/4" (19 mm)	2.2 ft ²

3 Material Specifications

Results provided by licensed engineering test laboratory and represent typical results from production materials. Actual results may vary from third party testing results; however, CERATECH's materials *meet and/or exceed* **ASTM C928**, and *exceed* established internal quality control standards, (available upon request). All samples were air cured.

Property	Results 2" cubes	Test Method
Compressive Strengths, psi		
3 hours	> 2,300	ASTM C 109
1 day - 24 hours	> 3,000	ASTM C 109
7 days	> 4,000	ASTM C 109
28 days	> 7,000	ASTM C 109
Flexural Strength, psi		
7 days	> 600	ASTM C 78
28 days	> 650	ASTM C 78
Splitting Tensile Strength, psi		
28 days	> 300	ASTM C 496
Direct Tension Strength, psi		
7 days	> 300	ASTM C 496
28 days	TBD	ASTM C 496
Bond Strength, psi		
1 day - 24 hours	> 1,500	ASTM C 882
7 days	> 1,600	ASTM C 882
Scaling Resistance, lbs/ft²		
25 cycles	0	ASTM C 672
Modulus of Elasticity, msi		
28 days	3.17	ASTM C 469
Coefficient of Thermal Expansion, in/in/°F		
28 days	2.01	AASHTO TP 60
Length Change, % of total length		
28 days soak / 28 days dry	-0.001 /-0.001	ASTM C 157
TBD - To be determined		



**Vertical, Overhead & Precast
RAPID REPAIR VERTICAL
& OVERHEAD MORTAR**



Updated 2.4.14

4 Site Preparation

Surfaces should be prepared in accordance with ICRI 03730, "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion" and / or ACI 546R-96 "Concrete Repair Guide". Concrete surfaces should be prepared by appropriate mechanical methods to obtain an exposed aggregate surface with a minimum surface profile of +/- 1/16" (1.5 mm) in accordance with ICRI 03732. Pre-existing coatings or surface treatments should be completely removed. Dry, clean, stable surfaces are required. Remove all standing water. Reinforcing steel should have no loose scale. **Surfaces of host concrete must be damp.**

5 Mixing Instructions

Standard NEAT Procedures (Bucket Mixing with Drill & Paddle)

- Loosen material by tumbling bucket & dry mixing *before* adding water.
- To ensure product performance, **DO NOT divide or separate individual units into smaller portions. MIX ENTIRE CONTENTS AT ONE TIME.**
- A drill (6 amp minimum) with a mixer blade turning at least 500 to 800 rpm is required. Drills with speeds greater than 800 RPMs may entrain air in the mix.
- **DO NOT HAND MIX**
- To begin the mixing process, add the proper amount of water:

For Each	Add
17lb (7.7 kg) - 2 gal. (7.6 L) bucket	1 U.S. quart (.95L) of water
- The desired water temperature is between **65°F/18°C** and **75°F/24°C**.
- **After adding the water, it is very important to rapidly incorporate all of the dry Pavemend VR™ powders to achieve a uniform wet mixture within the first 30 seconds of mixing.**
- In ambient temperatures under 72°F/22°C, CERATECH highly recommends the use of a thermal gun or temperature probe to verify that a **Critical Mix Temperature of 80°F/27°C has been reached.** Place material into repair area when this temperature has been achieved.
- In ambient temperatures over 72°F/22°C and without using a thermal measuring gun or temperature probe, mix material for 4 1/2 minutes in ambient temperatures of 72°F/22°C to 80°F/27°C, mix for 3 1/2 minutes in ambient temperatures of 80°F/27°C to 90°F/32°C, mix for 3 minutes in ambient temperatures above 90°F/32°C and place.

MIXING NOTES:

1. Pavemend VR™ undergoes an exothermic chemical reaction during blending. Heat, the by-product of the reaction, is the best indication that the

reaction is complete and that the product is ready to be poured. **Pavemend VR™ has a Critical Mix Temperature of 80°F/27°C which MUST BE REACHED before pouring to obtain optimum performance.** (In cold weather, it may be impossible to reach the **Critical Mix Temperature**, therefore a 20°F rise in material temperature is mandatory to ensure that the necessary chemical reactions have taken place to deliver the desired performance characteristics); Mixing time to reach the **Critical Mix Temperature** will vary with ambient air and mix water temperatures, however, **never mix Pavemend VR™ for less than 3 minutes.** It is recommended that a thermal gun or temperature probe be used to ensure that the **Critical Mix Temperature** has been achieved.

2. Special instructions for cold weather mixing: (Under 50°F)

- At temperatures of approximately 40°F, add a single unit of Pavemend VR™ Cold Weather Accelerant directly to material within bucket before adding mix water. Mix for 5 minutes (If Pavemend VR™ Cold Weather Accelerant is not available, mix material for approximately 10 minutes or achieve a 20°F rise in material temperature).
- At temperatures of approximately 50°F, add a single unit of Pavemend VR™ Cold Weather Accelerant directly to material within bucket before adding mix water. Mix for 4 minutes (If Pavemend VR Cold Weather Accelerant is not available, mix material for approximately 8 - 9 minutes or achieve a 20°F rise in material temperature).

