

Tie-Down Temporary Barrier System: Strap Fasteners

- Fasteners used in the crash test were Red Head 19 mm drop-in anchor with 19 mm dia x 57 mm ISO Class 8.8 bolts.
- ISO Class 8.8 capscrews meet the mechanical and chemical requirements of ISO 898/I, ASTM F568 and SAE J1199.
- ASTM F568 is a metric specification. The equivalent US customary Specification is ASTM A449.
- All Values shown based on f'c = 4000 psi concrete and 3/4" Anchor Dia. Embedment determined by linear interpolation.
- Required Ultimate Tension = 17,000lbs. Required Ultimate Shear = 13,500lbs. Values obtain from researcher.

Crash Test: Concrete f'c = 4000-5000 psi

| <u>Crash Test Anchor</u> | <u>Required Embedment</u> | <u>Hole Depth</u> | <u>Manufacture Catalog Ultimate: 4000psi Concrete</u> | | <u>ICBO Evaluation Results Ultimate: 4000psi Concrete</u> | | <u>Independent Test Report</u> |
|-----------------------------------|---------------------------|-------------------|---|--------------------|---|--------------------|--------------------------------|
| | | | <u>Tension (lbs)</u> | <u>Shear (lbs)</u> | <u>Tension (lbs)</u> | <u>Shear (lbs)</u> | |
| Red Head Multi-Set Drop-In Anchor | Not Given | 3-3/16" | 9480 | NG | Not Given | 9480 | 7680 ICBO ER-1372 (3/2000) |

KDOT Standard: f'c = 4000 psi

| <u>Anchor</u> | <u>Minimum^[1] Required Embedment</u> | <u>Required Hole Depth</u> | <u>Manufacture Catalog Ultimate: 4000psi Concrete</u> | | <u>ICBO Evaluation Results Ultimate: 4000psi Concrete</u> | | |
|--|---|----------------------------|---|--------------------|---|--------------------|---|
| | | | <u>Tension (lbs)</u> | <u>Shear (lbs)</u> | <u>Tension (lbs)</u> | <u>Shear (lbs)</u> | |
| <u>Drop-in Expandable Sleeve Anchors:</u> | | | | | | | |
| Red Head Multi-Set Drop-In Anchor | Not Given | 3-3/16" | 9480 | NG | Not Given | 9480 | 7680 ICBO ER-1372 (3/2000) |
| Power Fasteners Steel Drop-in Anchor | Not Given | 3-3/16" | 14405 | NG | 15680 | 14400 | 15680 ICBO ER-5225 (10/2000) |
| Simpson Strong-Tie Drop-in Anchor | Not Given | 3" | 10760 | NG | 16000 | 10760 | 16000 ICBO ER-3631 (3/2002) |
| <u>Wedge Type Expansion Anchors:</u> | | | | | | | |
| Red Head Trubolt Wedge Anchor | 6-3/8" | >6-3/8" | 17192 | NG ^[2] | 22996 | 17192 | 22996 ICBO ER-1372 (3/2000) |
| Power Fasteners Power-Stud Anchor | 6" | 6-3/4" | 17080 | NG ^[2] | 15060 | 12460 | 15060 ICBO ER-5225 (10/2000) |
| Simpson Wedge-All Anchor | 6-3/4" | >6-3/4" | 17000 | NG ^[2] | 18440 | 17000 | 18440 ICBO ER-3631 (3/2002) |
| <u>Concrete Screw Anchors:</u> | | | | | | | |
| Red Head LTD Anchors | 4-1/4" | 6" | 17359 | √ | 19353 | Not Tested | Not Tested ICES ER-5890 (Reissued 2/2004) |
| Power Fasteners Wedge-Bolt Anchor | 4-5/8" | 6-1/4" | 17240 | √ ^[3] | 25295 | 14000 | 25244 ICBO ER-5788 (8/2000) |
| Simpson Titen HD Anchor | 4-5/8" | 6-1/4" | 17426 | √ | 24680 | 17420 | 24680 ICES ER-1056 (3/2004) |

NG = No Good

[1] Embedment required for an ultimate tension capacity of 17,000 lbs.

[2] Slab thickness must be 1.5 times the embedment (See the footnotes in the ICBO reports.). Therefore, these anchors will not work on thin bridge deck slabs.

[3] The manufacture's catalog values for ultimate tension are greater than the independent test results.

Results and Recommendations:

There are three basic types of anchors:

1.) Drop-in Expandable Sleeve Anchors.

This type of anchor was used in the original test, but now is not considered adequate by the researcher. Also, this type of anchor has an ultimate tension capacity well below the required ultimate tension capacity of 17,000 lbs.

2.) Wedge Type Expansion Anchors.

This type of anchor will develop the required ultimate tension capacity, but at a depth that would preclude it's use on thin slabs. The ICBO Evaluation Reports note that the thickness of the concrete anchored into must be 1.5 times the embedment.

3.) Concrete Screw Anchors.

These anchors meet the required ultimate tension capacity of 17,000lbs. They have the advantage of easy removal. They come in one inch incremental lengths. These are the anchors recommended for use by KDOT.

| <u>Concrete f_c = 4000 psi</u> | <u>Actual</u> | | <u>Manufacture Catalog</u> | | <u>Required Hole Depth</u> | <u>Manufacture's Anchor Length</u> | <u>Manufacture's Required Addition Depth</u> | <u>Thickness of Material Being Anchored</u> |
|--|--|---------------------------------|---|----------------------|----------------------------|------------------------------------|--|---|
| | <u>Minimum Required Embedment</u> ^[4] | <u>Required Field Embedment</u> | <u>Ultimate</u> ^[5] : 4000psi Concrete | <u>Tension (lbs)</u> | | | | |
| <u>Concrete Screw Anchor:</u> | | | | | | | | |
| Red Head LTD Anchors | 4-1/4" | 4" | 16178 | 18094 | 5" | 4-1/2" | 1" | 1/2" |
| Red Head LTD Anchors | 4-1/4" | 5" | 20904 ◀ | 23132 | 6" | 5-1/2" | 1" | 1/2" |
| Power Fasteners Wedge-Bolt Anchor | 4-5/8" | 4-1/2" | 16752 | 24800 | 5-1/4" | 5" | 3/4" | 1/2" |
| Power Fasteners Wedge-Bolt Anchor | 4-5/8" | 5-1/2" | 20658 | 28665 | 6-1/4" | 6" | 3/4" | 1/2" |
| Simpson Titen HD Anchor | 4-5/8" | 4-1/2" | 15980 | 22917 | 5-1/4" | 5" | 3/4" ^[6] | 1/2" |
| Simpson Titen HD Anchor | 4-5/8" | 5-1/2" | 18401 | 24680 | 6-1/4" | 6" | 3/4" ^[6] | 1/2" |

[4] Embedment required for an ultimate tension capacity of 17,000 lbs.

[5] The Manufacture's recommend an allowable load based on a Safety Factor of 4.

[6] No information given in the Manufacture's documentation. One anchor diameter assumed.

The requirement of providing an Ultimate Tension Capacity of 17,000 lbs, severely limits the number of anchors which can be used. It is common practice that the anchor embedment depth should be kept in the upper two-thirds of the concrete slab. For a typical 8" thin slab this would be an embedment of 5-1/4" or less.

If this practice were to be observed, then only one anchor would meet both requirements (See: ◀) and the other manufacture's would be eliminated because they manufacture their anchors in whole inch increments. If the strength of the anchors used in the actual test were the criteria, then all three types of anchors could be used.