3.1 Product Details

3.2 Installation Information

3.3 Allowable Stress Load Capacities

Section 3.1 : Product Details -CIA-EA Epoxy Acrylate

3.1.1 Description

USP CIA-EA is a high strength, 2-component, 100% solids, moisture insensitive structural adhesive. It is ideally suited for a wide range of applications including anchoring and doweling into concrete and masonry substrates. CIA-EA is composed of a special proprietary blend of solvent free epoxy acrylate resins and is backed by extensive research and testing. It is formulated to achieve fast cure times even at low temperatures while maintaining excellent flowability.

3.1.2 Product Features

- Styrene, solvent, cement, and water free
- Moisture insensitive and can be used underwater
- No VOC's, non-toxic, non-flammable, non-shrink, and odorless
- Fast curing and flowable adhesive even at very low temperatures
- Wide temperature application range: -5˚F (-15˚C) to 104˚F (40˚C)
- Economical and labor saving, no setting tools required
- Pre-packaged in easy to use and reliable systems
- High strength, aggressive bonding formulation
- Excellent chemical resistance properties
- Very high ultimate load values

3.1.3 Listings/Approvals (see secton 8.0 for complete information)

ICC (ICBO) ES ESR 1702
City of Los Angeles LA RR 25113
Florida Building Code FL 4928

3.1.4 General Uses

- High-strength anchoring of threaded rod, reinforcing bar, and bolts into concrete and masonry
- Anchoring for steel bracing and seismic reinforcement projects
- Attachments for support brackets and vibrating equipment
- Water and wastewater treatment plant projects
- Tilt-up wall braces and expansion joint anchors
- Damp, wet, and underwater applications
- Anchoring for transportation projects
- Cold temperature applications

3.1.5 Product Specifications

Shelf Life: 18 months in properly stored and unopened containers. Store away from heat or direct sunlight.

Viscosity: Thixotropic soft paste when mixed

Color:		
	Component (Resin)	Beige
	Component (Hardener)	Black
	Mixed	Gray

3.1.6 Setting Times

Working time is the period of time after mixing that the material can be used and the anchor readjusted without the risk of reducing the ultimate performance. Setting time is the length of time that is needed to pass until a design load can be applied to the anchor. During this time the anchor should not be disturbed.

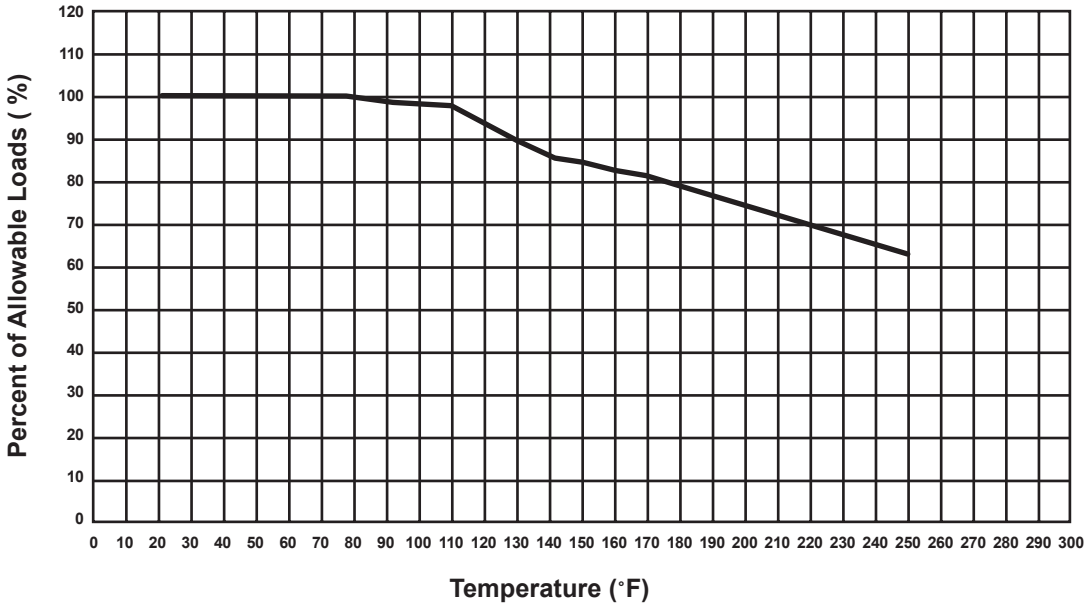
Temperature ˚F	Working Times	Settling Time
5˚F	12 hr	36 hr
23˚F	2.5 hr	12 hr
32˚F	45 mn	6 hr
41˚F	20 mn	2 hr
50˚F	15 mn	70 mn
68˚F	5 mn	30 mn
86˚F	3 mn	25 mn
95˚F	2 mn	20 mn

The material will harden and cure at temperatures as low as 5˚F (-15˚C). Pressure necessary to dispense the product will increase slightly if cartridges are left to cool below the freezing point.

