**Anchoring Systems**

**INSTALLATION PROCEDURES**

Anchor drill holes are typically produced using carbide tipped drill bits and rotary hammer drills. It is important that the correct drill-hole diameter and depth of each type of anchoring system is used for maximum performance. Careful cleaning of the anchor drill hole is important in order to obtain the best possible functioning of the anchor system.

**Concrete:**

**Normal Weight Concrete** is made from Portland cement, coarse and fine aggregates, water and various admixtures. The proportioning of these components controls the strength of the concrete. In the United States, concrete strength is specified by the compressive strength* of concrete test cylinders. These test cylinders measure six inches in diameter by 12 inches in length and are tested on the 28th day after they are produced.

**Light Weight Concrete** consists of the same components (cement, coarse and fine aggregates, water and admixtures) as normal weight concrete, except it is made with lightweight aggregate. One of the most common uses of lightweight concrete has been as a structural fill of steel decking in the construction of strong, yet light floor systems. Typical fasteners for both normal weight and lightweight concrete include Trubolt Wedge Anchors, LDT Self-Threading Anchors, Dynabolt Sleeve Anchors, Multi-Set II Drop-In Anchors, Stud Anchors and Adhesive Anchoring Systems.

**Loading = Holding Values**

![Diagram showing tension, shear, and combined loads](image)

- **Tension loads** = when load is applied along the axis of the anchor.
- **Shear loads** = when the loads are applied perpendicular to the axis of the anchor.
- **Combined loads** = when both tension and shear loads are applied to an anchor, a combined loading equation is provided to determine the maximum loads that can be applied to the anchor at the same time.
**MODES OF FAILURE**

When anchors are loaded to their maximum capacity, several different types (modes) of failure are possible depending on the type of anchor, strength of the base material, embedment depth, location of the anchor, etc. Common modes of failure include:

**Concrete Spall Cone**

- Occurs at shallow embedment where the resistance of the base material is less than the resistance of the anchor and the base material fails.

**Steel Breakage**

- The capacity of the anchorage exceeds the tensile or shear strength of the steel anchor or rod material.

**Anchor Pullout**

- Base material adjacent to the extension portion of an anchor crushes, resulting in the anchor pulling out of the hole until the capacity of the spall cone is reached, at which point the concrete will spall. This type of failure happens more commonly when anchors are set with deep embedment depths.

**Bond Failure**

- Shear failure of the adhesive at rod-adhesive interface or adhesive-base material interface. This occurs more commonly in deep embedment using high strength steel rods.

**Edge Distance and Spacing Reduction**

- Reduces the holding values, when anchors are placed too close to the edge. This also occurs when two or more anchors are spaced closely together.
## Anchors for Concrete Applications

<table>
<thead>
<tr>
<th>ANCHOR TYPE</th>
<th>KEY FEATURES</th>
<th>SIZE RANGE (Inches)</th>
</tr>
</thead>
</table>
| **Dynabolt®** Masonry Sleeve Anchors | - Concrete, block and brick  
- Many choices of head styles  
- Through-fixture fastening  
- Available in 304 stainless steel | Diameter: 1/4 – 3/4  
Length: 5/8 – 6 1/4 |
| **Trubolt®+** Seismic Wedge Anchors | - 2003 IBC & 2006 IBC Compliant  
- All seismic zone (A-F) and cracked concrete approved  
- Fully-threaded  
- Length ID head stamped  
- Through-fixture fastening | Diameter: 3/8, 1/2 & 5/8  
Length: 3 – 8 1/2 |
| **Trubolt®** Wedge Anchors | - 2003 IBC & 2006 IBC Compliant  
- Seismic zone (A-B) approved  
- Fully-threaded  
- Length ID head stamped  
- Stainless steel clip  
- Through-fixture fastening | Diameter: 1/4 – 1  
Length: 1 3/4 – 12 |
| **Large Diameter Tapcon (LDT) and LDTX** Self-Threading Anchor | - Anti-rotation serrated washer  
- Extra large hex washer head  
- Length ID head stamped  
- Through-fixture fastening  
- LDT with Zinc Plating  
  Diameter: 3/8 – 3/4  
  Length: 1 3/4 – 6 1/4  
- LDTX with Envirex Coating  
  Diameter: 3/8 & 1/2  
  Length: 3 – 5 | |
| **Multi-Set II®** Drop-In Anchors | - RM: Flanged body to keep anchor flush with surface of concrete  
- RL: Non-flanged body for recessed setting  
- RX: Designed for hollow core and post tension concrete  
- CL: Designed for one-sided forming, accepts coil rod | Diameter: 1/4 – 3/4  
Length: 1 – 3 3/16  
Diameter: 1/4 – 3/4  
Length: 1 – 3 3/16  
Diameter: 3/8 & 1/2  
Length: 3/4  
Diameter: 1/2 & 3/4  
Length: 2 & 3 3/16 |
| **Boa™ Coil** Expansion Anchors | - Heavy-Duty, Reusable Fastening  
- Easy installation  
- Removable  
- High shear strength  
- Replacement coil available for easy re-use | Diameter: 1/2 – 3/4  
Length: 3 – 6 |
| **Prima** High Expansion Sleeve Anchors | - Lightweight Concrete, and Masonry Fastening  
- Easy Installation  
- Removable fastening | Diameter: 1/4 – 1/2  
Length: 2 3/8 – 3 9/16 |
## Selection Guide