6 Packaging & Shelf Life

PACKAGING

17 lb (7.7 kg) 2 gallon (7.6 L) bucket
GSA P/N: C800

SHELF LIFE

Buckets - 3 years (when stored in original unopened bucket)

STORAGE

Buckets are environmentally sealed and require no special storage requirements

7 Limitations

- Not recommended for surface temperatures above **120°F/49°C** or below **40°F/10°C**.
- Will not bond to polymers.
- Pumping not recommended.





Vertical, Overhead & Precast
**RAPID REPAIR VERTICAL
& OVERHEAD MORTAR**



Updated 2.4.14

8 Application & Finish

- Minimum profile thickness is 0.06" (1.5mm).
- Maximum profile thickness is not limited. When placing profiles greater than 4.00" (10 cm) layering is required to minimize sag.
- Scrub coats can be utilized when the host concrete is excessively dry or when very thin cosmetic applications are desired.
- **All existing control joints must be honored and re-established if necessary 1 - 3 hours from final set.**
- Finish the repair to the desired texture and / or to match the surrounding concrete. **DO NOT use additional water during the finishing process.**
- **Self-curing**
- Clean all tools and equipment with water prior to the material reaching final set.

9 Safety

- See **Material Safety Data Sheet (MSDS)**.
- This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.
- Dispose of water and materials in accordance with Federal, State and Local regulations.
- The use of a dust mask, safety goggles and gloves is recommended.
- Keep out of the reach of children.

WARRANTY:

CERATECH, Inc. ("CERATECH") warrants that its products are free from defects in materials and workmanship. If any CERATECH product fails to conform to this warranty, CERATECH will replace the product at no cost to the buyer or refund the purchase price, at CERATECH's election. Any warranty claim must be made within one (1) year from the date of the shipment of the product to the buyer. In no event shall CERATECH be liable to the buyer for any consequential or incidental damages of any nature. CERATECH MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WRITTEN OR ORAL AS TO THE MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF ITS PRODUCTS AND EXCLUDES THE SAME. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.



Sikacrete® 211 SCC Plus

One-component, cementitious, polymer-modified, self consolidating concrete mix with an integral migrating corrosion inhibitor

Description	Sikacrete® 211 SCC Plus is a one-component, self consolidating concrete containing factory blended coarse aggregate. This self consolidating concrete bag is silica fume and polymer modified and also contains a migrating corrosion inhibitor.
Where to Use	<ul style="list-style-type: none"> ■ Full depth repairs. ■ On grade, above and below grade on concrete. ■ On horizontal surfaces. ■ Vertical and overhead surfaces when formed and pumped or poured. ■ As a structural repair material for parking facilities, industrial plants, walkways, bridges, tunnels, dams, and balconies. ■ Filler for voids and cavities.
Advantages	<ul style="list-style-type: none"> ■ Self consolidating concrete - Excellent placement characteristics. ■ Polymer-modified. ■ Integral Penetrating Corrosion Inhibitor. ■ Silica Fume Enhanced. ■ Prepackaged coarse aggregate. Eliminates the need to extend material in the field. Eliminates the risk of reactive aggregate. ■ Can be pumped or poured into forms and gets excellent consolidation without vibrating.
Coverage	Approximately 0.50 ft. ³ /bag. Actual results on site may vary.
Packaging	65 lb. bag.

Typical Data (Material and curing conditions @ 73°F (23°C) and 50% R.H.)

RESULTS MAY DIFFER BASED UPON STATISTICAL VARIATIONS DEPENDING UPON MIXING METHODS AND EQUIPMENT, TEMPERATURE, APPLICATION METHODS, TEST METHODS, ACTUAL SITE CONDITIONS AND CURING CONDITIONS.

Shelf Life	1 year in original, unopened packaging.	
Storage Conditions	Store dry at 40°-95°F (4°-35°C). Condition material to 65°-75°F (18°-24°C) before using.	
Initial Spread	SCC, 27-33 Inches approx.	
Spread at 30 min.	> 15 inches	
Application Time	60 minutes	
Flexural Strength (ASTM C-78)	1 day	500 psi (3.4 MPa)
	7 days	750 psi (5.2 MPa)
	28 days	1,000 psi (6.9 MPa)
Splitting Tensile Strength (ASTM C-496)	7 days	750 psi (5.1 MPa)
	28 days	1,000 psi (6.9 MPa)
Slant Shear Bond Strength* (ASTM C-882 modified)	1 day	1,000 psi (6.9 MPa)
	7 days	1,500 psi (10.3 MPa)
	28 days	2,500 psi (17.2 MPa)
Direct Tensile Bond (ACI 503)	1 day	250 psi (1.7 MPa)
	7 days	300 psi (2.1 MPa)
Compressive Strength (ASTM C-39)	1 day	2,000 psi (13.8 MPa)
	7 days	5,500 psi (37.9 MPa)
	28 days	6,500 psi (44.8 MPa)
Shrinkage (ASTM C-157)	28 days	<0.05%
Chloride ion permeability (ASTM C-1202)	28 days	<650 Coloumbs

Freeze Thaw Resistance (ASTM C-666)	300 cycles	> 99%
Scaling Resistance (ASTM C-672)	50 cycles	2
Sulfate Resistance (ASTM C-1012)		
Length change after 6 months		0.006

* Mortar scrubbed into substrate.