3.1.7 Elevated Temperature Sensitivity

The physical properties of adhesives gradually decrease with increasing temperature. This occurs because the modulus of an adhesive is not a constant and is subject to change in changing temperature environments. The heat deflection temperature (HDT) indicates the temperature range in which this modulus change is rather large. Below the heat deflection temperature, adhesive products exhibit a typically rigid behavior; above the heat deflection temperature, adhesive products exhibit typically flexible behavior. A rigid adhesive with a high heat deflection temperature can withstand sustained loads for long periods of time if the structure temperature is sufficiently distant from its HDT temperature. In most practical cases it is unlikely that the temperature of a structure exceeds the range from 100˚F/37.7˚C to 125˚F/52˚C.

In addition to determining the HDT, temperature sensitivity tests are also performed on adhesive anchors. For these tests, adhesive anchors are installed in concrete cubes and allowed to cure. The cubes are then heated to various temperatures ranging from 30˚F to 250°F When the unit has reached the desired temperature, the anchor is tested to ultimate capacity. The graph below tabulates the results of the temperature sensitivity tests performed on the CIA-EA epoxy acrylate. The load reduction factors noted in the graph must be applied to the tension values in the allowable load tables when the anchors are installed locations where the concrete temperature may exceed 70˚F.



3.1.8 Elevated Temperature Creep Resistance

Testing has been conducted to evaluate temperature resistance of anchors using CIAEA systems. Engineers and designers need to be aware of the stability of the adhesive in the event of an elevated temperature condition.

The CIA-EA has been tested and evaluated in accordance with ASTM E 1512 and ICC ES AC 58 creep requirements. The CIA-EA meets the requirements to be permtted for long term load applications.

3.1.9 Fire-resistive Construction

The designer may have to consider the effects of a fire on adhesive anchors. Current research on this subject includes the following variables: length of exposure to fire, effect anchor embedment has on the loss of strength during a fire, and expected temperature levels during a fire.

Construction adhesives, such as epoxies, break down completely if directly exposed to temperatures greater than 350˚F (177˚C). The designer may want to use firestop or insulation around the base material to absorb thermal energy and increase the fire resistance of the adhesive anchors. If possible, deeper anchor embedments (h_{ef}, > 12d) will also protect the adhesive, since the concrete itself is a very good insulating material. Heat from a fire may have more of an impact on the exposed anchor steel itself than on the epoxy. The exposed anchor steel may also behave as a thermal energy path into the base material.

General industry practice does allow the use of unprotected adhesive anchors in fire resistive construction if they are used for lateral load resistance (wind/seisrnic) or other secondary systems.

3.1.I0 Dynamic and Seismic Loading

CIA-EA adhesive anchors perform very well under dynamic loading. The bond stress transfer mechanism of adhesive anchors is much less likely to fail under dynamic toads than the friction stress mechanism of expansion anchors (example: a wedge anchor). Unlike mechanical anchors which generate very high and concentrated unit stresses, adhesive anchors transfer stress along the entire length of the hole, considerably reducing the unit stress on the concrete itself. The lower unit stresses also allows the designer to place adhesive anchors closer to an edge or in anchor clusters closely spaced together.

The seismic behavior of adhesive anchors depends on the amplitude of the imposed deformation reversals, the direction of application of the deformations (axial, shear, combined), the state of the surrounding structural member (cracked or uncracked), and the presence of reinforcement near the vicinity of the anchors.

The CIA-EA has been tested with threaded rod for seismic loading in tension and shear in accordance with the ICC ES AC 58 and ASTM E-1512 standards. The CIA-EA has passed the requirements of these standards and has earned the use of the short term load increases when applicable by the code.

The behavior of adhesive anchors, installed at embedments of h_{ef} = 10d and large edge distances, subjected to alternate cyclic shear loads and one-direction cyclic tension loads resulted in bolt fractures during the cyclic loading.

