Submittal / Substitution Request

SUBMITTED TO:

To: _____

Firm: _____

Project: _____

Submitted Product: **SIMPSON STRONG-TIE® SET-XP™ EPOXY-TIE® ANCHORING ADHESIVE**

TESTED TO MEET IBC® 2009

Specified Product: _____

Section: _____ Page: _____ Detail/Sheet No.: _____

Description of Application: _____

_____

_____

_____

_____

Attached information includes product description, installation instructions and pertinent technical data needed for evaluation of the submittal request.

SUBMITTED BY:

Name: _____ Signature: _____

Firm: _____

Address: _____

_____

Phone: _____ Fax: _____

E-Mail: _____

Date of Submittal: _____

FOR ARCHITECT/ENGINEER USE:

Approved: _____ Approved As Noted: _____ Not Approved: _____

(Please briefly explain why not approved)

_____

_____

_____

By: _____ Date: _____

Remarks: _____

_____

_____

_____

_____

Table of Contents

SET-XP® *High-Strength Epoxy-Tie Anchoring Adhesive for Cracked and Uncracked Concrete*

Cracked & Uncracked CONCRETE | IBC 2009 | ICC-ES ESR-2508

SIMPSON Strong-Tie ANCHOR SYSTEMS

SET-XP®, the popular epoxy-based anchoring adhesive formulated for optimum performance in both cracked and uncracked concrete, is now available in a 56 oz. cartridge for larger-volume jobs. Rigorously tested in accordance with ICC-ES AC308 2006 and 2009 IBC requirements, and proven to deliver increased reliability in the most adverse conditions, SET-XP provides greater convenience coupled with unmatched performance. This non-shrink epoxy anchoring adhesive meets the requirements of ASTM C881 specification for Type I and Type IV, Grade 3, Class C epoxy.

USES: When SET-XP® adhesive is used with threaded rod, rebar or the IXP™ anchor, the system can be used in tension and seismic zones where there is a risk of cracks occurring that pass through the anchor location. It is also suitable for uncracked concrete conditions.

CODES: ICC-ES ESR-2508; City of L.A. RR25744; Florida FL 11506.5 NSF/ANSI Standard 61 (216 in²/**1000** gal). ⚠ The load tables list values based upon results from the most recent testing and may not reflect those in current code reports. Where additional local jurisdiction requirements apply, consult the current reports for applicable load values.

APPLICATION: Surfaces to receive epoxy must be clean. The base-material temperature must be 50° F or above at the time of installation. For best results, material should be 70–80° F at the time of application. Cartridges should not be immersed in water to facilitate warming. To warm cold material, the cartridges should be stored in a warm, uniformly-heated area or storage container for a sufficient time to allow epoxy to warm completely. Mixed material in nozzle can harden in 5–7 minutes at a temperature of 40° F or above.

DESIGN EXAMPLE: See pages 26–28 of the *Anchoring and Fastening Systems for Concrete and Masonry* catalog

INSTALLATION: See pages 31–32 of the *Anchoring and Fastening Systems for Concrete and Masonry* catalog

SHELF LIFE: 24 months from date of manufacture in unopened side-by-side cartridge.

STORAGE CONDITIONS: For best results, store between 45–90° F. To store partially used cartridges, leave hardened nozzle in place. To re-use, attach new nozzle.

COLOR: Resin – white, hardener – black-green. When properly mixed, SET-XP adhesive will be a uniform teal color.

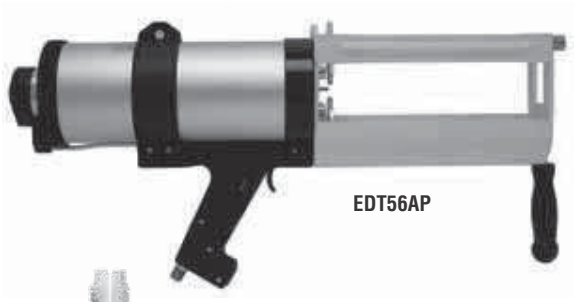
CLEAN UP: Uncured material – Wipe up with cotton cloths. If desired, scrub area with abrasive, waterbased cleaner and flush with water. If approved, solvents such as ketones (MEK, acetone, etc.), lacquer thinner or adhesive remover can be used. DO NOT USE SOLVENTS TO CLEAN ADHESIVE FROM SKIN. Take appropriate precautions when handling flammable solvents. Solvents may damage surfaces to which they are applied. Cured Material – chip or grind off surface.

TEST CRITERIA: Anchors installed with SET-XP® Epoxy-Tie® adhesive have been tested in accordance with ICC-ES's *Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308)* for the following:

- Seismic and wind loading in cracked and uncracked concrete
- Static tension and shear loading in cracked and uncracked concrete
- Horizontal and overhead installations
- Long-term creep at elevated temperatures
- Static loading at elevated temperatures
- Damp holes
- Freeze-thaw conditions
- Critical and minimum edge distance and spacing

PROPERTY	TEST METHOD	RESULTS
Consistency	ASTM C881	Passed, non-sag
Glass transition temperature	ASTM E1356	155°F (68°C)
Bond strength (moist cure)	ASTM C882	3,742 psi at 2 days
Water absorption	ASTM D570	0.10%
Compressive yield strength	ASTM D695	14,830 psi
Compressive modulus	ASTM D695	644,000 psi
Gel time	ASTM C881	49 minutes

CHEMICAL RESISTANCE: Very good to excellent against distilled water, in-organic acids and alkalis. Fair to good against organic acids and alkalis, and many organic solvents. Poor against ketones. For more detailed information, visit our website or contact Simpson Strong-Tie.



EDT56AP

SET-XP56

SET-XP Cartridge System

Model No.	Capacity ounces (cubic inches)	Cartridge Type	Carton Quantity	Dispensing tool(s)	Mixing Nozzle
SET-XP22	22 (39.7)	side-by-side	10	EDT22B EDT22AP EDT22CKT EDT22S	EMN22i
NEW SET-XP56	56 (101.1)	side-by-side	6	EDT56AP	EMN22i

1. Cartridge estimation guides are available on page 64 of the *Anchoring and Fastening Systems for Concrete and Masonry* catalog.
2. Detailed information on dispensing tools, mixing nozzles and other adhesive accessories is available on pages 87–92 of the *Anchoring and Fastening Systems for Concrete and Masonry* catalog.
3. Use only appropriate Simpson Strong-Tie® mixing nozzle in accordance with Simpson Strong-Tie instructions. Modification or improper use of mixing nozzle may impair epoxy performance.

Cure Schedule[1]

Base Material Temerature		Cure Time (hrs.)
°F	°C	
50	10	72 hrs.
60	16	48 hrs.
70	21	24 hrs.
90	32	24 hrs.
110	43	24 hrs.

1. For water-saturated concrete, the cure times must be doubled.

SUGGESTED SPECIFICATION: Anchoring adhesive shall be a two-component high-solids, epoxy-based system supplied in manufacturer's standard cartridge and dispensed through a static-mixing nozzle supplied by the manufacturer. The adhesive anchor shall have been tested and qualified for performance in cracked and uncracked concrete per ICC-ES AC308. Adhesive shall be Epoxy-Tie® SET-XP® adhesive from Simpson Strong-Tie, Pleasanton, CA. Anchors shall be installed per Simpson Strong-Tie instructions for SET-XP adhesive.

SET-XP® Epoxy Anchor Installation Information and Additional Data for Threaded Rod and Rebar in Normal-Weight Concrete[1]

Characteristic		Symbol	Units	Nominal Anchor Diameter (in.) / Rebar Size						
				⅜ / #3	½ / #4	⅝ / #5	¾ / #6	⅞ / #7	1 / #8	1¼ / #10
Installation Information										
Drill Bit Diameter		d_{hole}	in.	½	⅝	¾	⅞	1	1⅛	1⅜
Maximum Tightening Torque		T_{inst}	ft-lb	10	20	30	45	60	80	125
Permitted Embedment Depth Range[2]	Minimum	h_{ef}	in.	2⅜	2¾	3⅛	3½	3¾	4	5
	Maximum	h_{ef}	in.	7½	10	12½	15	17½	20	25
Minimum Concrete Thickness		h_{min}	in.	$h_{ef} + 5d_o$						
Critical Edge Distance		c_{ac}	in.	$3 \times h_{ef}$						
Minimum Edge Distance		c_{min}	in.	1¾						2¾
Minimum Anchor Spacing		s_{min}	in.	3						6

1. The information presented in this table is to be used in conjunction with the design criteria of ICC-ES AC308. See pages 18–19 of C-SAS-2009 *Anchoring and Fastening Systems for Concrete and Masonry* catalog.
2. Minimum and maximum embedment depths are are listed in accordance with ICC-ES AC308 requirements.

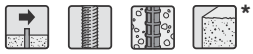
SET-XP® Epoxy Anchor Tension Design Data for Threaded Rod and Rebar in Normal-Weight Concrete[1,12]

*See page 5 for an explanation of the load table icons

Characteristic			Symbol	Units	Nominal Anchor Diameter (in.) / Rebar Size						
					⅜ / #3	½ / #4	⅝ / #5	¾ / #6	⅞ / #7	1 / #8	1¼ / #10
Steel Strength in Tension											
Threaded Rod	Minimum Tensile Stress Area		A_{se}	in^2	0.078	0.142	0.226	0.334	0.462	0.606	0.969
	Tension Resistance of Steel - ASTM A193, Grade B7		N_{sa}	lb.	9,750	17,750	28,250	41,750	57,750	75,750	121,125
	- ASTM A307, Grade C				4,525	8,235	13,110	19,370	26,795	35,150	56,200
	- Type 410 Stainless (ASTM A193, Grade B6)				8,580	15,620	24,860	36,740	50,820	66,660	106,590
	- Type 304 and 316 Stainless (ASTM A193, Grade B8 and B8M)				4,445	8,095	12,880	19,040	26,335	34,540	55,235
	Strength Reduction Factor - Steel Failure		⊠	—	0.75[9]						
Rebar	Minimum Tensile Stress Area		A_{se}	in^2	0.11	0.20	0.31	0.44	0.60	0.79	1.23
	Tension Resistance of Steel - Rebar (ASTM A615, Grade 60)		N_{sa}	lb.	9,900	18,000	27,900	39,600	54,000	71,100	110,700
	Strength Reduction Factor - Steel Failure		⊠	—	0.75[9]						
Concrete Breakout Strength in Tension (2,500 psi ≤ f'c ≤ 8,000 psi)[15]											
Effectiveness Factor - Uncracked Concrete			k_{uncr}	—	24						
Effectiveness Factor - Cracked Concrete			k_{cr}	—	17						
Strength Reduction Factor - Breakout Failure			⊠	—	0.65[11]						
Bond Strength in Tension (2,500 psi ≤ f'c ≤ 8,000 psi)[15]											
Temp. Range 1 for Uncracked Concrete[2,4,5]	Characteristic Bond Strength[8]		$\tau_{k,uncr}$	psi	1,651	2,422	2,263	1,942	1,670	2,003	1,094
	Permitted Embedment Depth Range	Minimum	h_{ef}	in	2⅜	2¾	3⅛	3½	3¾	4	5
		Maximum			7½	10	12½	15	17½	20	25
Temp. Range 1 for Cracked Concrete[2,4,5]	Characteristic Bond Strength[8,13,14]		$\tau_{k,cr}$	psi	1,177	1,040	718	1,003	619	968	716
	Permitted Embedment Depth Range	Minimum	h_{ef}	in	3	4	5	6	7	8	10
		Maximum			7½	10	12½	15	17½	20	25
Temp. Range 2 for Uncracked Concrete[3,4,5]	Characteristic Bond Strength[6,8]		$\tau_{k,uncr}$	psi	852	1,250	1,170	1,005	860	1,035	564
	Permitted Embedment Depth Range	Minimum	h_{ef}	in	2⅜	2¾	3⅛	3½	3¾	4	5
		Maximum			7½	10	12½	15	17½	20	25
Temp. Range 2 for Cracked Concrete[3,4,5]	Characteristic Bond Strength[6,8,13,14]		$\tau_{k,cr}$	psi	607	537	371	518	320	500	369
	Permitted Embedment Depth Range	Minimum	h_{ef}	in	3	4	5	6	7	8	10
		Maximum			7½	10	12½	15	17½	20	25
Bond Strength in Tension - Bond Strength Reduction Factors for Continuous Special Inspection											
Strength Reduction Factor - Dry Concrete			⊠dry, ci	—	0.65[10]						
Strength Reduction Factor - Water-saturated Concrete			⊠sat, ci	—	0.45[10]						
Additional Factor for Water-saturated Concrete[7]			$K_{sat, ci}$	—	0.57						
Bond Strength in Tension - Bond Strength Reduction Factors for Periodic Special Inspection											
Strength Reduction Factor - Dry Concrete			⊠dry, pi	—	0.55[10]						
Strength Reduction Factor - Water-saturated Concrete			⊠sat, pi	—	0.45[10]						
Additional Factor for Water-saturated Concrete[7]			$K_{sat, pi}$	—	0.48						