How to Use

Surface Preparation

Remove all deteriorated concrete, dirt, oil, grease, and all bond-inhibiting materials from surface. Be sure repair area is not less than 1 in. in depth. Preparation work should be done by high pressure water blast, scabber, or other appropriate mechanical means to obtain an exposed aggregate surface with a minimum surface profile of $\pm 1/8$ in. (CSP-7-8). Saturate surface with clean water. Substrate should be saturated surface dry (SSD) with no standing water during application.

Reinforcing Steel: Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. Where corrosion has occurred due to the presence of chlorides, the steel should be high-pressure washed with clean water after mechanical cleaning. For priming and protection of reinforcing steel use Sika® Armatec® 110 EpoCem (consult Technical Data Sheet).

Mixing

Start mixing with 5.5 pints of water. An additional 0.5 pint can be added if needed. Do not over water as excess water will cause segregation. Add Sikacrete® 211 while continuing to mix. Mix to a uniform consistency, maximum 3 minutes. Mechanically mix with a low-speed drill (400-600 rpm) and paddle or in appropriate-size mortar mixer or concrete mixer.

Application

Pre-wet surface to SSD (Saturated Surface Dry). Ensure good intimate contact with the substrate is achieved. To accomplish this, material should be scrubbed into the substrate or other suitable means should be employed such as vibration of the material or pumping under pressure. Vibrate form while pouring or pumping. Pump with a variable pressure pump. Continue pumping until a 3 to 5 psi increase in normal line pressure is evident then STOP pumping. Form should not deflect. Vent to be capped when steady flow is evident, and forms stripped when appropriate.

Tooling and finishing

As per ACI recommendations for portland cement concrete, curing is required. Moist cure with wet burlap and polyethylene, a fine mist of water or a water based* compatible curing compound. Curing compounds adversely affect the adhesion of following layers of mortar, leveling mortar or protective coatings. Moist curing should commence immediately after finishing. Protect newly applied material from direct sunlight, wind, rain and frost.

*Pretesting of curing compound is recommended.

Limitations

- Application thickness: Minimum 1 in. (25 mm); Maximum 8 in. (200 mm). Thicker applications have been done successfully. Please consult Sika Technical Service.
- Minimum ambient and surface temperatures 45°F (7°C) and rising at time of application.
- As with all cement based materials, avoid contact with aluminum to prevent adverse chemical reaction and possible product failure. Insulate potential areas of contact by coating aluminum bars, rails, posts, with an appropriate epoxy such as Sikadur® 32 Hi-Mod.

PRIOR TO EACH USE OF ANY SIKA PRODUCT, THE USER MUST ALWAYS READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS ON THE PRODUCT'S MOST CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET WHICH ARE AVAILABLE ONLINE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING SIKA'S TECHNICAL SERVICE DEPARTMENT AT 800-933-7452. NOTHING CONTAINED IN ANY SIKA MATERIALS RELIEVES THE USER OF THE OBLIGATION TO READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS FOR EACH SIKA PRODUCT AS SET FORTH IN THE CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET PRIOR TO PRODUCT USE.

KEEP CONTAINER TIGHTLY CLOSED. KEEP OUT OF REACH OF CHILDREN. NOT FOR INTERNAL CONSUMPTION. FOR INDUSTRIAL USE ONLY. FOR PROFESSIONAL USE ONLY.

For further information and advice regarding transportation, handling, storage and disposal of chemical products, users should refer to the actual Safety Data Sheets containing physical, ecological, toxicological and other safety related data. Read the current actual Safety Data Sheet before using the product. In case of emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's most current Product Data Sheet, product label and Safety Data Sheet which are available online at <http://usa.sika.com/> or by calling Sika's Technical Service Department at 800-933-7452. Nothing contained in any Sika materials relieves the user of the obligation to read and follow the warnings and instruction for each Sika product as set forth in the current Product Data Sheet, product label and Safety Data Sheet prior to product use.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within shelf life. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor. NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS. SALE OF SIKA PRODUCTS ARE SUBJECT SIKA'S TERMS AND CONDITIONS OF SALE AVAILABLE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING 201-933-8800.

Visit our website at usa.sika.com

1-800-933-SIKA NATIONWIDE

Regional Information and Sales Centers. For the location of your nearest Sika sales office, contact your regional center.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 800-933-7452
Fax: 201-933-6225

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire
Quebec H9R 4A9
Phone: 514-697-2610
Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537



Sika and Sikacrete are registered trademarks. Made in USA. Printed in Canada.



Sikacrete® 211

One-component, cementitious,
pumpable and pourable concrete mix

Description	Sikacrete® 211 is a 1-component, portland-cement concrete containing factory blended coarse aggregate.
Where to Use	<ul style="list-style-type: none"> ■ Full depth repairs. ■ On grade, above, and below grade on concrete. ■ On horizontal, vertical and overhead surfaces. ■ As a structural repair material for parking facilities, industrial plants, walkways, bridges, tunnels, dams and balconies. ■ Filler for voids and cavities.
Advantages	<ul style="list-style-type: none"> ■ Pre-packaged coarse aggregate: Eliminates need to extend material in the field; Eliminates the risk of reactive aggregate. ■ High bond strength. ■ Compatible with coefficient of thermal expansion of concrete. ■ Increased resistance to deicing salts. ■ Simple-to-use labor-saving system. ■ Easily mixed. ■ Good freeze/thaw resistance. ■ Easily applied to clean, sound substrate. ■ Not a vapor barrier. ■ Not flammable
Coverage	Approximately 0.65 ft. ³ /unit
Packaging	80 lb. multi-wall bag.