3.1.11 Threaded Anchor Rod Materials

A 307 anchor bolts have been specificed for anchorage to concrete and masonry by the code and by engineers for many years, however the ASTM A 307 specifically covers headed bolts of relatively short lengths. If A 307 type steel strength is desired, a threaded rod that meets one of the AISI 1000 series such as AISI 1018 is very commonly available. AISI 1018 steel typically has an ultimate tensile strength between 70 ksi and 80 ksi. Yield stress is generally not provided for AISI 1018 steel, therefore if ductile elongation of the threaded rod is required, a material with a more defined separation between yield and ultimate strength should be selected. A 36 steel is also available although typically more expensive because it is usually cut from solid bar rather than roll formed. A 36 steel is a good ductile material with a minimum yield stress of 36 ksi and a minimum ultimate strength of 60 ksi. ASTM A 193, Grade B7 threaded rod is a good high strength commonly available ductile steel. It has a yield stress of 105 ksi and a ultimate strength of 125 ksi.

3.1.12 Deformed Reinforcing Bar

ASTM A 615 reinforcing bar is commonly available as Grade 40 and Grade 60. Grade 40 rebar typically has an ultimate tensile strength of 70 ksi with a minimum yield stress of 40 ksi. Grade 60 rebar typically has an ultimate tensile strength of 90 ksi with a minimum yield stress of 60 ksi. Both grades of reinforcing bar are very good ductile materials.

3.1.13 Chemical Resistance Chart

Products	Long Term immersion	Temporary immersion	Short Term immersion
Fresh Water	X		
Sea Water	X		
Hot Water (140˚F)	X		
Petrol	X		
Jet Fuel (Kerosene)	X		
Gasoline	X		
Methanol		X	
Ketone		X	
Soda (50%)		X	
Chlorhydric Acid (20%)		X	
Suylfuric Acid (5%)			X
Citric Acid (30%)		X	
Chlorinated Water	X		
White Spirit		X	

3.2 Installation Information

3.2.1 Installation in Concrete and Solid Masonry

A hole is drilled to the specified depth with a hand-held electro-pneumatic rotary hammer drill using carbide-tipped drill bits conforming to ANSI Specification B212.15-1994. The holes are cleaned of dust and debris with a nylon brush and a jet of compressed air. The hole diameter, anchor embedment, spacing and edge distances must comply with Tables 3.3 and 3.4. A mixing nozzle is attached to the adhesive cartridge and the assembly is placed into the hand or pneumatic injection tool. Before placement into the hole, a small amount of adhesive is pumped out of the nozzle until a uniform gray material is achieved. Holes are approximately half filled with the mixed adhesive. The threaded rods or deformed reinforcement bars are inserted with a rotating motion until the anchor contacts the bottom of the hole. The adhesive must be level with the concrete surface after insertion of the rod or bar. Oil, scale, and rust must be removed from the threaded rod or reinforcing bar prior to installation. During anchor installation, the hole and surrounding location shall be surface dry. Anchors shall not be loaded until adhesive cure time has passed.

3.2.2 Recommended Hole Sizes

TABLE 3.3 - SPECIFICATION AND INSTALLATION DETAILS FOR THREADED ROD INSTALLED WITH USP CIA-EA

d	**ROD DIAMETER (in.)**	3/8	1/2	5/8	3/4	7/8	1	1 1/4
d_o	**NOMINAL BIT DIAMETER HOLE SIZE (in.)**	7/16	9/16	11/16	13/16	15/16	1 1/8	1 3/8
A_s	**TENSILE STRESS AREA (in.^{2})**	0.0775	0.142	0.226	0.334	0.462	0.606	0.969
A_b	**NOMINAL AREA OF ROD (in.^{2})**	0.1042	0.1867	0.2935	0.4246	0.6013	0.7854	1.227
T_{max}	**MAXIMUM TIGHTENING TORQUE (ft.-lbs.)**	15	30	70	150	200	310	375

For S1: 1 inch = 25.4 mm, 1 in.^{2} = 645 mm^2, 1 ft. = 1356 N-mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N.