1. The information presented in this table is to be used in conjunction with the design criteria of ICC-ES AC308, except as modified below. See pages 18–19 of C-SAS-2009 *Anchoring and Fastening Systems for Concrete and Masonry* catalog.
2. Temperature Range 1: Maximum short-term temperature of 110°F (43°C). Maximum long-term temperature of 75°F (24°C).
3. Temperature Range 2: Maximum short-term temperature of 150°F (66°C). Maximum long-term temperature of 110°F (43°C).
4. Short-term concrete temperatures are those that occur over short intervals (diurnal cycling).
5. Long-term concrete temperature are constant temperatures over a significant time period.
6. For anchors that only resist wind or seismic loads, bond strengths may be increased by 72%.
7. In water-saturated concrete, multiply $\tau_{k,uncr}$ and $\tau_{k,cr}$ by K_{sat}.
8. For anchors installed in overhead and subjected to tension resulting from sustained loading, multiply the value calculated for N_a according to ICC-ES AC308 by 0.75. See page 18 of C-SAS-2009 *Anchoring and Fastening Systems for Concrete and Masonry* catalog.
9. The value of ⊠ applies when the load combinations of ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, refer to Section D.4.5 to determine the appropriate value of ⊠.
10. The value of ⊠ applies when both the load combinations of ACI 318 Section 9.2 are used and the requirements of Section D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, refer to Section D.4.5 to determine the appropriate value of ⊠.
11. The value of ⊠ applies when both the load combinations of ACI 318 Section 9.2 are used and the requirements of Section D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Section 9.2 are used and the requirements of Section D.4.4(c) for Condition A are met, refer to Section D.4.4 to determine the appropriate value of ⊠. If the load combinations of ACI 318 Appendix C are used, refer to Section D.4.5 to determine the appropriate value of ⊠.
12. Sand-lightweight and all-lightweight concrete are beyond the scope of this table.
13. For anchors installed in regions assigned to Seismic Design Category C, D, E or F, the bond strength values for ⅞" anchors or #7 rebar anchors must be multiplied by $\alpha_{N,seis} = 0.80$.
14. For anchors installed in regions assigned to Seismic Design Category C, D, E or F, the bond strength values for 1" anchors or #8 rebar anchors must be multiplied by $\alpha_{N,seis} = 0.92$
15. The values of f'_c used for calculation purposes must not exceed 8000 psi (55.1 MPa) for uncracked concrete. The value of f'_c used for calculation purposes must not exceed 2,500 psi (17.2 MPa) for cracked concrete.

SET-XP® Epoxy Anchor Shear Design Data for Threaded Rod and Rebar in Normal-Weight Concrete[1,5]



*See page 5 for an explanation of the load table icons

Characteristic		Symbol	Units	Nominal Anchor Diameter (in.) / Rebar Size						
				⅜ / #3	½ / #4	⅝ / #5	¾ / #6	⅞ / #7	1 / #8	1¼ / #10
Steel Strength in Shear										
Threaded Rod	Minimum Shear Stress Area	A_{se}	in²	0.078	0.142	0.226	0.334	0.462	0.606	0.969
	Shear Resistance of Steel - ASTM A193, Grade B7	V_{sa}[6]	lb.	5,850	10,650	16,950	25,050	34,650	45,450	72,675
	- ASTM A307, Grade C			2,715	4,940	7,865	11,625	16,080	21,090	33,720
	- Type 410 Stainless (ASTM A193, Grade B6)			5,150	9,370	14,910	22,040	30,490	40,000	63,955
	- Type 304 and 316 Stainless (ASTM A193, Grade B8 and B8M)			2,670	4,855	7,730	11,420	15,800	20,725	33,140
	Reduction for Seismic Shear - ASTM A307, Grade C[6]	$\alpha_{V,seis}$	—	0.71						
	Reduction for Seismic Shear - ASTM A193, Grade B7[6]			0.71						
	Reduction for Seismic Shear - Stainless (ASTM A193, Grade B6)[6]			0.80						
	Reduction for Seismic Shear - Stainless (ASTM A193, Grade B8 and B8M)[6]			0.80						
	Strength Reduction Factor - Steel Failure	⊠	—	0.65[2]						
Rebar	Minimum Shear Stress Area	A_{se}	in²	0.11	0.20	0.31	0.44	0.60	0.79	1.23
	Shear Resistance of Steel - Rebar (ASTM A615, Grade 60)	V_{sa}[6]	lb.	5,940	10,800	16,740	23,760	32,400	42,660	66,420
	Reduction for Seismic Shear - Rebar (ASTM A615, Grade 60)[6]	$\alpha_{V,seis}$	—	0.80						
	Strength Reduction Factor - Steel Failure	⊠	—	0.65[2]						
Concrete Breakout Strength in Shear										
Outside Diameter of Anchor		d_o	in.	0.375	0.500	0.625	0.750	0.875	1.000	1.250
Load Bearing Length of Anchor in Shear		ℓ_e	in.	h_{ef}						
Strength Reduction Factor - Breakout Failure		⊠	—	0.70[3]						
Concrete Pryout Strength in Shear										
Coefficient for Pryout Strength		k_{cp}	—	2.0						
Strength Reduction Factor - Pryout Failure		⊠	—	0.70[4]						

1. The information presented in this table is to be used in conjunction with the design criteria of ICC-ES AC308, except as modified below. See pages 18–19 of the *Anchoring and Fastening Systems for Concrete and Masonry* catalog.
2. The value of ⊠ applies when the load combinations of ACI 318 Section 9.2 are used. If the load combinations of AC 318 Appendix C are used, refer to Section D.4.5 to determine the appropriate value of ⊠.
3. The value of ⊠ applies when both the load combinations of ACI 318 Section 9.2 are used and the requirements of Section D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Section 9.2 are used and the requirements of Section D.4.4(c) for Condition A are met, refer to Section D.4.4 to determine the appropriate value of ⊠. If the load combinations of ACI 318 Appendix C are used, refer to Section D.4.5 to determine the appropriate value of ⊠.
4. The value of ⊠ applies when both the load combinations of ACI 318 Section 9.2 are used and the requirements of Section D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, refer to Section D.4.5 to determine the appropriate value of ⊠.
5. Sand-lightweight and all-lightweight concrete are beyond the scope of this table.
6. The values of V_{sa} are applicable for both cracked and uncracked concrete. For anchors installed in regions assigned to Seismic Design Category C, D, E or F, V_{sa} must be multiplied by $\alpha_{V,seis}$ for the corresponding anchor material.

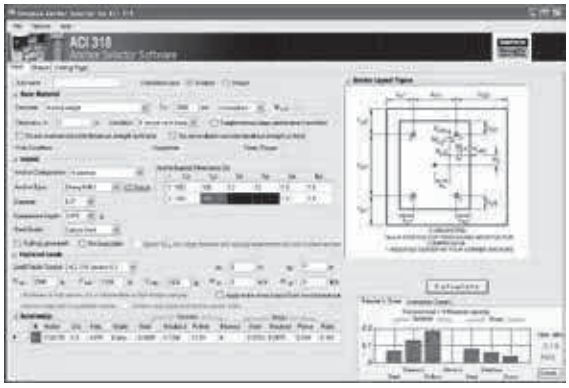
Anchor Selector™ Software ACI 318

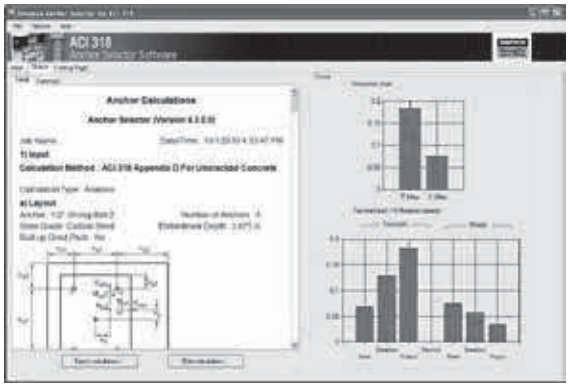
Anchor Selector™ Software for ACI 318
Anchor Selector Software for ACI 318 analyzes and offers anchor solutions using the ACI 318, Appendix D strength design methodology (or CAN/CSA A23.3 Annex D limit states design methodology). It provides cracked- and uncracked-concrete anchor solutions for many Simpson Strong-Tie Anchor Systems® mechanical and adhesive anchors.

With its easy-to-use graphical interface, Anchor Selector Software for ACI 318 eliminates the need for tedious calculations by hand that would otherwise be necessary to determine cracked concrete anchor solutions.

Features/Benefits

- Free download
- Quick and accurate analysis or design of anchor solutions results in increased productivity by eliminating the need to conduct time consuming calculations
- Graphical User Interface is intuitive and easy to use
- Includes prequalified post-installed mechanical and adhesive anchor solutions for cracked and/or uncracked concrete
- Includes a variety of concrete base material configurations
- Concrete Types
  - Normal weight concrete
  - Lightweight concrete
  - Normal weight concrete over metal deck
  - Sand-lightweight concrete over metal deck
- Includes cast-in-place anchor solutions
- Single and multiple anchor layouts provide solutions for multiple design applications
- Determines proper anchor solutions in situations where tension and shear forces will be acting simultaneously
- Capability to save input and results allows the designer to save data for later use. Additionally, input files can be easily modified to create new analysis/ design cases.
- Ability to save and print detailed calculations allows for verification of results
- Capability to resolve bi-axial bending moments imposed from attached member into anchor forces
- Auto update feature allows notification and download of the latest version of the software as updates become available





To download this free software, go to **www.simpsonanchors.com/software/as-aci318**.

800-999-5099
www.simpsonanchors.com

ICC-ES Evaluation Report

ESR-2508*

Reissued December 1, 2008
This report is subject to re-examination in one year.

www.icc-es.org | (800) 423-6587 | (562) 699-0543 *A Subsidiary of the International Code Council®*

DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

REPORT HOLDER:

SIMPSON STRONG-TIE COMPANY, INC.
5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CALIFORNIA 94588
(800) 999-5099
www.strongtie.com

EVALUATION SUBJECT:

SET-XP EPOXY ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2006 *International Building Code*® (2006 IBC)
- 2006 *International Residential Code*® (2006 IRC)
- 2003 *International Building Code*® (2003 IBC)
- 2003 *International Residential Code*® (2003 IRC)
- 1997 *Uniform Building Code*™ (UBC)

Property evaluated:

Structural

2.0 USES

The Simpson Strong-Tie SET-XP Epoxy Adhesive Anchors are used to resist static, wind and seismic tension and shear loads in cracked and uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). The anchor is an alternative to anchors described in Section 1911 and 1912 of the 2006 IBC, Section 1912 and 1913 of the 2003 IBC, and Section and 1923.1 and 1923.2 of the UBC. The anchors may also be used where an engineering design is submitted in accordance with Section R301.1.3 of the 2006 and 2003 IRC.