Typical Data (Material and curing conditions @ 73°F (23°C) and 50% R.H.)

RESULTS MAY DIFFER BASED UPON STATISTICAL VARIATIONS DEPENDING UPON MIXING METHODS AND EQUIPMENT, TEMPERATURE, APPLICATION METHODS, TEST METHODS, ACTUAL SITE CONDITIONS AND CURING CONDITIONS.

Shelf Life	1 year in original, unopened packaging.
Storage Conditions	Store dry at 40°-95°F (4°-35°C). Condition material to 65°-75°F before using.
Color	Concrete gray when mixed.
Mixing Ratio	Mix with clean potable water at rate of up to 1 gallon per bag. Start with 4/5 gallon and mix to consistency required with remainder of gallon.
Application Time	Initial Slump 5"-7"; Slump at 30 minutes >4"
Flexural Strength (ASTM C-78)	28 days 700 psi (5.0 MPa)
Splitting Tensile Strength (ASTM C-496)	28 days 750 psi (3.4 MPa)
Bond Strength* (ASTM C-882 modified)	28 days 1,500 psi (15.2 MPa)
Compressive Strength (ASTM C-39)	
1 day	2,000 psi (13.8 MPa)
7 days	4,500 psi (31.0 MPa)
28 days	5,000 psi (37.9 MPa)
Shrinkage (ASTM C-157)	28 days <0.05%
Chloride ion permeability (Astm C-1202)	28 days <1,500 Coloumbs

* Mortar scrubbed into substrate.



PRIOR TO EACH USE OF ANY SIKA PRODUCT, THE USER MUST ALWAYS READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS ON THE PRODUCT'S MOST CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET WHICH ARE AVAILABLE ONLINE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING SIKA'S TECHNICAL SERVICE DEPARTMENT AT 800.933.7452 NOTHING CONTAINED IN ANY SIKA MATERIALS RELIEVES THE USER OF THE OBLIGATION TO READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS FOR EACH SIKA PRODUCT AS SET FORTH IN THE CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET PRIOR TO PRODUCT USE.

How to Use

Substrate

Concrete, mortar, and masonry products.

Surface Preparation

Concrete: Remove all deteriorated concrete, dirt, oil, grease, and all bond-inhibiting materials from surface. Be sure repair area is not less than 1 in. in depth. Preparation work should be done by high pressure water blast, scabbler, or other appropriate mechanical means to obtain an exposed aggregate surface with a minimum surface profile of $\pm 1/8$ in. (CSP-7). Saturate surface with clean water. Substrate should be saturated surface dry (SSD) with no standing water during application.

Reinforcing Steel: Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. Where corrosion has occurred due to the presence of chlorides, the steel should be high-pressure washed with clean water after mechanical cleaning. For priming of reinforcing steel use Sika® Armatec® 110 EpoCem (consult Technical Data Sheet).

Priming

For priming of reinforcing steel use Sika® Armatec® 110 EpoCem (consult Technical Data Sheet).

Mixing

Place 4/5 of 1 gallon water in mixing container. Add Sikacrete® 211 while continuing to mix. Add additional water up to 1 gallon total. Mix to a uniform consistency, maximum 3 minutes. Mechanically mix with a low-speed drill (400-600 rpm) and paddle or in appropriate size mortar mixer or concrete mixer.

Application

Form and pour or pump applications: Pre-wet surface to SSD. Ensure good intimate contact with the substrate is achieved. To accomplish this, material should be scrubbed into the substrate or other suitable means should be employed such as vibration of the material or pumping under pressure. Vibrate form while pouring or pumping. Pump with a variable pressure pump. Continue pumping until a 3 to 5 psi increase in normal line pressure is evident then STOP pumping. Form should not deflect. Vent to be capped when steady flow is evident, and forms stripped when appropriate.

Tooling & finishing

As per ACI recommendations for portland cement concrete, curing is required. Moist cure with wet burlap and polyethylene, a fine mist of water or a water based* compatible curing compound. Curing compounds adversely affect the adhesion of following layers of mortar, leveling mortar or protective coatings. Moist curing should commence immediately after finishing. Protect newly applied material from direct sunlight, wind, rain and frost.

*Pretesting of curing compound is recommended.

Limitations

- Application thickness: Minimum 1 in. (25 mm); Maximum 8 in. (200 mm)
- Minimum ambient and surface temperatures 45°F (7°C) and rising at time of application.
- Using SikaLatex®, SikaLatex® R or similar products will result in loss of slump and slump retention. Field tests for suitability are strongly recommended.

PRIOR TO EACH USE OF ANY SIKA PRODUCT, THE USER MUST ALWAYS READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS ON THE PRODUCT'S MOST CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET WHICH ARE AVAILABLE ONLINE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING SIKA'S TECHNICAL SERVICE DEPARTMENT AT 800.933.7452 NOTHING CONTAINED IN ANY SIKA MATERIALS RELIEVES THE USER OF THE OBLIGATION TO READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS FOR EACH SIKA PRODUCT AS SET FORTH IN THE CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET PRIOR TO PRODUCT USE.