TABLE 3.4 - SPECIFICATION AND INSTALLATION DETAILS FOR REINFORCING BAR (REBAR)INSTALLED WITH USP INJECTION ADHESIVE CIA-EA

d	**REBAR SIZE**	#3	#4	#5	#6	#7	#8	#9	#10	#11
d_o	**NOMINAL AREA (in.^{2})**	0.11	0.20	0.31	0.44	0.80	0.79	1.0	1 27	1.56
A_s	**NOMINAL BIT DIAMETER HOLE SIZE**	1/2	5/8	3/4	1	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4

3.3 Allowable Stress Design

3.3.1 Allowable Load Tables

TABLE 3.5 - ALLOWABLE TENSION LOADS FOR THREADED ROD INSTALLED IN NORMAL-WEIGHT CONCRETE USING USP CIA-EA EPOXY ACRYLATE(pounds) [1,2,3]

STUD DIAMETER *d* (inch)	MINIMUM EMBEDMENT DEPTH, *h of* d (inches)	MINIMUM SPACING *s* (inches)	MINIMUM EDGE DISTANCE *c* (inches)	BASED ON STEEL STRENGTH			BOND STRENGTH f'_c = 2,500 psi
				A 307 (SAE 1018)	A 193 Gr. B7 (SAE 4140)	SS 304 (F 593)	
3/8	3 3/8	7 1/2	3 3/8	2,185	4,580	2,732	1,700
1/2	4 1/2	9	4 1/2	3,885	8,210	4,860	2,895
5/8	5 3/4	11 1/2	5 3/4	6,070	12,910	7,590	5,845
3/4	6 3/4	13 1/2	6 3/4	8,740	18,660	10,925	7,115
1	9	18	9	15,540	33,390	19,428	11,050

[1]Allowable load must be the lesser of bond or steel strength.
[2]Values are for anchors installed at the specified spacing (s) and edge distances (c). Apply appropriate factors for reduced spacing.
[3] Bond values are based on a factor of safety of 4.

TABLE 3.6- ALLOWABLE SHEAR LOADS FOR THREADED ROD INSTALLED IN NORMAL-WEIGHT CONCRETE USING USP CIA-EA EPOXY ACRYLATE(pounds) [1,2,3]

STUD DIAMETER *d* (inch)	MINIMUM EMBEDMENT DEPTH, *h of* d (inches)	MINIMUM SPACING *s* (inches)	MINIMUM EDGE DISTANCE *c* (inches)	BASED ON STEEL STRENGTH			BOND STRENGTH f'_c = 2,500 psi
				A 307 (SAE 1018)	A 193 Gr. B7 (SAE 4140)	SS 304 (F 593)	
3/8	3 3/8	5	5	1,125	2,347	1,400	1,485
1/2	4 1/2	6 3/4	6 3/4	2,000	4,170	2,500	2,560
5/8	5 3/4	6 1/2	7	3,125	6,520	3,900	4,410
3/4	6 3/4	10	10	4,500	9,390	5,610	6,325
1	8 3/4	13 1/2	13 1/2	8,000	16,700	10,000	10,245

[1]Allowable load must be the lesser of bond or steel strength.
[2]Values are for anchors installed at the specified spacing (s) and edge distances (c). Apply appropriate factors for reduced spacing.
[3] Bond values are based on a factor of safety of 4.

TABLE 3.7 - ALLOWABLE TENSILE LOADS FOR THREADED ROD INSTALLED IN NORMAL WEIGHT CONCRETE USING USP CIA-EA ACRYLATE FOR SILL PLATE AND OTHER CLOSE EDGE DISTANCE APPLICATIONS [1,2,3]

STUD DIAMETER (inch)	MINIMUM EMBEDMENT DEPTH, *h of* d (inches)	SPACING *s* (inches)	EDGE DISTANCE *c* (inches)	BASED ON BOND STRENGTH	BASED ON STEEL STRENGTH		
				f'_c = 2,500 psi	A 307 (SAE 1018)	A 193 Gr. B7 (SAE 4140)	SS 304 (F 593)
3/8	3 3/8	5	1/3/4	1,454	2,185	4,580	2,732
1/2	3 3/8	5	1/3/4	1,454	3,885	8,210	4,860
5/8	5 1/2	8 1/4	1/3/4	2,627	6,070	12,910	7,590
	9	13 1/2	1/3/4	4,439			
3/4	6 3/4	10	1/3/4	3,054	8,740	18,680	10,925
	11	16 1/2	1/3/4	5,987			
7/8	7 3/4	11 1/2	1/3/4	5,642	11,900	25,520	14,875
1	9	13 1/2	1/3/4	6,515	15,540	33,390	19,428
	15	20	1/3/4	7,627			

[1]Allowable load must be the lesser of bond or steel strength.
[2]Values are for anchors installed at the specified spacing (s) and edge distances(c). Apply appropriate factors for reduced spacing.
[3] Bond values are based on a factor of safety of 4.