3.0 DESCRIPTION

3.1 General:

The SET-XP Epoxy Adhesive Anchor System is comprised of the following components:

- SET-XP epoxy adhesive
- Adhesive mixing and dispensing equipment
- Equipment for hole cleaning and adhesive injection

SET-XP epoxy adhesive is used with continuously threaded rods or deformed steel reinforcing bars. Installation information and parameters are included with each adhesive unit package.

3.1.1 SET-XP Epoxy Adhesive: SET-XP epoxy adhesive is an injectable, two-component, 100 percent solids, epoxy-based adhesive mixed as a 1-to-1 volume ratio of hardener-to-resin. SET-XP is available in 8.5-ounce (230 mL), 22-ounce (600 mL), and 56-ounce (1.5 L) cartridges. The two components combine and react when dispensed through a static mixing nozzle attached to the cartridge. The shelf life of SET-XP in unopened cartridges is two years from the date of manufacture.

3.1.2 Dispensing Equipment: SET-XP epoxy adhesive must be dispensed using Simpson Strong-Tie manual dispensing tools, battery-powered dispensing tools or pneumatic dispensing tools.

3.1.3 Equipment for Hole Preparation: Hole cleaning equipment (brushes) must be Simpson Strong-Tie hole cleaning brushes, identified by Simpson Strong-Tie catalog number series ETB. See Tables 7 and 8 in this report and the installation instructions for additional information.

3.2 Anchor Materials:

3.2.1 Threaded Rods: Threaded anchor rods, having diameters from $^1/_2$ inch to 1 inch (12.7 mm to 25.4 mm), must be carbon steel conforming to ASTM A307, Grade C, or ASTM A 193, Grade B7; or stainless steel conforming to ASTM A193, Grade B6 or B8. Table 2 in this report provides additional details.

3.2.2 Deformed Reinforcing Bar (Rebar): Deformed steel rebars, having sizes from No. 4 to No. 8, must conform to ASTM A 615. Table 3 in this report provides additional details.

3.2.3 Ductility: In accordance with D.3.3.4 of ACI 318-05 Appendix D, for the steel element to be considered ductile, the threaded rod elongation must be at least 14 percent and reduction of area must be at least 30 percent. Steel elements used for anchoring with an elongation of less than 14 percent or a reduction of area less than 30 percent, or both, are considered brittle. The design professional must verify that the ASTM A 307 Grade C rod, ASTM A 193 Grade B7 rod, ASTM A 193 Grade B6 or B8 stainless steel rods and ASTM A 615 rebar comply with this requirement.

3.3 Concrete:

Normal-weight concrete with a minimum compressive strength at the time of anchor installation of 2,500 psi (17.2 MPa), but not less than that required by the applicable code, nor more than 8,500 psi (58.6 MPa), must conform to Sections 1903 and 1905 of the IBC or UBC, as applicable.

***Revised November 2010**

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Anchor design strengths, ΦN_n and ΦV_n, must be determined in accordance with ACI 318-05 Appendix D and this report. A design example is given in Figure 2. Design parameters are provided in Tables 2, 3, 4 and 5 of this report. The anchor design must satisfy the requirements of ACI 318 Sections D.4.1.1 and D.4.1.2. Strength reduction factors, Φ, described in ACI 318 Section D.4.4, and noted in Tables 2, 3, 4 and 5 of this report, must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC or Section 1612.2.1 of the UBC. Strength reductions factors, Φ, described in ACI 318 Section D.4.5 must be used for load combinations calculated in accordance with Appendix C of ACI 318 or Section 1909.2 of the UBC.

This section provides amendments to ACI 318 Appendix D as required for the strength design of adhesive anchors. In conformance with ACI 318, all equations are expressed in inch-pound units.

Modify ACI 318 D.4.1.2 as follows:

D.4.1.2 – In Eq. (D-1) and (D-2), ΦN_n and ΦV_n are the lowest design strengths determined from all appropriate failure modes. ΦN_n is the lowest design strength in tension of an anchor or group of anchors as determined from consideration of ΦN_{sa}, either ΦN_a or ΦN_{ag} and either ΦN_{cb} or ΦN_{cbg}. ΦV_n is the lowest design strength in shear of an anchor or a group of anchors as determined from consideration of: ΦV_{sa}, either ΦV_{cb} or ΦV_{cbg}, and either ΦV_{cp} or ΦV_{cpg}. For adhesive anchors subjected to tension resulting from sustained loading, see D.4.1.4.

D.4.1.4 – For adhesive anchors subjected to tension resulting from sustained loading, a supplementary design analysis shall be performed using Eq. (D-1) whereby N_{ua} is determined from the sustained load alone, e.g., the dead load and that portion of the live load acting that may be considered as sustained and ΦN_n is determined as follows:

D.4.1.4.1 – For single anchors, $\Phi N_n = 0.75\ \Phi N_{a0}$

D.4.1.4.2 – For anchor groups, Eq. (D-1) shall be satisfied by taking $\Phi N_n = 0.75\ \Phi N_{a0}$ for that anchor in an anchor group that resists the highest tension load.

D.4.1.4.3 – Where shear loads act concurrently with the sustained tension load, interaction of tension and shear shall be analyzed in accordance with D.4.1.3

4.1.2 Static Steel Strength in Tension: The nominal steel strength in tension, N_{sa}, in accordance with ACI 318 Section D.5.1.2, is given in Tables 2 and 3 of this report. The strength reduction factor, Φ, corresponding to the steel element selected, is also given in Tables 2 and 3 of this report for use with the load combinations of ACI 318 Section 9.2 as set forth in Section D.4.4.

4.1.3 Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength in tension, N_{cb} and N_{cbg}, must be calculated in accordance with ACI 318 Section D.5.2, with the following addition:

D.5.2.9 – The limiting concrete strength of adhesive anchors in tension shall be calculated in accordance with D.5.2.1 to D.5.2.8 where the value of k_c to be used in Eq. (D-7) shall be:

- $k_{c,cr}$ – where analysis indicates cracking at service load levels in the anchor vicinity (cracked concrete)
- $k_{c,uncr}$ – where analysis indicates no cracking at service load levels in the anchor vicinity (uncracked concrete)

The basic concrete breakout strength in tension, N_b, must be calculated in accordance with ACI 318 Section 5.2.2 using the values of h_{ef} and k_c as described in Table 4 of this report. The value of f'_c must be limited to 8000 psi (55.1 MPa) for uncracked concrete and f'_c must be limited to 2500 psi (17.2 MPa) for cracked concrete.

4.1.4 Static Pullout Strength in Tension: In lieu of determining the nominal pullout strength in accordance with ACI 318 Section D.5.3, the nominal bond strength in tension must be calculated in accordance with the following sections added to ACI 318 and using values described in Table 5 of this report:

D.5.3.7 - The nominal strength of an adhesive anchor N_a or group of adhesive anchors N_{ag} in tension must not exceed:

(a) for a single anchor

$$N_a = \frac{A_{Na}}{A_{Na0}} \Psi_{ed,\,Na}\, \Psi_{p,\,Na}\, N_{a0} \qquad \text{(D-16a)}$$

(b) for a $\frac{A_{Na}}{A_{Na0}}$ group of anchors

$$N_{ag} = \Psi_{g,\,Na}\, \Psi_{ec,\,Na}\, \Psi_{ed,\,Na}\, \Psi_{p,\,Na}\, N_{a0} \qquad \text{(D-16b)}$$

where:

A_{Na} is the projected area of the failure surface for the anchor or group of anchors that must be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward a distance $c_{cr,Na}$ from the centerline of the single anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. A_{Na} must not exceed nA_{Na0} where n is the number of anchors in tension in the group. (Refer to ACI 318 Figures RD.5.2.1a and RD.5.2.1b and replace the terms $1.5h_{ef}$ and $3.0h_{ef}$ with $c_{cr,Na}$ and $s_{cr,Na}$, respectively.)

A_{Na0} is the projected area of the failure surface of a single anchor without the influence of proximate edges in accordance with Eq. (D-16c):

$$A_{Na0} = (s_{cr,Na})^2 \qquad \text{(D-16c)}$$

with:

$$s_{cr,Na} = 20\, d \times (\tau_{k,uncr}\,/1450)^{0.5} \le 3 \times h_{ef} \qquad \text{(D-16d)}$$

D.5.3.8 - The critical spacing $s_{cr,Na}$ and critical edge $c_{cr,Na}$ must be calculated as follows:

$s_{cr,Na}$ = *as given by Eq. (D-16d)*

$$c_{cr,Na} = s_{cr,Na}/2 \qquad \text{(D-16e)}$$

D.5.3.9 – The basic strength of single adhesive anchor in tension in cracked concrete shall not exceed:

$$N_{a0} = \tau_{k,cr} \times \pi \times d \times h_{ef} \qquad \text{(D-16f)}$$

D.5.3.10 - The modification factor for the influence of the failure surface of a group of adhesive anchors is:

$$\Psi_{g,Na} = \Psi_{g,Na0} + [(s/s_{cr,Na})^{0.5} \times (1 - \Psi_{g,Na0})] \qquad \text{(D-16g)}$$

where:

$$\Psi_{g,Na0} = n^{0.5} - [(n^{0.5} - 1) \times (\tau_{k,cr} \,/\, \tau_{k\max,cr})^{1.5}] \ge 1.0 \qquad \text{(D-16h)}$$

n = *the number of tension loaded adhesive anchors in a group.*

$$\tau_{k,\max,cr} = \{k_{c,\,cr}/(\pi \times d)\} \times (h_{ef}\, f'_c)^{0.5} \qquad \text{(D-16i)}$$

$\tau_{k,cr}$ = *the characteristic bond strength in cracked concrete having specified compressive strength, f′c. See Table 5 of this report.*

D.5.3.11 - The modification factor for eccentrically loaded adhesive anchor groups is:

$\Psi_{ec,Na} = 1/\{1 + (2e'_N/s_{cr,Na})\} \leq 1.0$ *(D-16j)*

Eq. (D-16j) is valid for $e'_N \leq s/2$

If the loading on an anchor group is such that only some anchors are in tension, only those anchors that are in tension must be considered when determining the eccentricity e'_N *for use in Eq. (D-16j).*

In the case where eccentric loading exists about two orthogonal axes, the modification factor $\Psi_{ec,Na}$ *must be computed for each axis individually and the product of these factors used as* $\Psi_{ec,Na}$ *in Eq.(D-16b).*

D.5.3.12 - The modification factor for edge effects for single adhesive anchors or anchor groups loaded in tension is:

$\Psi_{ed,Na} = 1.0$ *(D-16l)*

when $c_{a,min} \geq c_{cr,Na}$

or

$\Psi_{ed,Na} = [0.7 + 0.3 \times (c_{a,min} / c_{cr,Na})] \leq 1.0$ *(D-16m)*

when $c_{a,min} < c_{cr,Na}$

D.5.3.13 – When an adhesive anchor or group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the nominal strength N_a *or* N_{ag} *of a single adhesive anchor or a group of adhesive anchors shall be calculated according to Eq. (D-16a) and Eq. (D-16b) with* $\tau_{k,uncr}$ *(see Table 5 of this report) substituted for* $\tau_{k,cr}$ *in the calculation of the basic strength* N_{a0} *in accordance with Eq. (D-16f). The factor* $\Psi_{g,Na0}$ *shall be calculated in accordance with Eq. (D-16h) whereby the value of* $\tau_{k,uncr}$ *must be substituted for* $\tau_{k,cr}$ *and the value of* $\tau_{k,\max,uncr}$ *shall be calculated in accordance with Eq. (D-16n) and substituted for* $\tau_{k,\max,cr}$ *in Eq. (D-16h).*

$\tau_{k,\max,uncr} = \{k_{c,uncr}/(\pi \times d)\} \times (h_{ef} f'_c)^{0.5}$ *(D-16n)*

D.5.3.14 – When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicated no cracking at service load levels, the modification factor $\Psi_{p,Na}$ *shall be taken as:*

$\Psi_{p,Na} = 1.0$ *when* $c_{a,min} \geq c_{ac}$ *(D-16o)*

or

$\Psi_{p,Na} = \frac{\max\left|c_{a\min}; c_{cr,Na}\right|}{c_{ac}}$ *when* $c_{a,min} < c_{ac}$ *(D-16p)*

For all other cases, $\Psi_{p,Na} = 1.0$.