KEEP CONTAINER TIGHTLY CLOSED. KEEP OUT OF REACH OF CHILDREN. NOT FOR INTERNAL CONSUMPTION. FOR INDUSTRIAL USE ONLY. FOR PROFESSIONAL USE ONLY.

For further information and advice regarding transportation, handling, storage and disposal of chemical products, users should refer to the actual Safety Data Sheets containing physical, ecological, toxicological and other safety related data. Read the current actual Safety Data Sheet before using the product. In case of emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's most current Product Data Sheet, product label and Safety Data Sheet which are available online at <http://usa.sika.com/> or by calling Sika's Technical Service Department at 800-933-7452. Nothing contained in any Sika materials relieves the user of the obligation to read and follow the warnings and instruction for each Sika product as set forth in the current Product Data Sheet, product label and Safety Data Sheet prior to product use.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within shelf life. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor. NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS. SALE OF SIKA PRODUCTS ARE SUBJECT SIKA'S TERMS AND CONDITIONS OF SALE AVAILABLE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING 201-933-8800.

Visit our website at usa.sika.com

1-800-933-SIKA NATIONWIDE

Regional Information and Sales Centers. For the location of your nearest Sika sales office, contact your regional center.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 800-933-7452
Fax: 201-933-6225

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire
Quebec H9R 4A9
Phone: 514-697-2610
Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537



Sika and Sikacrete are registered trademarks. Printed in Canada.



SikaQuick® VOH

Fast Setting, one component, cementitious vertical and overhead repair mortar with superior high build properties

Description	SikaQuick® VOH is a fast setting, one component, ready-to-use repair mortar for vertical and overhead applications using specialty cement blends.
Where to Use	<ul style="list-style-type: none"> ■ Fast repairs to overhead and vertical concrete and mortar surfaces on grade, above and below grade. ■ As a repair material for building facades, parking structures, industrial plants, bridges, etc. ■ As a fast setting repair material for new construction defects.
Advantages	<ul style="list-style-type: none"> ■ Minimal time required between lifts. ■ Fast finishing time ■ Time/labor-saving material; application up to 3 inches on vertical surfaces in one layer ■ Easy to use; just add water ■ High bond strength ensures excellent adhesion ■ High early and ultimate strength ■ Increased freeze/thaw durability and resistance to deicing salts ■ Suitable for exterior and interior applications. ■ Not a vapor barrier ■ Overhead thickness up to 2" ■ Fiber reinforced and polymer modified ■ Contains corrosion inhibitor
Coverage	~.44 cu. ft.
Packaging	44 lb bag

Typical Data (Material and curing conditions @ 73°F (23°C) and 50% R.H.)

RESULTS MAY DIFFER BASED UPON STATISTICAL VARIATIONS DEPENDING UPON MIXING METHODS AND EQUIPMENT, TEMPERATURE, APPLICATION METHODS, TEST METHODS, ACTUAL SITE CONDITIONS AND CURING CONDITIONS. THIS DATA REFLECTS MATERIAL TESTED AT A MIXING RATIO OF 6.25 PINTS/UNIT.

Shelf Life:	One year in original, unopened bags.			
Storage Conditions:	Store dry at 40°-95°F (4°-35°C).			
Product Conditioning:	Condition material to 65°-75°F before using.			
Color:	Concrete gray.			
Mixing Ratio:	6 - 6.5 pints/unit			
Density (Wet mix):	~ 125 lbs. / cu. ft.			
Application Time:	Approximately 20 minutes.			
Finishing Time:	20-30 minutes			
Lift Height:	Max: 3" Min: 1/8"			
Time Between Lifts:	After final set			
Splitting Tensile Strength, psi (ASTM C-496)		1 day 200	7 days 250	28 days 500
Compressive Strength, psi (ASTM C-109):	3 hrs >2000	1 day >3000	7 days >4500	28 days 5500
Flexural Strength, psi (ASTM C-293):		1 day 400	7 days 600	28 days 1000
Bond Strength*, psi (ASTM C-882 modified):		1 day 1000	7 days 1600	28 days 2000
Modulus of Elasticity, psi (ASTM C-469)			7 days >2.2 x 10 ⁶	
Rapid Chloride Permeability (ASTM C1202)		Low Range		
Bond Strength, psi - Direct Tensile (IRC No. 210.3):		Substrate failure >250		
Shrinkage (50% R.H.) (ASTM C-157; ICRI protocol):		<.05%		
Initial Set, min. (ASTM C-266)		20-25		
Final Set, min. (ASTM C-266)		30-40		