TABLE 3.8 - ALLOWABLE SHEAR LOADS FOR THREADED ROD INSTALLED IN NORMAL-WEIGHT CONCRETE USING USP CIA-EA FOR SILL PLATE AND OTHER CLOSE EDGE DISTANCE APPLICATIONS[1,2,3]

STUD DIAMETER *d* (inch)	MINIMUM EMBEDMENT DEPTH, *h of* d (inches)	SPACING *s* (inches)	MINIMUM EDGE DISTANCE *c* (inches)	BASED ON BOND STRENGTH	BASED ON STEEL STRENGTH		
				f'_c = 2,500 psi	A 307 (SAE 1018)	A 193 Gr. B7 (SAE 4140)	F 593 SS 304
3/8	3 3/8	5	1 3/4	790	1,125	2,350	1,400
1/2	4 1/2	6 3/4	1 3/4	1,040	2,000	4,170	2,500
5/8	4 1/2	6 3/4	1 3/4	1,040	3,125	6,520	3,900
3/4	4 1/2	6 3/4	1 3/4	1,040	4,500	9,390	5,610
7/8	4 1/2	6 3/4	1 3/4	1,040	6,130	12,775	7,650
1	4 1/2	6 3/4	1 3/4	1,040	8,000	16,700	10,000

[1]Allowable load must be the lesser of bond or steel strength. Loads based on bond strength are for anchors loaded parallel to the edge.
[2]Values are for anchors installed at the specified spacing (s) and edge distances(c). Apply appropriate factors for reduced spacing.
[3] Bond values are based on a factor of safety of 4.

TABLE 3.9 - ALLOWABLE TENSILE LOADS FOR ASTM A 615 GRADE 60 REINFORCING BAR INSTALLED IN NORMAL-WEIGHT CONCRETE USING USP CIA-EA EPOXY ACRYLATE(pounds) [1,2,3]

REBAR SIZE	DRILL BIT DIAMETER (inches)	MINIMUM EMBEDMENT DEPTH, *h of* d (inches)	MINIMUM SPACING *s* (inches)	MINIMUM EDGE DISTANCE *c* (inches)	BASED ON CONCRETE f'_c = 2,500 psi	BASED ON STEEL STRENGTH: ASTM A 615, GRADE 60
#3	1/2	3 3/8	6	3	933	2,650
#4	5/8	4 1/2	6 3/4	3 3/8	3,298	4,710
#5	3/4	5 5/8	8 1/2	4 1/4	4,398	7,365
#6	7/8	6 3/4	10 1/8	5	4,837	10,605
#8	1 1/18	9 5/8	13 1/2	6 3/4	10,320	18,850

[1]Allowable load must be the lesser of bond or steel strength.
[2]Values are for anchors installed at the specified spacing (s) and edge distances(c). Apply appropriate factors for reduced spacing.
[3] Bond values are based on a factor of safety of 4.

TABLE 3.9 - ALLOWABLE SHEAR LOADS FOR ASTM A 615 GRADE 60 REINFORCING BAR INSTALLED IN NORMAL-WEIGHT CONCRETE USING USP CIA-EA EPOXY ACRYLATE(pounds) [1,2,3]

REBAR SIZE	DRILL BIT DIAMETER (inches)	MINIMUM EMBEDMENT DEPTH, *h of* d (inches)	MINIMUM SPACING *s* (inches)	MINIMUM EDGE DISTANCE *c* (inches)	BASED ON CONCRETE f'_c = 2,500 psi	BASED ON STEEL STRENGTH: ASTM A 615, GRADE 60
#3	1/2	3 3/8	5	5	1,492	1,700
#4	5/8	4 1/2	6 3/4	6 3/4	2,549	3,030
#5	3/4	5 3/4	7	7	3,655	5,150
#6	7/8	6 3/4	10 1/8	10 1/8	5,844	7,530
#8	1 1/18	9	13 1/2	13 1/2	8,617	9,620

[1]Allowable load must be the lesser of bond or steel strength.
[2]Values are for anchors installed at the specified spacing (s) and edge distances(c). Apply appropriate factors for reduced spacing.
[3] Bond values are based on a factor of safety of 4.