The value of c_{ac} must be as noted in Table 1 of the report. $c_{cr,Na}$ is determined using equation D-16e.

Additional information for the determination of nominal bond strength in tension is given in Section 4.1.8 of this report.

4.1.5 Static Steel Strength in Shear: The nominal steel strength in shear, V_{sa}, in accordance with ACI 318 Section D.6.1.2, is given in Tables 2 and 3 of this report. The strength reduction factor, Φ, corresponding to the steel element selected, is also given in Tables 2 and 3 of this report for use with load combinations of ACI 318 Section 9.2 as set forth in Section D.4.4.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength in shear, V_{cb} and V_{cbg}, must be calculated in accordance with ACI 318 Section D.6.2, with modifications as described in this section. The basic concrete breakout strength in tension, V_b, must be calculated in accordance with ACI 318 Section 6.2.2 using the values of l_e and d_o as described in Table 4 of this report. The value of f'_c must be limited to 8,000 psi (55.1 MPa), in accordance with ACI 318 Section D.3.5.

4.1.7 Static Concrete Pryout Strength in Shear: In lieu of determining the nominal pryout strength in accordance with ACI 318 Section D.6.3.1, nominal pryout strength in shear must be calculated in accordance with the following sections added to ACI 318:

D.6.3.2 - The nominal pryout strength of an adhesive anchor V_{cp} *or group of adhesive anchors* V_{cpg} *must not exceed:*

(a) for a single adhesive anchor

$V_{cp} = \min | k_{cp} N_a; k_{cp} N_{cb} |$ *(D-30a)*

(b) for a group of adhesive anchors

$V_{cpg} = \min | k_{cp} N_{ag}; k_{cp} N_{cbg} |$ *(D-30b)*

where:

$k_{cp} = 1.0$ for $h_{ef} < 2.5$ inches

$k_{cp} = 2.0$ for $h_{ef} \geq 2.5$ inches

N_a is calculated in accordance with Eq. *(D-16a)*

N_{ag} is calculated in accordance with Eq. *(D-16b)*

N_{cb}, N_{cbg} are determined in accordance with D.5.2.1 to D.5.2.9.

4.1.8 Bond Strength Determination: Bond strength values are a function of the special inspection level provided and installation conditions. Bond strength values must be modified with the factor K_{sat} for cases where the holes are drilled in water-saturated concrete as follows:

SPECIAL INSPECTION LEVEL	PERMISSIBLE INSTALLATION CONDITION	BOND STRENGTH	ASSOCIATED STRENGTH REDUCTION FACTOR
Continuous	Dry concrete	τ_k	$\kappa_{dry,ci}$
Continuous	Water-saturated	τ_k x $K_{sat,ci}$	$\kappa_{sat,ci}$
Periodic	Dry concrete	τ_k	$\kappa_{dry,pi}$
Periodic	Water-saturated	τ_k x $K_{sat,pi}$	$\kappa_{sat,pi}$

Where applicable, the modified bond strengths must be used in lieu of $\tau_{k,cr}$ or $\tau_{k,uncr}$ in Equations (D-16a) and (D-16b). The resulting nominal bond strength must be multiplied by the strength reduction factor for the special inspection level listed above. The various factors are given in Table 5 of the report.

4.1.9 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of using ACI 318 Section D.8.3, values of c_{min} and s_{min} provided in Table 1 of this report must be used. In lieu of using ACI 318 Section D.8.5, minimum member thickness, h_{min}, must be in accordance with Table 1 of this report.

4.1.10 Design Strength in Seismic design Categories C, D, E and F: In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, or Seismic Zone 2B, 3 or 4 under the UBC, the anchor strength must be adjusted in accordance with 2006 IBC Section 1908.1.16. For brittle steel elements, the anchor strength must be adjusted in accordance with 2006 IBC Section 1908.1.16 D.3.3.5. The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$ as given in Tables 2 and 3 of this report for the corresponding anchor steel. The nominal bond strength, $\tau_{k,cr}$, must be adjusted by $\alpha_{N,seis}$ for the $^7/_8$-inch (22 mm) and 1-inch (25.4 mm) diameter anchors, as given in Table 5 of this report.

4.1.11 Critical Edge Distance: In lieu of using ACI 318 Section D.8.6, values of c_{ac} provided in Table 1 of this report must be used.

4.1.12 Interaction of Tensile and Shear Forces: For loadings that include combined tension and shear, the design must be performed in accordance with ACI 318 Section D.7.

4.2 Allowable Stress Design (ASD):

4.2.1 General: For anchors designed using load combinations calculated in accordance with Sections 1605.3 of the IBC and Section 1612.3 of the UBC, allowable loads must be established using the following relationships:

$$T_{allowable,ASD} = \phi N_n / \alpha$$

and

$$V_{allowable,ASD} = \phi V_n / \alpha$$

where:

$T_{allowable,ASD}$ = Allowable tension load (lbf or kn)

$V_{allowable,ASD}$ = Allowable shear load (lbf or kn)

ΦNn = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D as amended in Section 4.1 of this report and Section 1908.1.16 of the IBC.

ΦV_n = The lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D as amended in Section 4.1 of this report and Section 1908.1.16 of the IBC.

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for non-ductile failure modes and required over-strength.

Table 6 provides an illustration of calculated Allowable Stress Design (ASD) values for each anchor diameter at minimum embedment depth.

The requirements for member thickness, edge distance and spacing, described in Table 1 of this report, must apply.

4.2.2 Interaction of Tensile and Shear Forces: In lieu of ACI Sections D.7.1, D.7.2 and D.7.3, interaction of tension and shear loads must be calculated as follows:

If $T_{applied} \leq 0.2\ T_{allowable,ASD}$, then the full allowable strength in shear, $V_{allowable,ASD}$, must be permitted.

If $V_{applied} \leq 0.2\ V_{allowable,ASD}$, then the full allowable strength in tension, $T_{allowable,ASD}$, must be permitted.

For all other cases:

$$T_{applied} / T_{allowable,ASD} + V_{applied} / V_{allowable,ASD} \leq 1.2$$

4.3 Installation:

Installation parameters are provided in Table 1, 7, 8, 9 and in Figure 1. Anchor locations must comply with this report and the plans and specifications approved by the building official. Installation of the SET-XP Epoxy Adhesive Anchor System must conform to the manufacturer's published installation instructions included in each package unit and as described in Figure 1.

4.4 Special Inspection:

Installations may be made under continuous special inspection or periodic special inspection, as determined by the registered design professional. See Section 4.1.8 and Table 5 of this report for special inspection requirements. Installations made under continuous special inspection with an on-site proof loading program must be performed in accordance with Section 1704.13 of the IBC and Section 1701.5.2 of the UBC. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, adhesive identification and expiration date, anchor dimensions, concrete type, concrete compressive strength, hole drilling method, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's printed installation instructions.

The proof loading program must be established by the registered design professional. As a minimum, the following requirements must be addressed in the proof loading program:

1. Frequency of proof loading based on anchor type, diameter, and embedment.
2. Proof loads by anchor type, diameter, embedment and location.
3. Acceptable displacements at proof load.
4. Remedial action in the event of failure to achieve proof load, or excessive displacement.

Unless otherwise directed by the registered design professional, proof loads must be applied as confined tension tests. Proof load levels must not exceed the lesser of 50 percent of expected peak load based on adhesive bond strength or 80 percent of the anchor yield strength. The proof load shall be maintained at the required load level for a minimum of 10 seconds.

Continuous special inspection is required for all cases where anchors installed overhead (vertical up) are designed to resist sustained tension loads.

Installations made under periodic special inspection must be performed where required in accordance with Section 1704.13 of the IBC, or Section 1701.5 of the UBC, whereby periodic special inspection is defined in Section 1701.6.2 of the UBC or Section 1702.1 of the IBC and this report. The special inspector must be on the jobsite initially during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's

printed installation instructions. The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same construction personnel is permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation must require an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

See Section 4.1.8 and Table 5 in this report for special inspection requirements.

Under the IBC, additional requirements as set forth in Sections 1705 or 1706 must be observed, where applicable.

4.5 Compliance with NSF/ANSI Standard 61:

SET-XP Epoxy Adhesive Anchor Systems comply with requirements of NSF/ANSI Standard 61, as reference in Section 605 of the 2000 International Plumbing Code (IPC) for products used in water distribution systems. SET-XP Epoxy Adhesive Anchor Systems may have a maximum exposed surface area to volume ratio of 216 square inches per 1000 gallons (3785 L) of potable water and/or drinking water treatment chemicals. The focus of NSF/ANSI Standard 61 as it pertains to adhesive anchors is to ensure that the contaminants or impurities imparted from the adhesive products to the potable water do not exceed acceptable levels.

5.0 CONDITION OF USES

The Simpson Strong-Tie SET-XP Epoxy Adhesive Anchor System described in this report complies with the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 SET-XP epoxy adhesive anchors must be installed in accordance with the manufacturer's published installation instructions and this report.

5.2 The anchors must be installed in cracked and uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

5.3 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa) for uncracked concrete. The value of f'_c used for calculation purposes must not exceed 2500 psi (17.2 MPa) for cracked concrete.

5.4 Anchors must be installed in concrete base materials in holes predrilled with carbide-tipped drill bits complying with ANSI B212.15-1994.

5.5 Loads applied to the anchors must be adjusted in accordance with Section 1605.2 of the IBC or Sections 1612.3 or 1909.2 of the UBC for strength design, and in accordance with Section 1612.3 of the UBC and Section 1605.3 of the IBC for allowable stress design.

5.6 SET-XP epoxy adhesive anchors are recognized for use to resist short-term and long-term loads, including wind and earthquake loads, subject to the conditions of this report.

5.7 Strength design values are established in accordance with Section 4.1 of this report.

5.8 Allowable design values are established in accordance with Section 4.2 of this report.

5.9 Minimum anchor spacing and edge distance as well as minimum member thickness and critical edge distance must comply with the values described in this report.

5.10 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.11 Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, SET-XP epoxy adhesive anchors are permitted for installation in fire-resistive construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support gravity load–bearing structural elements are within a fire-resistive envelope or a fire-resistive membrane, are protected by approved fire-resistance rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

5.12 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.13 Steel anchoring materials in contact with preservative-treated and fire-retardant-treated wood shall be zinc-coated steel or stainless steel. The coating weights for zinc-coated steel shall be in accordance with ASTM A 153.

5.14 Special inspection must be provided in accordance with Section 4.4 of this report. Continuous special inspection for overhead installations (vertical up) that are designed to resist sustained tension loads must be provided in accordance with Section 4.4 of this report.

5.15 SET-XP epoxy adhesive is manufactured and packaged into cartridges by Simpson Strong-Tie Company, Inc., in Addison, Illinois, with quality control inspections by CEL Consulting (AA-639).

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated October 2008.

6.2 Data in accordance with NSF/ANSI Standard 61, Drinking Water Systems Components-Health Effects, for the SET-XP adhesive.

7.0 IDENTIFICATION

7.1 SET-XP Epoxy Adhesive is identified in the field by labels on the cartridge or packaging, bearing the company name (Simpson Strong-Tie Company, Inc.), product name (SET-XP), the batch number, the expiration date, the name of the inspection agency (CEL Consulting), and the evaluation report number (ESR-2508).

7.2 Threaded rods, nuts, washers and deformed reinforcing bars are standard elements and must conform to applicable national or international specifications.

TABLE 1—SET-XP EPOXY ADHESIVE ANCHOR INSTALLATION INFORMATION

Characteristic	Symbol	Units	Nominal Rod Diameter (inches)				
			$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1
Drill Bit Diameter	d_{hole}		$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$
Maximum Tightening Torque	T_{inst}	ft-lb	20	30	45	60	80
Permitted Embedment Depth Range Min/Max	(h_{ef})	in.	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4
			10	$12^1/_2$	15	$17^1/_2$	20
Minimum Concrete Thickness	h_{min}	in.	$h_{ef} + 5d_o$				
Critical Edge Distance	c_{ac}	in.	$3 \times h_{ef}$				
Minimum Edge Distance	c_{min}	in.	$1^3/_4$				
Minimum Anchor Spacing	s_{min}	in.	3				

For **SI:** = 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-M.