<table>
<thead>
<tr>
<th></th>
<th>Corrosion Resistance</th>
<th>Performance</th>
<th>Head Styles</th>
<th>Approvals/Listings</th>
</tr>
</thead>
</table>
| **Dynabolt**        | Zinc plated carbon steel to ASTM B633, SC1, Type III  
Type 304 stainless steel | Ultimate Pullout Performance In 4000 psi Concrete up to 8,900 lbs. (3/4" diameter) | Flat head  
Hex nut  
Acorn nut  
Tie Wire  
Round head  
Threshold flat head | GSA: A A-1922A  
(Formerly GSA: FF-S-325 Group II, Type 3, Class 3)  
Factory Mutual  
California State Fire Marshal |
| **Trubolt+**         | Zinc plated carbon steel to ASTM B633, SC1, Type III | Pullout strength of 4,980 lbs in 2,500 psi Cracked Concrete (1/2" diameter) | Hex nut | ICC Evaluation Service, Inc. — #ESR-2527  
(Approved for: Seismic zones A, F and Cracked Concrete)  
Category 1 performance rating  
2003 IBC & 2006 IBC Compliant  
Meets ACI 318 Ductility Requirements  
Tested in accordance with ACI 355.2 and ICC ES AC 103 |
| **Trubolt**          | Zinc plated carbon steel to ASTM B633, SC1, Type III  
Hot dip galvanized to ASTM A-153  
Type 304 and 316 stainless steel | Ultimate Pullout Performance In 4000 psi Concrete up to 26,904 lbs. (1" diameter) | Hex nut  
Tie Wire version | ICC Evaluation Service, Inc. — #ESR-2251  
(Formerly ICRI ER1372 which includes seismic loading conditions)  
GSA: A A-1923A Type 4  
(Formerly GSA: FF-S-325 Group II, Type 4, Class 1)  
Underwriters Laboratories  
Factory Mutual  
City of Los Angeles — WB2748  
California State Fire Marshal  
Caltrans |
| **LDT**              | Zinc plated carbon steel to ASTM B695 & B633  
Type 410 stainless steel | Ultimate Pullout Performance In 4,000 psi Concrete up to 23,266 lbs. (3/4" diameter) | Finished bolt style | Miami Dade County — 404-1025.08  
Florida Building Code  
1,000 hours salt spray ASTM B117 |
| **Multi-Set II Drop-In** | Zinc plated carbon steel to ASTM B633, SC1, Type III  
Type 18-8 and 316 stainless steel | Ultimate Pullout Performance In 4000 psi Concrete up to 9,480 lbs. (3/4" diameter) | RM: Flanged body  
RL: Non-flanged body  
Use any bolt or threaded rod | GSA: A A-55614 Type 1  
(Formerly GSA: FF-S-325 Group VIII)  
Underwriters Laboratories  
Factory Mutual  
City of Los Angeles — WB2748  
California State Fire Marshal  
Caltrans |
| **Boa Coil**         | Zinc plated carbon steel to ASTM B633, SC1, Type III | Ultimate Pullout Performance In 4000 psi Concrete up to 38,500 lbs. (3/4" diameter) | Finished bolt style | |
| **Prima**            | Sleeve S300 Pb NFA 35561  
Bolt Grade 5 1035 carbon steel  
Cone S300 Pb NFA 35561  
Zinc coating NFE 25009, passivation NFA 91472 | Ultimate Pullout Performance In 4,000 psi Concrete up to 8,500 lbs. (1/2" diameter) | Finished bolt style | |