*Mortar scrubbed into substrate

How to Use	
Surface Preparation	<p>Concrete/Mortar: Remove all deteriorated concrete, dirt, oil, grease, and all bond-inhibiting materials from surface. Preparation work should be done by high pressure water blast, scab-bler or other appropriate mechanical means to obtain an exposed aggregate surface profile of +/- 1/16 in. (CSP-5). After preparation, substrate strength should be verified prior to patch placement. Substrate should be saturated surface dry (SSD) with no standing water during application.</p> <p>Reinforcing Steel: Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. Where corrosion has occurred due to the presence of chlorides, the steel should be high pressure washed with clean water after mechanical cleaning.</p>
Priming:	<p>Reinforcement Steel: For priming of reinforcement steel use Sika® Armatec® 110 EpoCem (Consult Technical Data Sheet).</p> <p>Concrete Substrate: A scrub coat of SikaQuick® VOH should be applied prior to placement of mortar. The repair mortar has to be applied into the wet scrub coat before it dries. The use of Sika® Armatec® 110 EpoCem as a bonding agent for concrete is not recommended.</p>
Mixing	<p>Wet down all tools and mixer to be used. Mix mechanically with a low-speed drill (400 - 600 rpm) and mixing paddle or mortar mixer. Mix to a uniform consistency, maximum 3 minutes. Manual mixing can be tolerated only for less than a full unit. Thorough mixing and proper proportioning of the powder and liquid is necessary. Inaccurate proportioning of the powder to liquid will result in a finished product that may not conform with stated properties.</p> <p>With water: Start mixing with 6 pints of water per 44 lb. bag. Adjust the water dosage by a maximum amount of +/- 1/2 pint, if necessary, to achieve the desired consistency. Do not over-water. Over-watering may result in difficulty handling and/or not meeting stated property values.</p> <p>With Latex R: Start mixing with 6 pints of SikaLatex® R per 44 lb. bag. Adjust the SikaLatex® R dosage by a maximum amount of +/- 1/2 pint, if necessary, to achieve the desired consistency.</p>
Application	<p>The mixed SikaQuick® VOH must be worked well into the prepared substrate, filling all pores and voids. Compact well. Force material against edge of repair working towards the center. Thoroughly compact the mortar around exposed reinforcement. After filling repair, consolidate, then screed. Finish with steel, magnesium, wood, plastic floats, or damp sponges, depending on the desired surface texture. Where multiple lifts are required, score top surface on each lift to produce a roughened substrate for next lift. Allow preceding lift to harden before applying fresh material. Saturate surface of the lift with clean water. If previous layers are over 6 hours old, mechanically prepare the substrate and dampen.</p>
Tooling and Finishing	<p>As per ACI recommendations for portland cement concrete, curing is required. Moist cure with wet burlap and polyethylene, a fine mist of water or a water based* compatible curing compound. Curing compounds adversely affect the adhesion of following lifts of mortar, leveling mortar or protective coatings. Moist curing should commence immediately after finishing. Protect freshly applied mortar from direct sunlight, wind, rain and frost.</p> <p>* Pretesting of curing compound is recommended.</p>
Removal	<p>Cured product must be removed mechanically.</p>
Over Painting	<p>Acrylic waterbased systems - 4 hrs Epoxy/PU based systems - 6 hrs Compatibility and adhesion testing is always recommended.</p>
Limitations	<ul style="list-style-type: none"> ■ Application thickness: Minimum: With water: 1/8 inch (3 mm). Maximum in one lift: 3 inches (75 mm) vertical, 2 inches (51 mm) overhead. ■ Minimum ambient and surface temperatures 45°F (7°C) and rising at time of application. ■ To control setting times, cold water should be used in hot weather and hot water used in cold weather. ■ Do not use solvent based curing compounds. As with all cement based materials, avoid contact with aluminum to prevent adverse chemical reaction and possible product failure. Insulate potential areas of contact by coating aluminum bars, rails, posts etc. with an appropriate epoxy such as Sikadur® Hi-Mod 32. ■ Remixing product after it begins to set is prohibited. ■ Do not use Sika® Armatec® 110 EpoCem as a bonding agent with SikaQuick® VOH.

Construction



PRIOR TO EACH USE OF ANY SIKA PRODUCT, THE USER MUST ALWAYS READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS ON THE PRODUCT'S MOST CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET WHICH ARE AVAILABLE ONLINE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING SIKA'S TECHNICAL SERVICE DEPARTMENT AT 800.933.7452 NOTHING CONTAINED IN ANY SIKA MATERIALS RELIEVES THE USER OF THE OBLIGATION TO READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS FOR EACH SIKA PRODUCT AS SET FORTH IN THE CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET PRIOR TO PRODUCT USE.

KEEP CONTAINER TIGHTLY CLOSED. KEEP OUT OF REACH OF CHILDREN. NOT FOR INTERNAL CONSUMPTION. FOR INDUSTRIAL USE ONLY. FOR PROFESSIONAL USE ONLY.

For further information and advice regarding transportation, handling, storage and disposal of chemical products, users should refer to the actual Safety Data Sheets containing physical, ecological, toxicological and other safety related data. Read the current actual Safety Data Sheet before using the product. In case of emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's most current Product Data Sheet, product label and Safety Data Sheet which are available online at <http://usa.sika.com/> or by calling Sika's Technical Service Department at 800-933-7452. Nothing contained in any Sika materials relieves the user of the obligation to read and follow the warnings and instruction for each Sika product as set forth in the current Product Data Sheet, product label and Safety Data Sheet prior to product use.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within shelf life. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor. NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS. SALE OF SIKA PRODUCTS ARE SUBJECT SIKA'S TERMS AND CONDITIONS OF SALE AVAILABLE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING 201-933-8800.

Visit our website at usa.sika.com

1-800-933-SIKA NATIONWIDE

Regional Information and Sales Centers. For the location of your nearest Sika sales office, contact your regional center.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 800-933-7452
Fax: 201-933-6225

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire
Quebec H9R 4A9
Phone: 514-697-2610
Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537



Sika and SikaGrout are registered trademarks.
Printed in Canada.