TABLE 2—STEEL DESIGN INFORMATION FOR THREADED ROD

Characteristic	Symbol	Units	Nominal Rod Diameter (inches)				
			$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1
Nominal Diameter	d_o	in.	0.5	0.625	0.75	0.875	1
Minimum Tensile Stress Area	A_{se}	$in.^2$	0.142	0.226	0.334	0.462	0.606
Tension Resistance of Steel - ASTM A 307, Grade C	N_{sa}	lb.	8235	13110	19370	26795	35150
Tension Resistance of Steel - ASTM A193, Grade B7			17750	28250	41750	57750	75750
Tension Resistance of Steel - Stainless Steel ASTM A193, Grade B6			15620	24860	36740	50820	66660
Tension Resistance of Steel - Stainless Steel ASTM A193, Grade B8			10650	16950	25050	34650	45450
Strength Reduction Factor for Tension - Steel Failure[1]	Φ		0.75				
Minimum Shear Stress Area	A_{se}	$in.^2$	0.142	0.226	0.334	0.462	0.606
Shear Resistance of Steel - ASTM A 307, Grade C	V_{sa}	lb.	4940	7865	11625	16080	21090
Shear Resistance of Steel - ASTM A193, Grade B7			10650	16950	25050	34650	45450
Shear Resistance of Steel - Stainless Steel ASTM A193, Grade B6			9370	14910	22040	30490	40000
Shear Resistance of Steel - Stainless Steel ASTM A193, Grade B8			6390	10170	15030	20790	27270
Reduction for Seismic Shear - ASTM A 307, Grade C	$\alpha_{V,seis}$		0.71				
Reduction for Seismic Shear - ASTM A193, Grade B7			0.71				
Reduction for Seismic Shear - Stainless Steel ASTM A193, Grade B6			0.8				
Reduction for Seismic Shear - Stainless Steel ASTM A193, Grade B8			0.8				
Strength Reduction Factor for Shear - Steel Failure[1]	Φ		0.65				

[1]The tabulated value of Φ applies when the load combinations of Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 Section 9.2 are used. If the load combinations of Section 1909.2 of the UBC or ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5 (b).

TABLE 3—STEEL DESIGN INFORMATION FOR REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Bar Size				
			#4	#5	#6	#7	#8
Nominal Diameter	d_o	in.	0.5	0.625	0.75	0.875	1
Minimum Tensile Stress Area	A_{se}	$in.^2$	0.2	0.31	0.44	0.6	0.79
Tension Resistance of Steel - Rebar (ASTM A 615)	N_{sa}	lb.	18000	27900	39600	54000	71100
Strength Reduction Factor for Tension - Steel Failure[1]	Φ		0.75				
Minimum Shear Stress Area	A_{se}	$in.^2$	0.2	0.31	0.44	0.6	0.79
Shear Resistance of Steel - Rebar (ASTM A 615)	V_{sa}	lb.	10800	16740	23760	32400	42660
Reduction for Seismic Shear - Rebar (ASTM A 615)	$\alpha_{V,seis}$	-	0.8				
Strength Reduction Factor for Shear - Steel Failure[1]	Φ	-	0.65				

[1]The tabulated value of Φ applies when the load combinations of Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 Section 9.2 are used. If the load combinations of Section 1909.2 of the UBC or ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5(b).

TABLE 4—CONCRETE BREAKOUT AND PRYOUT DESIGN INFORMATION FOR THREADED ROD/REBAR ANCHORS

Characteristic	Symbol	Units	Nominal Rod/Rebar Diameter				
			$^1/_2$" or #4	$^5/_8$" or #5	$^3/_4$" or #6	$^7/_8$" or #7	1" or #8
Minimum Concrete Thickness	h_{min}	in.	$h_{ef} + 5d_o$				
Critical Edge Distance	c_{ac}	in.	$3 \times h_{ef}$				
Minimum Edge Distance	c_{min}	in.	$1^3/_4$				
Minimum Anchor Spacing	s_{min}	in.	3				
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	-	17				
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	-	24				
Strength Reduction Factor - Concrete Breakout Failure in Tension[1]	Φ	-	0.65				
Nominal Diameter	d_o	in.	0.5	0.625	0.75	0.875	1
Load Bearing Length of Anchor in Shear	ℓe	in.	h_{ef}				
Strength Reduction Factor - Concrete Breakout Failure in Shear[1]	Φ	-	0.7				
Coefficient for Pryout Strength	k_{cp}	-	2				
Strength Reduction Factor - Pryout Failure[1]	Φ	-	0.7				

[1]The tabulated values of Φ applies when both the load combinations of Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of Section 1909.2 of the UBC or ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5(c) for Condition B.

TABLE 5—SET-XP EPOXY ADHESIVE ANCHOR BOND STRENGTH DESIGN INFORMATION

Condition	Characteristic		Symbol	Units	Nominal Rod/Rebar Diameter				
					$^1/_2$" or #4	$^5/_8$" or #5	$^3/_4$" or #6	$^7/_8$" or #7	1" or #8
Temperature Range 1 for Uncracked Concrete[1,3]	Characteristic Bond Strength		$\tau_{k,uncr}$	psi	2422	2263	1942	1670	2003
	Permitted Embedment Depth Range	Minimum	h_{ef}	in.	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4
		Maximum			10	$12^1/_2$	15	$17^1/_2$	20
Temperature Range 1 for Cracked Concrete[1,3]	Characteristic Bond Strength[5,6]		$\tau_{k,cr}$	psi	1040	718	1003	619	968
	Permitted Embedment Depth Range	Minimum	h_{ef}	in.	4	5	6	7	8
		Maximum			10	$12^1/_2$	15	$17^1/_2$	20
Temperature Range 2 for Uncracked Concrete[2,3,4]	Characteristic Bond Strength		$\tau_{k,uncr}$	psi	1250	1170	1005	860	1035
	Permitted Embedment Depth Range	Minimum	h_{ef}	in.	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4
		Maximum			10	$12^1/_2$	15	$17^1/_2$	20
Temperature Range 2 for Cracked Concrete[2,3,4]	Characteristic Bond Strength[5,6]		$\tau_{k,cr}$	psi	537	371	518	320	500
	Permitted Embedment Depth Range	Minimum	h_{ef}	in.	4	5	6	7	8
		Maximum			10	$12^1/_2$	15	$17^1/_2$	20
Continuous Inspection	Strength Reduction Factor - Dry Concrete		$\Phi_{dry,ci}$	-	0.65				
	Strength Reduction Factor – Water-saturated Concrete		$\Phi_{sat,ci}$	-	0.45				
	Additional Factor - Water-saturated Concrete		$K_{sat,ci}$	-	0.57				
Periodic Inspection	Strength Reduction Factor - Dry Concrete		$\Phi_{dry,pi}$	-	0.55				
	Strength Reduction Factor – Water-saturated Concrete		$\Phi_{sat,pi}$	-	0.45				
	Additional Factor - Water-saturated Concrete		$K_{sat,pi}$	-	0.48				

[1]Temperature Range 1: Maximum short term temperature of 110°F. Maximum long term temperature of 75°F.
[2]Temperature Range 2: Maximum short term temperature of 150°F. Maximum long term temperature of 110°F.
[3]Short term concrete temperatures are those that occur over short intervals (diurnal cycling). Long term temperatures are constant over a significant time period.
[4]For load combinations consisting of only short-term loads, such as wind or seismic loads, bond strengths may be increased by 72%.
[5]As detailed in Section 4.1.10 of this report, bond strength values for $^7/_8$" anchors or #7 rebar anchors must be multiplied by $\alpha_{N,seis} = 0.80$.
[6]As detailed in Section 4.1.10 of this report, bond strength values for 1" anchors or #8 rebar anchors must be multiplied by $\alpha_{N,seis} = 0.92$.

TABLE 6—EXAMPLE SET-XP EPOXY ADHESIVE ANCHOR ALLOWABLE STRESS DESIGN (ASD) TENSION VALUES FOR ILLUSTRATIVE PURPOSES

Nominal Anchor Diameter, d_o (inches)	Drill Bit Diameter, d_{hole} (inches)	Effective Embedment Depth, h_{ef} (inches)	Allowable Tension Load, $\Phi N_n/\alpha$ (lb.)
$^1/_2$	$^5/_8$	$2^3/_4$	2405
$^5/_8$	$^3/_4$	$3^1/_8$	2910
$^3/_4$	$^7/_8$	$3^1/_2$	3450
$^7/_8$	1	$3^3/_4$	3825
1	$1^1/_8$	4	4215**

For **SI:** = 1 inch = 25.4 mm, 1lb = 4.45N.

Design Assumptions:

1. Single Anchor with static tension load only; ASTM A 193 Grade B7 threaded rod.
2. Vertical downward installation direction.
3. Inspection Regimen = Continuous.
4. Installation temperature = 50° - 110° F.
5. Long term temperature = 75° F.
6. Short term temperature = 110° F.
7. Dry hole condition - carbide drilled hole.
8. Embedment = $h_{ef,min}$
9. Concrete determined to remain uncracked for the life of the anchorage.
10. Load combinations from ACI 318 Section 9.2 (no seismic loading).
11. 30% Dead Load (D) and 70% Live Load (L); Controlling load combination is 1.2 D + 1.6L
12. Calculation of α based on weighted average: α = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48
13. Normal weight concrete: f′c = 2500 psi
14. $c_{a1} = c_{a2} \geq c_{ac}$
15. $h \geq h_{min}$

**** Illustrative Procedure (reference Table 2, 4 and 5 of this report):**

1" SET-XP Epoxy Adhesive Anchor (ASTM A193, Grade B7 Threaded Rod) with an Effective Embedment, h_{ef} = 4"

Step 1: Calculate Static Steel Strength in Tension per ACI 318-05 Section D.5.1 = $\Phi_{sa}N_{sa}$ = 0.75 x 75,750 = 56,810 lbs.

Step 2: Calculate Static Concrete Breakout Strength in Tension per ACI 318-05 Section D.5.2 = $\Phi_{cb}N_{cb}$ = 0.65 x 9,600 = 6,240 lbs.

Step 3: Calculate Static Pullout Strength in Tension per ACI 318-05 Section D.5.3, as amended in Section 4.1.4 of this report, = $\Phi_p N_a$ = 0.65 x 25,175 = 16,360 lbs.

Step 4: The controlling value (from Steps 1, 2 and 3 above) per ACI 318-05 Section D.4.1.2 = ΦN_n = 6,240 lbs.

Step 5: Divide the controlling value by the conversion factor α as determined in footnote 12 above and section 4.2.1 of this report: $T_{allowable,ASD} = \Phi N_n/\alpha$ = 6,240 / 1.48 = 4,215 lbs.

TABLE 7—INSTALLATION DETAILS FOR THREADED ROD ANCHORS (ASTM A307, ASTM A193 GRADE B7, STAINLESS STEEL)

Anchor Diameter (inches)	Drill Bit Diameter[1] (inches)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number [2]
$^1/_2$	$^5/_8$	ETB6	EMN22i	CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC50-RP25
$^5/_8$	$^3/_4$	ETB6			ARC62-RP25
$^3/_4$	$^7/_8$	ETB8			ARC75-RP25
$^7/_8$	1	ETB10			ARC87-RP25
1	$1^1/_8$	ETB10			ARC100-RP25

For **SI:** = 1 inch = 25.4 mm.

[1]Rotary Hammer must be used to drill all holes.
[2]Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

TABLE 8—INSTALLATION DETAILS FOR REINFORCING BAR ANCHORS (ASTM A615, GRADE 60)

Rebar	Drill Bit Diameter[1] (inches)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number [2]
#4	$^5/_8$	ETB6	EMN22i	CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC50-RP25
#5	$^3/_4$	ETB6			ARC62-RP25
#6	$^7/_8$	ETB8			ARC75-RP25
#7	1	ETB10			ARC87-RP25
#8	$1^1/_8$	ETB10			ARC100-RP25

For **SI:** = 1 inch = 25.4 mm.

[1]Rotary Hammer must be used to drill all holes.
[2]Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

TABLE 9—CURE SCHEDULE[1]

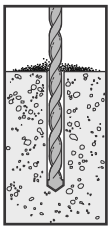
Concrete Temperature		Cure Time[1] (hours)
(°F)	(°C)	
50	10	72
70	21	24
90	32	24
110	43	24

For **SI:** = 1 °F = (c x $^9/_5$) + 32.

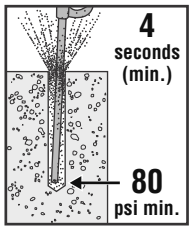
[1]For water-saturated concrete, the cure times should be doubled.

1 HOLE PREPARATION

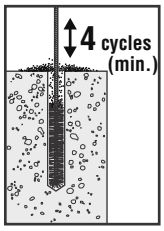
For horizontal, vertical and overhead applications.



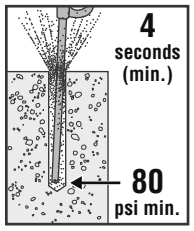
1. **Drill**–Drill hole to specified diameter and depth.



2. **Blow**–Remove dust from hole with oil-free compressed air for a minimum of 4 seconds.



3. **Brush**–Clean with a nylon brush for a minimum of 4 cycles.



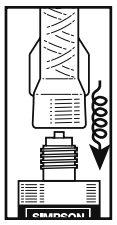
4. **Blow**–Remove dust from hole with oil-free compressed air for a minimum of 4 seconds.

Note: Refer to Tables A and B for proper drill bit size and brush part number.

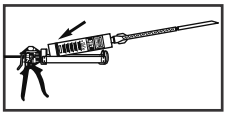
2 CARTRIDGE PREPARATION

1. **Check**–Check cartridge expiration date. **Do not use expired product.** Product is usable until end of printed expiration month.

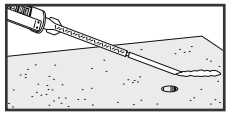
2. **Open**–Open cartridge per package instructions.



3. **Attach**–Attach proper Simpson Strong-Tie® nozzle to cartridge. Do not modify nozzle.



4. **Insert**–Insert cartridge into dispensing tool.



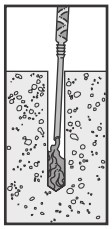
5. **Dispense**–Dispense adhesive to the side until properly mixed (uniform color).

Note: Refer to Tables A and B for proper nozzle and dispensing tool part number.

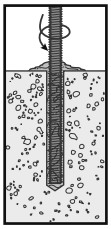
3 FILLING THE HOLE: Vertical Anchorage

Prepare the hole per instructions "Hole Preparation".

Dry and Damp Holes:

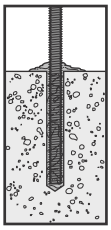


1. **Fill**–Fill hole ½ - ⅔ full, starting from bottom of hole to prevent air pockets. Withdraw nozzle as hole fills up.



Threaded rod or rebar

2. **Insert**–Insert clean, oil free anchor, turning slowly until the anchor contacts the bottom of the hole.

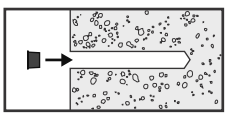


3. **Do not disturb**–Do not disturb anchor until fully cured.

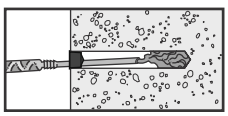
Note: Refer to Table C for proper cure times and Table D for maximum tightening torgue.

3 FILLING THE HOLE: Horizontal and Overhead Anchorage

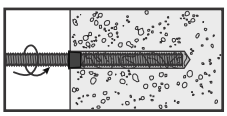
Prepare the hole per instructions "Hole Preparation".



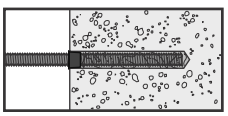
1. **Install**–Install Simpson Strong-Tie® ARC adhesive retaining cap. (ARC required. Refer to Tables A and B.)



2. **Fill**–Fill hole ½ - ⅔ full, starting from bottom of hole to prevent air pockets. Withdraw nozzle as hole fills up.



3. **Insert**–Insert clean, oil free anchor, turning slowly until the anchor contacts the bottom of the hole.



4. **Do not disturb**–Do not disturb anchor until fully cured.

Figure 1 – Installation Details

Table A - Installation Details for Threaded Rod Anchors (ASTM A307, ASTM A193 Grade B7, Stainless Steel)

Anchor Diameter (in)	Drill Bit Diameter[1] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number [2]
½	⅝	ETB6	EMN22i	CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC50-RP25
⅝	¾	ETB6			ARC62-RP25
¾	⅞	ETB8			ARC75-RP25
⅞	1	ETB10			ARC87-RP25
1	1⅛	ETB10			ARC100-RP25

1. Rotary Hammer must be used to drill all holes.
2. Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

Table B - Installation Details for Reinforcing Bar Anchors (ASTM A615, Grade 60)

Anchor Diameter (in)	Drill Bit Diameter[1] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number [2]
#4	⅝	ETB6	EMN22i	CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC50-RP25
#5	¾	ETB6			ARC62-RP25
#6	⅞	ETB8			ARC75-RP25
#7	1	ETB10			ARC87-RP25
#8	1⅛	ETB10			ARC100-RP25

1. Rotary Hammer must be used to drill all holes.
2. Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

Table C - Cure Schedule

Concrete Temperature		Cure Time[1] (hours)
(° F)	(° C)	
50	10	72
70	21	24
90	32	24
110	43	24

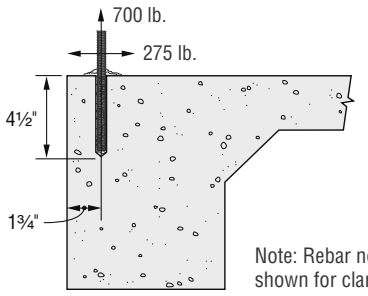
1. For water-saturated concrete, the cure times should be doubled.

Table D - Maximum Tightening Torque

Anchor Diameter (in)	Maximum Tightening Torque T_{inst} (ft-lb)
½	20
⅝	30
¾	45
⅞	60
1	80

Figure 1 – Installation Details (continued)

Determine if a single ½" diameter ASTM A193 Grade B7 anchor rod in SET-XP™ epoxy adhesive with a minimum 4½" embedment (h_{ef} = 4½") installed 1¾" from the edge of a 12" deep spandrel beam is adequate for a service tension load of 700 lb. for wind and a reversible service shear load of 275 lb. for wind. The anchor will be in the tension zone, away from other anchors in f'_c = 3,000 psi normal-weight concrete (dry). The anchor will be subjected to a maximum short-term temperature of 110˚F and a maximum long-term temperature of 75˚F. Continuous inspection will be provided.



Note: Rebar not shown for clarity.

CALCULATIONS AND DISCUSSION	REFERENCE
1. Determine the factored tension and shear design loads:	*ACI 318, 9.2.1*
$N_{ua} = 1.6W = 1.6 \times 700 = 1{,}120$ lb.	
$V_{ua} = 1.6W = 1.6 \times 275 = 440$ lb.	
2. Design considerations:	*D.4.1.2*
This is a combined tension and shear interaction problem where values for both ϕN_n and ϕV_n need to be determined. ϕN_n is the lesser of the design tension strength controlled by: steel (ϕN_{sa}), concrete breakout (ϕN_{cb}), or adhesive (ϕN_a). ϕV_n is the lesser of the design shear strength controlled by: steel (ϕV_{sa}), concrete breakout (ϕV_{cb}), or pryout (ϕV_{cp}).	
3. Steel capacity under tension loading:	*D.5.1*
$\phi N_{sa} \geq N_{ua}$	*Eq. (D-1)*
N_{sa} = 17,750 lb.	*Table 2*
ϕ = 0.75	*Table 2*
n = 1 (single anchor)	
Calculating for ϕN_{sa}:	
$\phi N_{sa} = 0.75 \times 1 \times 17{,}750 = 13{,}313$ lb. > 1,120 lb. – OK	

CALCULATIONS AND DISCUSSION	REFERENCE
4. Concrete breakout capacity under tension loading:	*D.5.2*
$\phi N_{cb} \geq N_{ua}$	*Eq. (D-1)*
$N_{cb} = \frac{A_{Nc}}{A_{Nco}} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$	*Eq. (D-4);*
where:	
$N_b = k_c \sqrt{f'_c}\, h_{ef}^{1.5}$	*Eq. (D-7)*
substituting:	
$\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nco}} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} k_c \sqrt{f'_c}\, h_{ef}^{1.5}$	
where:	
$k_c = k_{cr} = 17$ *(Anchor is installed in a tension zone, therefore, cracking is assumed at service loads)*	*Table 4*
$\Psi_{cp,N} = 1.0$	*D.5.2.7*
$\Psi_{ed,N} = 0.7 + 0.3 \frac{c_{a,min}}{1.5 h_{ef}}$ when $c_{a,min} < 1.5\ h_{ef}$	*Eq. (D-11)*
by observation, $c_{a,min} < 1.5 h_{ef}$	
$\Psi_{ed,N} = 0.7 + 0.3 \frac{1.75}{1.5(4.5)} = 0.78$	
$\Psi_{c,N} = 1.0$ *(assuming cracking at service loads)*	*D.5.2.6*
ϕ = 0.65 for Condition B (no supplementary reinforcement provided)	*Table 4*
$A_{Nco} = 9 h_{ef}^2 = 9(4.5)^2 = 182.25$ in.^{2}	*Eq. (D-6)*
$A_{Nc} = (c_{a1} + 1.5 h_{ef})(2 \times 1.5 h_{ef}) = (1.75 + 1.5(4.5))(2 \times 1.5(4.5)) = 114.75$ in.^{2}	*Fig. RD.5.2.1(a)*
$\frac{A_{Nc}}{A_{Nco}} = \frac{114.75}{182.25} = 0.63$	
Calculating for ϕN_{cb}:	
$\phi N_{cb} = 0.65 \times 0.63 \times 1.0 \times 0.78 \times 1 \times 17 \times \sqrt{2{,}500} \times (4.5)^{1.5} = 2{,}592$ lb. > 1,120 lb. – OK	*Section 5.3*

Figure 2 – Example Calculation

CALCULATIONS AND DISCUSSION	REFERENCE

5. Adhesive anchor capacity under tension loading: Section 4.1.4

$\phi N_a \geq N_{ua}$ *Eq. (D-1)*

$N_a = \frac{A_{Na}}{A_{Nao}} \Psi_{ed,Na} \Psi_{p,Na} N_{ao}$ *Eq. (D-16a)*

$N_{ao} = \tau_{k,cr} \pi d h_{ef} = 1{,}040\pi(0.5)(4.5) = 7{,}351$ *lb.* *Eq. (D-16f)*

$s_{cr,Na} = 20d \sqrt{\frac{\tau_{k,uncr}}{1{,}450}} \leq 3h_{ef}$ *Eq. (D-16d)*

$s_{cr,Na} = (20)(0.5) \sqrt{\frac{2{,}422}{1{,}450}} = 12.92" \leq 3h_{ef} = 13.5"$ *Table 5*

$s_{cr,Na} = 12.92"$

$c_{cr,Na} = \frac{s_{cr,Na}}{2} = \frac{12.92}{2} = 6.46"$ *Eq. (D-16e)*

$A_{Nao} = (s_{cr,Na})^2 = (12.92)^2 = 166.93"$ *Eq. (D-16c)*

$A_{Na} = (c_{a1} + c_{cr,Na})(s_{cr,Na}) = (1.75 + 6.46)(12.92) = 106.07"$

$\Psi_{ed,Na} = (0.7 + 0.3 \frac{c_{a,min}}{c_{cr,Na}}) \leq 1.0$ *Since* $c_{a,min} < c_{cr,Na}$ *Eq. (D-16m)*