Product Data Sheet

Edition 7.14.2014

SikaRepair® 224

SikaRepair® 224

One-component, cementitious,
sprayable mortar for structural repairs

Description	SikaRepair® 224 is a one-component, pre-packaged, ready-to-use, cementitious, silica fume, fiber reinforced, high strength shrinkage-compensated mortar. Formulated for application by trowel or low pressure spray. It is designed especially for repair of overhead and vertical surfaces.
Where to Use	A high performance repair mortar for wet spray application. Suitable for new construction, repairs, and maintenance work. Typical applications include: <ul style="list-style-type: none"> ■ Structural repair material for water and wastewater treatment plants, parking structures, industrial plants, bridges, tunnels and dams, etc. ■ Use on vertical and overhead surfaces. ■ Use on grade, above, and below grade on concrete and mortar. ■ Potable water tank. (NSF approved in Marion, OH and Santa Fe Springs, CA)
Advantages	<ul style="list-style-type: none"> ■ Ready-for-use, one-component material. ■ Easy to use; just add water. ■ Sprayable system. ■ Potable water approved. ■ Superior workability. Can be trowelled and screeded after application. ■ Labor-saving system. ■ Superior abrasion resistance over conventional Portland cement mortar. ■ Bond strength ensures superior adhesion. ■ Not a vapor barrier. ■ Compatible with coefficient of thermal expansion of concrete. ■ Increased resistance to de-icing salts. ■ Good freeze/thaw resistance. ■ High early strengths. ■ Very low shrinkage. ■ Silica Fume enhanced. ■ Fiber reinforced.
Coverage	Yield in service will vary. Average yield is approximately 0.40 cu. ft./bag. Estimating should be based on prior experience or actual field evaluation.
Packaging	50-lb. (22.7 kg) multi-wall bags.

Typical Data (Material and curing conditions @ 73°F and 100% R.H.)

RESULTS MAY DIFFER BASED UPON STATISTICAL VARIATIONS DEPENDING UPON MIXING METHODS AND EQUIPMENT, TEMPERATURE, APPLICATION METHODS, TEST METHODS, ACTUAL SITE CONDITIONS AND CURING CONDITIONS.

Shelf Life	1 year in original, unopened bags.
Storage Conditions	Store dry at 40°-95°F (4°-35°C). Condition material to 65°-75°F before using.
Color	Dark gray.
Mixing Ratio	3/4 gallon to 7/8 gallon liquid per 50 lb. bag of material
Density (wet mix)	125 lbs./cu. ft. (2.0 kg./l.)
Compressive Strength (ASTM C-109)	73°F
	1 day 4,500 psi (31 MPa)
	7 day 8,000 psi (55 MPa)
	28 day 10,000 psi (69 MPa)
Flexural Strength (ASTM C-348)	28 day 1,100 psi (7.6 MPa)
Tensile Strength (ASTM C-496)	28 day 735 psi (5.0 MPa)
Direct Tensile Pull off (ACI 503)	28 day greater than 350 psi (Failure in substrate. Substrate prepared with 20,000 psi hydroblasting)
Slant Shear (ASTM C -882 modified)	28 day >2,500 psi (24.1 MPa)
Chloride Permeability (ASTM C1202/AASHTO T277)	28 day less than 500 coulombs
Sulfate Resistance (ASTM C-1012)	1 year less than 0.06%
Setting Time (ASTM C 266)	Initial: 2 to 3 hours. Final: 5 to 6.5 hours.



PRIOR TO EACH USE OF ANY SIKA PRODUCT, THE USER MUST ALWAYS READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS ON THE PRODUCT'S MOST CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET WHICH ARE AVAILABLE ONLINE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING SIKA'S TECHNICAL SERVICE DEPARTMENT AT 800.933.7452 NOTHING CONTAINED IN ANY SIKA MATERIALS RELIEVES THE USER OF THE OBLIGATION TO READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS FOR EACH SIKA PRODUCT AS SET FORTH IN THE CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET PRIOR TO PRODUCT USE.

How to Use

Surface Preparation

Substrate must be sound, clean, and free from oil, grease, loose material, surface contaminants and other bond-inhibiting materials. Steel reinforcement must be clean and free from any rust. Be sure repair area is not less than 3/8 in. in depth. Preparation work should be done by high pressure water blast, or other appropriate mechanical means, to obtain an exposed aggregate surface (CSP-6). Saturate surface with clean water. Substrate should be saturated surface dry (SSD) with no standing water during application. Reinforcing Steel: Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. Where corrosion has occurred due to the presence of chlorides, the steel should be high-pressure washed with clean water after mechanical cleaning. For priming of reinforcing steel, use Sika® Armatex® 110 EpoCem (consult Technical Data Sheet).

Priming

Concrete Substrate: Prime the prepared substrate with a brush or sprayed applied coat of Sika® Armatex® 110 EpoCem (consult Technical Data Sheet). Alternately, a scrub coat of Sika Repair 224 can be applied prior to placement of the mortar. The repair mortar has to be applied into the wet scrub coat before it dries.

Mixing

With water: Add the water (approx. 3/4 gal.) directly into mixer. Start the mixer in motion and add the SikaRepair® 224 mortar while continuing to mix. Mix to uniform consistency using a maximum of 7/8 gallons of water per 50 lb. (22.7 kg.) bag (approx. 3 minutes).

With Latex R: Pour 6-7 pints of SikaLatex® R into the mixing container. Slowly add powder and mix as above.

With diluted Latex R: SikaLatex® R may be diluted up to 5:1 (water: SikaLatex® R) for projects requiring minimal polymer-modification. Pour 6-7 pints of the mixture into the mixing container. Slowly add powder and mix as above.

SikaRepair 224 Concrete: For horizontal applications greater than 1 inch deep, add 3/8 inch coarse aggregate. Aggregate must be non-reactive (reference ASTM C1260, C227 and C289), clean, well-graded, saturated surface dry (SSD), have low absorption and high density, and comply with ASTM C33 size number 8 per Table 2. Addition rate must not exceed 25 lbs. of aggregate/bag of SikaRepair® 224 (25 lbs. of 3/8 in. aggregate is approximately 2.0 to 2.5 gal. by loose volume of aggregate). If the placement is vertical or overhead, temporary support of the material is required. Contact Sika Technical Service for application details.

Application

Conventional wet-process shotcreting equipment such as a low-pressure or a high-pressure machine should be used. At time of application, surfaces should be saturated surface dry but hold no standing water. Apply SikaRepair® 224 mortar by low pressure spraying or trowelling for repairing vertical or overhead surfaces. Shoot the shotcrete perpendicular to the surface. This minimizes rebound, creates the smoothest pattern (reduces 'bumps') and properly encases the rebars. The velocity of the shotcrete is sufficient if, at a distance of 18 to 24 in., the shotcrete pattern flattens out on contact with the surface and the rebars are encased. After applying the shotcrete, allow it to stiffen for about 10 minutes before removing bumpy areas with a trowel. Before applying the next layer, allow the shotcrete to reach initial set. This will take anywhere from 45 minutes to several hours, depending on mix consistency, mix and ambient temperature, wind conditions and humidity. Begin and finish a given patch on the same day.

Tooling and Finishing

As per ACI recommendations for portland cement mortar, curing is required when jobsite conditions warrant. Moist cure with wet burlap and polyethylene, a fine mist of water or a water based* compatible curing compound. Curing compounds adversely affect the adhesion of following layers of mortar, leveling mortar or protective coatings. Moist curing should commence immediately after finishing. Protect newly applied material from direct sunlight, wind, rain and frost.

*Pretesting of curing compound is recommended.

Limitations

Application thickness:

- Minimum 3/8 inch (9 mm).

Vertical applications:

- SikaRepair® 224 can be spray applied up to 2" thickness in one lift.

Overhead applications:

- The thickness should be no more than 1 to 1.5" per pass. If repair requires several lifts (over 1.5"), each lift should be applied as soon as the previous lift will support it.

General:

- For additional information, consult Technical Service.
- Minimum ambient and surface temperatures 40°F (4°C) and rising at the time of application.
- As with all cement based materials, avoid contact with aluminum to prevent adverse chemical reaction and possible product failure. Insulate potential areas of contact by coating aluminum bars, rails, posts etc. with an appropriate epoxy such as Sikadur® Hi-Mod 32.

PRIOR TO EACH USE OF ANY SIKA PRODUCT, THE USER MUST ALWAYS READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS ON THE PRODUCT'S MOST CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET WHICH ARE AVAILABLE ONLINE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING SIKA'S TECHNICAL SERVICE DEPARTMENT AT 800.933.7452. NOTHING CONTAINED IN ANY SIKA MATERIALS RELIEVES THE USER OF THE OBLIGATION TO READ AND FOLLOW THE WARNINGS AND INSTRUCTIONS FOR EACH SIKA PRODUCT AS SET FORTH IN THE CURRENT PRODUCT DATA SHEET, PRODUCT LABEL AND SAFETY DATA SHEET PRIOR TO PRODUCT USE.

KEEP CONTAINER TIGHTLY CLOSED. KEEP OUT OF REACH OF CHILDREN. NOT FOR INTERNAL CONSUMPTION. FOR INDUSTRIAL USE ONLY. FOR PROFESSIONAL USE ONLY.

For further information and advice regarding transportation, handling, storage and disposal of chemical products, users should refer to the actual Safety Data Sheets containing physical, ecological, toxicological and other safety related data. Read the current actual Safety Data Sheet before using the product. In case of emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's most current Product Data Sheet, product label and Safety Data Sheet which are available online at <http://usa.sika.com/> or by calling Sika's Technical Service Department at 800-933-7452. Nothing contained in any Sika materials relieves the user of the obligation to read and follow the warnings and instruction for each Sika product as set forth in the current Product Data Sheet, product label and Safety Data Sheet prior to product use.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within shelf life. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor. NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS. SALE OF SIKA PRODUCTS ARE SUBJECT SIKA'S TERMS AND CONDITIONS OF SALE AVAILABLE AT [HTTP://USA.SIKA.COM/](http://usa.sika.com/) OR BY CALLING 201-933-8800.

Visit our website at usa.sika.com

1-800-933-SIKA NATIONWIDE

Regional Information and Sales Centers. For the location of your nearest Sika sales office, contact your regional center.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 800-933-7452
Fax: 201-933-6225

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire
Quebec H9R 4A9
Phone: 514-697-2610
Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537



Sika and SikaRepair are registered trademarks.
Printed in Canada.

Sika®