$\Psi_{ed,Na} = (0.7 + 0.3 \frac{c_{a,min}}{c_{cr,Na}}) = (0.7 + 0.3 \frac{1.75}{6.46}) = 0.78$

$\Psi_{p,Na} = 1.0$ *AC308 D.5.3.14*

$\phi = 0.65$ for dry concrete *Table 5*

Calculating for ϕN_a*:*

$\phi N_a = 0.65 \times \frac{106.07}{166.93} \times 0.78 \times 1 \times 7{,}351 = 2{,}368$ *lb.* $> 1{,}120$ *lb. – OK*

6. Check all failure modes under tension loading: *D.4.1.2*

Summary:

Steel capacity	= 13,313 lb.
Concrete breakout capacity	= 2,592 lb.
Adhesive capacity	= 2,368 lb. ← **Controls**

∴ ϕN_n = 2,368 lb. as adhesive capacity controls

7. Steel capacity under shear loading: *D.6.1*

$\phi V_{sa} \geq V_{ua}$ *Eq. (D-2)*

$V_{sa} = 10{,}650$ lb. *Table 2*

$\phi = 0.65$ *Table 2*

Calculating for ϕV_{sa}:

$\phi V_{sa} = 0.65 \times 10{,}650 = 6{,}923$ lb. > 440 lb. – OK

CALCULATIONS AND DISCUSSION	REFERENCE

8. Concrete breakout capacity under shear loading: *D.6.2*

$\phi V_{cb} \geq V_{ua}$ *Eq. (D-2)*

$V_{cb} = \frac{A_{Vc}}{A_{Vco}} \Psi_{ed,V} \Psi_{c,V} V_b$ *Eq. (D-21)*

where:

$V_b = 7\left(\frac{\ell_e}{d_o}\right)^{0.2} \sqrt{d_o} \sqrt{f'_c} c_{a1}^{1.5}$ *Eq. (D-24)*

substituting:

$\phi V_{cb} = \phi \frac{A_{Vc}}{A_{Vco}} \Psi_{ed,V} \Psi_{c,V} 7\left(\frac{\ell_e}{d_o}\right)^{0.2} \sqrt{d_o} \sqrt{f'_c} c_{a1}^{1.5}$

where:

$\phi = 0.70$ *for Condition B (no supplementary reinforcement provided)* *D4.4(c)(i)*

$A_{Vco} = 4.5 c_{a1}^2 = 4.5(1.75)^2$ *Eq. (D-23)*

$\therefore A_{Vco} = 13.78$ in.^{2}

$A_{Vc} = 2(1.5c_{a1})(1.5c_{a1}) = 2(1.5(1.75))(1.5(1.75))$ *Fig. RD.6.2.1(a)*

$\therefore A_{Vc} = 13.78$ in.^{2}

$\frac{A_{Vc}}{A_{Vco}} = \frac{13.78}{13.78} = 1$ *D.6.2.1*

$\Psi_{ed,V} = 1.0$ *since* $c_{a2} > 1.5c_{a1}$ *Eq. (D-27)*

$\Psi_{c,V} = 1.0$ *D.6.2.7*

(assuming cracking at service loads)

$d_o = 0.5$ in.

$\ell_e = 8d_o = 8\ (0.5) = 4"$ *D.6.2.2*

$c_{a1} = 1.75$ in.

$\phi V_{cb} = 0.70 \times 1 \times 1 \times 1 \times 7 \times \left(\frac{4}{0.5}\right)^{0.2} \times \sqrt{0.5}$ *Section 5.3*

$\times \sqrt{2{,}500} \times (1.75)^{1.5} = 608$ lb. > 440 lb. – OK

9. Concrete pryout capacity *Section 4.1.7*

$V_{cp} = \min[k_{cp} N_a; k_{cp} N_{cb}]$ *Eq. (D-30a)*

$k_{cp} = 2.0$ *for* $h_{ef} \geq 2.5"$

$N_a = 3{,}643$ *lb. from adhesive-capacity calculation without* ϕ *factor*

$N_{cb} = 3{,}988$ *lb. from concrete-breakout calculation without* ϕ *factor*

$V_{cp} = (2.0)(3{,}643) = 7{,}286$ *lb. controls*

$\phi = 0.7$ *Table 4*

$\phi V_{cp} = (0.7)(7{,}286) = 5{,}100$ *lb.* > 440 *lb. – OK*

Figure 2 – Example Calculation (continued)

CALCULATIONS AND DISCUSSION	REFERENCE

10. Check all failure modes under shear loading: *D.4.1.2*

Summary:

Steel capacity = 6,923 lb.

Concrete breakout capacity = 608 lb. ← **Controls**

Pryout capacity = 5,100 lb.

∴ ϕV_n **= 608 lb. as concrete breakout capacity controls**

11. Check interaction of tension and shear forces: *D.7*

If $0.2\,\phi V_n \geq V_{ua,}$ then the full tension design strength is permitted. *D.7.1*

By observation, this is not the case.

If $0.2\,\phi N_n \geq N_{ua}$, then the full shear design strength is permitted *D.7.2*

By observation, this is not the case.

Therefore:

$$\frac{N_{ua}}{\phi N_n} + \frac{V_{ua}}{\phi V_n} \leq 1.2 \qquad \textit{Eq. (D-31)}$$

$$\frac{1{,}120}{2{,}368} + \frac{440}{608} = 0.47 + 0.72 = 1.19 < 1.2 - \text{OK}$$

12. Summary

A single ½" diameter ASTM A193 Grade B7 anchor rod in SET-XP™ epoxy adhesive at a 4½" embedment depth is adequate to resist the applied service tension and shear loads of 700 lb. and 275 lb., respectively.

Figure 2 – Example Calculation (continued)

OFFICIAL LISTING

NSF International Certifies that the products appearing on this Listing conform to the requirements of NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects

These NSF Official Listings are current as of Thursday, March 10, 2011

SIMPSON STRONG-TIE COMPANY
5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CA 94588
800-999-5099

Facility: ADDISON, IL

Joining and Sealing Materials

Trade Designation	Size	Water Contact Temp	Water Contact Material
Adhesives			
AT08	[1]	CLD23	JSM
AT10	[1]	CLD23	JSM
AT13	[1]	CLD23	JSM
AT30	[1]	CLD23	JSM
AT5.5	[1]	CLD23	JSM
Acrylic - Tie	[1]	CLD23	JSM
ETI-LV Injection Epoxy	[3]	CLD23	EPOXY
ETILV	[3]	CLD23	EPOXY
ETILV22	[3]	CLD23	EPOXY
SET High Strength Epoxy	[2]	CLD23	EPOXY
SET-PAC	[2]	CLD23	EPOXY
SET-XP	[2]	CLD23	EPOXY
SET-XP22	[2]	CLD23	EPOXY
SET22	[2]	CLD23	EPOXY
SET56	[2]	CLD23	EPOXY
SETPAC-EZ	[2]	CLD23	EPOXY
Sealants			
SET High Strength Epoxy	[2]	CLD23	EPOXY
SET-PAC	[2]	CLD23	EPOXY
SET-XP	[2]	CLD23	EPOXY
SET-XP22	[2]	CLD23	EPOXY
SET22	[2]	CLD23	EPOXY
SET56	[2]	CLD23	EPOXY
SETPAC-EZ	[2]	CLD23	EPOXY

[1] Certified for a maximum exposed surface area of 2.2 sq. in./1000 gal.
[2] Certified for a maximum exposed surface area of 216 sq. in./1000 gal.
[3] Certified for a maximum exposed surface area of 22 sq. in./1000 gal.

Note: All Listed products from this facility are NSF Certified, whether or not they bear the NSF Mark.

Note: Additions shall not be made to this document without prior evaluation and acceptance by NSF International.

I. PRODUCT AND COMPANY IDENTIFICATION

Company: Simpson Strong-Tie Company, Inc.
Address: 5956 W. Las Positas Blvd.
Pleasanton, CA 94588

Product Name: **Cartridges: SET-XP22, SET-XP56**
Single Packaging – SET-XP™ Resin

Product Description: Structural Epoxy-Tie® Anchoring Adhesive for Cracked and Uncracked Concrete – Epoxy Resin

Emergency Contact No.: 1-800-535-5053 **USA**
1-352-323-3500 **International**

Date Prepared or Revised: September 2009
Supercedes: May 2008
For most current MSDS, please visit our web site at www.simpsonanchors.com.

II. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Names	CAS Numbers
BisPhenolA/Epichlorohydrin (Epoxy Resin)	25068-38-6
N-butyl glycidyl ether	2426-08-06
Silica, crystalline quartz	14808-60-7
Titanium dioxide	1317-80-2

The remaining ingredients are designated as “trade secret”.

III. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

Non-corrosive.
May cause eye and skin irritation.
May cause skin sensitization.

POTENTIAL HEALTH EFFECTS

ACUTE

Eye Contact: May cause eye irritation, swelling, tearing, redness or cornea damage.
Skin Contact: Moderate irritation. May cause skin sensitization, evidenced by rashes and hives.
Inhalation: Moderate irritation to the nose and respiratory tract. May cause Central Nervous System depression, evidenced by headache, dizziness, and nausea.
Ingestion: May cause irritation to the gastrointestinal tract. May cause Central Nervous System depression or other systemic effects.
Systemic Effects: Lungs, eyes, and skin.

IV. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with plenty of cool water for at least 15 minutes while holding the eyes open. If redness, burning, blurred vision, or swelling persists, **CONSULT A PHYSICIAN**.

Skin Contact: Remove product and immediately wash affected area with soap and water. Do not apply greases or ointments. Remove contaminated clothing. Wash clothing with soap and water before reuse. If redness, burning, or swelling persists, **CONSULT A PHYSICIAN**.

Ingestion: **DO NOT INDUCE VOMITING**. Never administer anything by mouth to an unconscious person. Rinse out mouth with water, then drink sips of water to remove taste from mouth. **CONSULT A PHYSICIAN** if vomiting occurs spontaneously, keep head below hips to prevent aspiration.

Inhalation: Remove patient to fresh air. If patient continues to experience difficulty breathing, **CONSULT A PHYSICIAN**.

V. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media: Water fog, carbon dioxide or dry chemical, aqueous foam.

Fire And Explosion Hazard: Hazardous decomposition products may occur when materials polymerize at temperatures above 500°F. Do not allow run-off from fire fighting to enter drains or water courses.

Fire Fighting Equipment and Procedures: Wear full protective clothing and self-contained breathing apparatus for fire fighting. Isolate fuel supply from fire. Clear fire area of all non-emergency personnel. Use water spray to cool fire-exposed surfaces and containers.

VI. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Use cautious judgment when cleaning up spill. Shut off leaks, if possible without personal risk. Wear suitable protective clothing, gloves and eye/face protection. Evacuate personnel to safe areas.

Environmental Precautions: Construct a dike to prevent spreading. Keep out of sewers, storm drains, surface waters, and soils.

Clean-up Methods: **Small spills**: Soak up with absorbent material such as clay, sand or other suitable non-reactive material. Place in leak-proof containers. Seal tightly for proper disposal. **Large spills**: Approach suspected leak areas with caution. Create a dike or trench to contain material. Soak up with absorbent material such as clay, sand or other suitable non-reactive material. Place in leak-proof containers. Seal tightly for proper disposal.

Additional Information: Notify authorities if any exposures to the general public or environment occur or are likely to occur. Dispose in accordance with federal, state, and local regulations.

VII. STORAGE AND HANDLING

Storage: Keep away from: acids, oxidizers, heat, or flames. Keep in cool, dry, well-ventilated area in closed containers. Protect containers from physical damage.

Handling: To prevent skin and eye contact under the foreseeable conditions of use, wear appropriate protective clothing and safety eyewear. When handling, do not eat, drink, or smoke. Wash thoroughly after handling. Avoid breathing fumes. Handle in a well-ventilated work area.

VIII. EXPOSURE CONTROLS / PERSONAL PROTECTION

Protective Measure: Wear appropriate personal protective equipment.

Eye Protection: Avoid contact with eyes. Wear chemical splash goggles or safety glasses with side shield.

Hand Protection: Wear chemical-resistant gloves such as: Nitrile, neoprene, butyl.

Skin and Body Protection: Wear chemical-resistant gloves and other clothing as required to minimize contact.

Respirator Protection: Not required for properly ventilated areas.

Exposure Limits:

COMPONENT	ACGIH (TLV)	OSHA (PEL)
BisPhenolA/Epichlorohydrin (Epoxy Resin)	N/E	N/E
N-butyl glycidyl ether	25 ppm	25 ppm
Silica, crystalline quartz (airborne particulates of respirable size)	0.1 mg/m^3	0.4 mg/m^3
Titanium dioxide (total dust)	10 mg/m^3	15 mg/m^3

IX. PHYSICAL AND CHEMICAL PROPERTIES

Form: Paste

Color: White

Odor: Sweet

Vapor Pressure: Not Volatile

Boiling Point: >500˚F (> 260˚C)

Freezing Point: N/E

Flash Point: >250°F (Open Cup)

Specific Gravity: 1.21@ 72°F
Solubility In Water: Insoluble

X. REACTIVITY DATA

Stability: Stable under normal storage conditions.
Conditions To Avoid: Incompatible chemicals, high heat and open flame.
Materials To Avoid: Oxidizing agents, acids, organic bases, and amines.
Hazardous Decomposition Products: Combustion may produce carbon monoxide, carbon dioxide, aldehydes, acids and other organic substances.
Hazardous Polymerization: Will not occur.

XI. TOXICOLOGICAL PROPERTIES

Acute Oral (LD_{50}, Rat): Non toxic
Acute Dermal (LD_{50}, Rabbit): N/E
Acute Inhalation (LC_{50}, Rat): N/E
Chronic Health Hazard The Diglycidyl Ether of Bisphenol A has shown weak carcinogenicity in 2-year mice bioassays. This material has shown activity in-vitro microbial mutagenicity screening and has produced chromosomal aberrations in cultured rat liver cells. No activity when tested by vivo mutagenicity assays.

XII. DISPOSAL CONSIDERATIONS

Waste From Residues / Unused Products: This material is not a hazardous waste by RCRA criteria (40 CFR 261). Dispose of container and unused contents in accordance with federal, state, and local requirements.

XIII. TRANSPORTATION

US DOT: Not Regulated For Transport.
IATA: Not Regulated For Transport.
IMO: Not Regulated For Transport.

XIV. REGULATORY INFORMATION

Country	Regulatory List
USA	TSCA

EPA SARA Title III Section 312 (40 CFR 370) Hazardous Classification:
Acute/Chronic Health Hazard.
EPA SARA Title III Section 313 (40 CFR 372) Component(s) above 'de minimus' level: None.
US. California "Safe Drinking Water and Toxic Enforcement Act" (Proposition 65): This product contains small traces of the following chemicals that are known to the State of California to cause cancer and/or reproductive toxicity and other harm.

Component	Regulation	Concentration	Remarks
Phenylglycidyl ether*	ACGIH	Trace	Carcinogenic
Epichlorohydrin*	ACGIH	Trace	Carcinogenic

* May be absorbed through skin.

XV. OTHER INFORMATION

HMIS RATING

Health	Flammability	Physical Hazard
2	1	0

N/E – Not Established

This Material Safety Data Sheet (MSDS) is prepared by Simpson Strong-Tie Co. in compliance with the requirements of OSHA 29 CFR Part 1910.1200. The information it contains is offered in good faith as accurate as of the date of this MSDS. This MSDS is provided solely for the purpose of conveying health, safety, and environmental information. No warranty, expressed or implied, is given. Health and Safety precautions may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations.

I. PRODUCT AND COMPANY IDENTIFICATION

Company:	Simpson Strong-Tie Company, Inc.
Address:	5956 W. Las Positas Blvd. Pleasanton, CA 94588
Product Name:	**Cartridges: SET-XP22, SET-XP56** **Single Packaging: SETXPH**
Product Description:	Structural Epoxy-Tie® Anchoring Adhesive for Cracked and Uncracked Concrete – Epoxy Hardener
Emergency Contact No.:	1-800-535-5053 **USA** 1-352-323-3500 **International**
Date Prepared or Revised:	September 2009
Supercedes:	May 2008
	For most current MSDS, please visit our web site at www.simpsonanchors.com.

II. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Names	CAS Numbers
Phenol (Benzenol)	108-95-2
Benzene-1, 3-Dimethaneamine	1477-55-0
Silica, crystalline quartz	14808-60-7

The remaining ingredients are designated as "trade secret".

III. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

Corrosive.
Severe irritation to eyes and skin.
May cause skin sensitization.
Components of the product may affect the nervous system.

POTENTIAL HEALTH EFFECTS

ACUTE

Eye Contact:	Severe irritation, swelling, tearing, redness or cornea damage. May cause burns and tissue damage.
Skin Contact:	Severe irritation. May cause burns and tissue damage. May cause skin sensitization evidenced by rashes and hives.
Inhalation:	Moderate irritation to the nose and respiratory tract. May cause Central Nervous System depression, evidenced by giddiness, headache, dizziness, and nausea.
Ingestion:	May cause irritation to the gastrointestinal tract. May cause headache nausea. May cause Central Nervous System depression or other systemic effects.
Systemic Effects:	Lungs, eyes, and skin.

IV. FIRST AID MEASURES

Eye Contact:	Immediately flush eyes with plenty of cool water for at least 15 minutes while holding the eyes open. If redness, burning, blurred vision, or swelling persists, **CONSULT A PHYSICIAN**.
Skin Contact:	Remove product and immediately wash affected area with soap and water. Do not apply greases or ointments. Remove contaminated clothing. Wash clothing with soap and water before reuse. If redness, burning, or swelling persists, **CONSULT A PHYSICIAN**.
Ingestion:	**DO NOT INDUCE VOMITING**. Never administer anything by mouth to an unconscious person. Rinse out mouth with water, then drink sips of water to remove taste from mouth. **CONSULT A PHYSICIAN** if vomiting occurs spontaneously, keep head below hips to prevent aspiration.
Inhalation:	Remove patient to fresh air. If patient continues to experience difficulty breathing, **CONSULT A PHYSICIAN**.

V. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media: Water spray, fog or foam, carbon dioxide, dry chemical, limestone powder.

Fire And Explosion Hazard: Irritating and toxic fumes may be produced at high temperature. In a fire, may produce carbon monoxide**,** toxic nitrogen oxide, ammonia, and carbon dioxide. Use of water may result in the formation of very toxic aqueous solution. Do not allow run-off from fire fighting to enter drains or water courses.

Fire Fighting Equipment and Procedures: Wear full protective clothing and self-contained breathing apparatus for fire fighting. Isolate fuel supply from fire. Clear fire area of all non-emergency personnel.

VI. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Use cautious judgment when cleaning up spill. Shut off leaks, if possible without personal risk. Wear suitable protective clothing, gloves and eye/face protection. Evacuate personnel to safe areas.

Environmental Precautions: Construct a dike to prevent spreading. Keep out of sewers, storm drains, surface waters, and soils.

Clean-up Methods: **Small spills**: Soak up with absorbent material such as clay, sand or other suitable non-reactive material. Place in leak-proof containers. Seal tightly for proper disposal. **Large spills**: Approach suspected leak areas with caution. Create a dike or trench to contain material. Soak up with absorbent material such as clay, sand or other suitable non-reactive material. Place in leak-proof containers. Seal tightly for proper disposal.

Additional Information: Notify authorities if any exposures to the general public or environment occur or are likely to occur. Dispose in accordance with federal, state, and local regulations.

VII. STORAGE AND HANDLING

Storage: Keep away from: acids, oxidizers, heat, or flames. Keep in cool, dry, well-ventilated area in closed containers. Protect containers from physical damage.

Handling: To prevent skin and eye contact under the foreseeable conditions of use, wear appropriate protective clothing and safety eyewear. When handling, do not eat, drink, or smoke. Wash thoroughly after handling. Avoid breathing fumes. Handle in a well ventilated work area.

VIII. EXPOSURE CONTROLS / PERSONAL PROTECTION

Protective Measure: Wear appropriate personal protective equipment.

Eye Protection: Avoid contact with eyes. Wear chemical splash goggles or safety glasses with side shield.

Hand Protection: Wear chemical-resistant gloves such as: Nitrile, neoprene, butyl.

Skin and Body Protection: Wear chemical-resistant gloves and other clothing as required to minimize contact.

Respirator Protection: Not required for properly ventilated areas.

Exposure Limits:

Chemical Names	ACGIH (TLV)	OSHA (PEL)
Phenol (Benzenol)	5 ppm	5 ppm
Benzene-1, 3-Dimethaneamine	0.1 mg/m^3	0.1mg/m^3
Silica, crystalline quartz (airborne particulates of respirable size)	0.1 mg/m^3	0.1 mg/m^3

IX. PHYSICAL PROPERTIES

Form: Paste

Color: Dark Green

Odor: Ammonia

Boiling Point: N/E

Freezing Point: N/E

Vapor Pressure: N/E

Flash Point: 262ºF (128ºC)

Specific Gravity: 1.59@ 72°F

Solubility In Water: Slight

X. REACTIVITY DATA

Stability:	Stable under normal storage conditions.
Conditions To Avoid:	Incompatible chemicals, high heat, and open flame.
Materials To Avoid:	Oxidizing agents and acids.
Hazardous Decomposition Products:	Combustion may produce carbon monoxide, carbon dioxide, and nitrogen oxide, and other organic substances.
Hazardous Polymerization:	Will not occur.

XI. TOXICOLOGICAL PROPERTIES

Acute Oral (LD_{50}, Rat):	N/E
Acute Dermal (LD_{50}, Rabbit):	N/E
Acute Inhalation (LC_{50}, Rat):	N/E
Chronic Health Hazard	Components of this product are not listed as carcinogens in concentrations of 0.1% or greater. Repeated or prolonged exposure may cause allergic reaction and/or limited sensitization.

XII. DISPOSAL CONSIDERATIONS

Waste From Residues / Unused Products:	Dispose of container and unused contents in accordance with federal, state, and local requirements.

XIII. TRANSPORTATION

US DOT: Cartridges:	Consumer Commodity, ORM-D
Single Packaging:	UN2735, Amines, Liquid, Corrosive, n.o.s. (Benzene-1, 3-Dimethaneamine), 8, II
IATA:	UN2735, Amines, Liquid, Corrosive, n.o.s. (Benzene-1, 3-Dimethaneamine), 8, II
IMO:	UN2735, Amines, Liquid, Corrosive, n.o.s. (Benzene-1, 3-Dimethaneamine), 8, II

XIV. REGULATORY INFORMATION

Country	Regulatory List
USA	TSCA

EPA SARA Title III Section 312 (40 CFR 370) Hazardous Classification:
Acute/Chronic Health Hazard.
EPA SARA Title III Section 313 (40 CFR 372) Component(s) above 'de minimus' level:
Phenol.
US. California "Safe Drinking Water and Toxic Enforcement Act" (Proposition 65): This product contains small traces of the following chemicals that are known to the State of California to cause cancer and/or reproductive toxicity and other harm.

Component	Regulation	Concentration	Remarks
Carbon Black	ACGIH	Trace	Carcinogenic
Silica Quartz	ACGIH	Trace	Carcinogenic

***** May be absorbed through skin.

XV. OTHER INFORMATION

HMIS RATING

Health	Flammability	Physical Hazard
3	1	0

N/E – Not Established

This Material Safety Data Sheet (MSDS) is prepared by Simpson Strong-Tie Co. in compliance with the requirements of OSHA 29 CFR Part 1910.1200. The information it contains is offered in good faith as accurate as of the date of this MSDS. This MSDS is provided solely for the purpose of conveying health, safety, and environmental information. No warranty, expressed or implied, is given. Health and Safety precautions may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations.