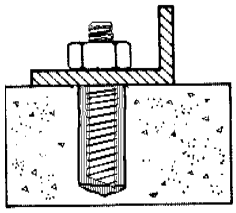
CONCRETE ANCHOR GUIDE

HOW ANCHORS WORK

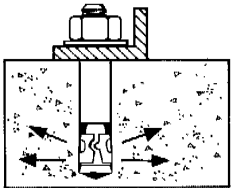
Adhesive Bond



ADVANTAGES
- High Strength.
- Imparts no expansion stress on base material.
- Corrosion Resistant.

DISADVANTAGES
- Variable setting time.
- Temperature sensitive at time of installation and while in service.
- Mixing sensitivity.

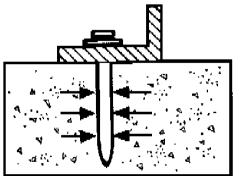
Wedging



ADVANTAGES
- Easy to use.
- Fast installation.
- Versatility in design.

DISADVANTAGES
- Imparts expansion stress on base material.
- Those utilizing angular expansion slip under load.

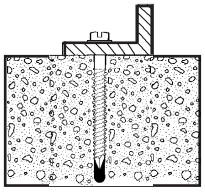
Friction



ADVANTAGES
- Fast installation
- Low cost

DISADVANTAGES
- Difficult to ascertain performance reliabilty.
- Limited removability.
- Difficult to remove.

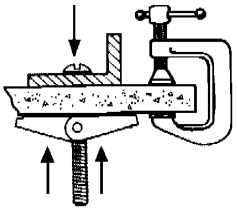
Threaded



ADVANTAGES
- Imparts little expansion stress on base material.
- Fast installation.
- High strength.

DISADVANTAGES
- Limited diameters.
- Limited use in hard aggregate concrete.

Clamping

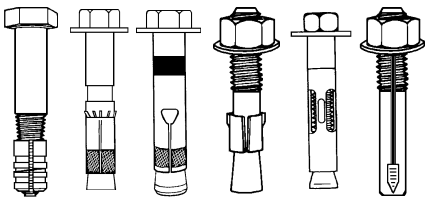


ADVANTAGES
- Supports weak materials.
- Positive consistent process.

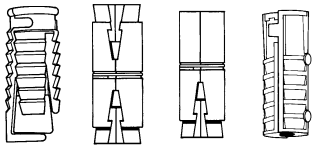
DISADVANTAGES
- Large installation hole
- Limited removability.

MECHANICALLY EXPANDED

ADVANTAGES:
- Can be loaded immediately.
- Can be retightened.
- Setting action can be felt.
- Installation torque can be measured.
- Stud and sleeve types are bolt size/hole size.
- Shell types accept threaded rod.
- Sleeve types work in hollow block when proper length is used.
- Some are removable and reusable.
- Available in wide range of



Bolt Size/ Hole Size Types

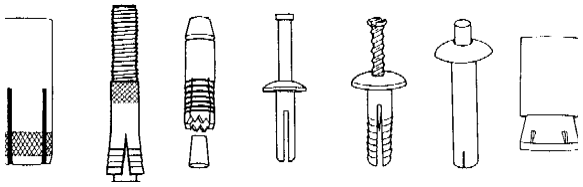


Shell Types

DISADVANTAGES
- Shell types require hole spotting.
- Studs and sleeves slip under load.
- Types made entirely of steel should not be used in high vibration.
- Bolt size/hole size are not removable (except Taper-Bolt, Rawl Bolt & Hilti HSL).
- Limited fastening lengths with bolt size/hole size.
- Zinc anchors are malleable and compress under high loads.

Set with a wrench. Uses the mechanical advantage of screw threads to obtain high expansion pressure.

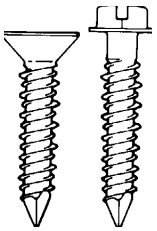
MANUALLY EXPANDED



Set with a hammering action. Uses material displacement and fixed expansion to obtain holding power.

ADVANTAGES:
- Designed for shallow holes.
- Shell types accept threaded rod.
- Fast setting action.

DISADVANTAGES:
- Cannot be retightened.
- Difficult to tell if properly set.
- Torque cannot be checked.
- Should not be used in crumbling or old concrete.



SELF-THREADING

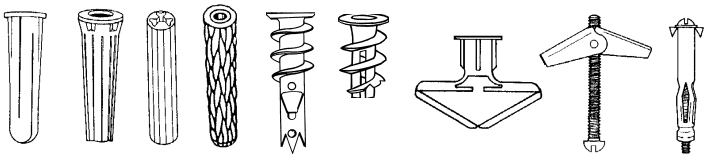
This is a true fastener, not an anchor

Set by turning fastener into pre-drilled hole

ADVANTAGES
- High strength
- Works in hollow block
- Removable
- No hole spotting
- No hole cleaning

DISADVANTAGES
- Not recommended for hard base materials.
- Requires special drill bit.
- Requires special setting tool.
- Only avail. in 3/16 & 1/4".

PLUGS & HOLLOW WALL

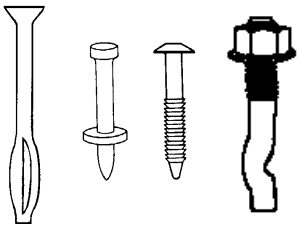


Plugs are set by material displacement. Toggles are set by mechanical displacement.

ADVANTAGES
- Accepts all types of thread forms.
- Works in a wide variety of materials.

DISADVANTAGES
- Never use plugs overhead.
- Low holding power.
- Toggles require oversize hole.

FRICTION



Set by hammering action. Holding power from friction between fastener and base material

ADVANTAGES
- Accepts all types of thread forms.
- Works in a wide variety of materials.

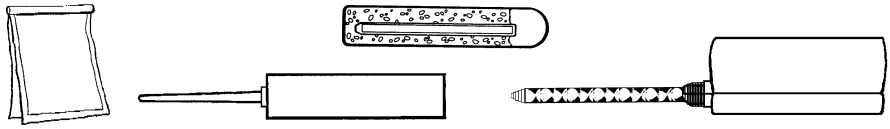
DISADVANTAGES
- Critical hole diameter.
- Cannot be retightened.
- Not removable.
- Dead loads only.
- Light loads only.

ADHESIVE BONDED ANCHORS

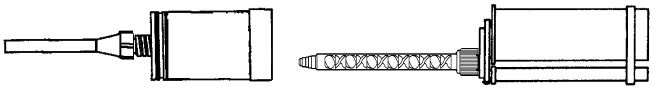
Applied as liquid or gel. Holding power is obtained by an adhesive bond.

ADVANTAGES
- Exceptional strength.
- High Reliability.
- Can be used in hollow wall (with screen).
- Excellent in old crumbling material.
- Excellent resistance to vibration and corrosion.
- Imparts no expansion stres on base material.

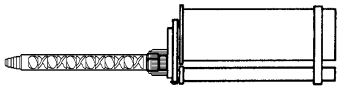
DISADVANTAGES
- Cure time 10 Min. to 24 Hours.
- Once mixed, it must be used (certain types).
- Motionless mixers and dispensers may be expensive.
- Not bolt size/Hole size.
- Setting time is dependent on temperature.
- Shelf life is from 6 months to 3 years.



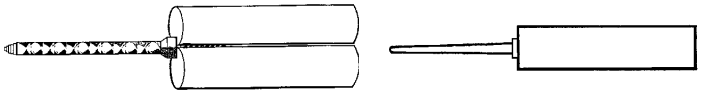
POLYESTER- Available in pourable liquid, capsule and thixotropic gel.



EPOXY ACRYLATE (also called Vinyl Ester and Acrylic Epoxy) Available as a thixotropic gel.



ACRYLIC - An ester type, solvent free resin. Available as a thixotropic gel.

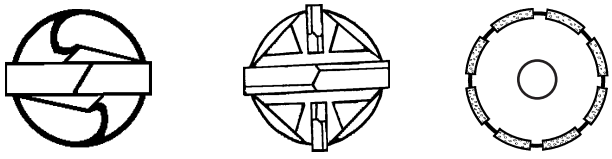


EPOXY- Amine based offers high strength & low odor, Mercaptan based is fast setting with strong odor. Available in various vicosities from water like to putty.

ADHESIVE SPECIFICATIONS

	Cure Time (68° F.)	Cure Temp	High Temp. Service	Shelf Life	Mix Ratio	Weathering	Chemical Resistance	Shrinkage
POLYESTER		10-30 Min.	15-100°F	176°F	6-12 Mths	Important	Fair	Fair 4%
EPOXY ACRYLATE	15-45 Min.	15-100°F	250°F	6-12 Mths	Important	Good	Good	2%
ACRLIC	45-60 Min.	23-104°F	180°F	6-9 Mths	Important	Good	Fair	1/2-1%
EPOXY	6-72 Hrs	125-200°F	125-200°F	12-24Mths	Critical	Excellent	Excellent	>1/2%

DRILL TYPES VS ANCHOR PERFORMANCE



Presently there are three cutting tools available to drill anchor holes - Single cutter carbide bits, multi-cutter carbide bits and diamond core bits. As of this writing, it is recommended that single cutter carbide bits be used to obtain the maximum performance of an anchor. Anchor performance is a direct relationship of the friction between the anchor and the concrete. Multi-cutter carbide bits and diamond core bits produce rounder and smoother holes thus decreasing friction and ultimate holding power.

SAFETY, PERFORMANCE AND TECHNICAL FACTS

CODES , STANDARDS and SAFETY

A.N.S.I. B 212.15-1994

CARBIDE TIPPED DRILL TOLERANCES

Developed to help insure maximum holding power by matching drill tolerances to anchor dimensions.

NOMINAL DRILL DIAMETER	TOLERANCE BAND	NOMINAL DRILL DIAMETER	TOLERANCE BAND
3/16	.206 -.198	5/8	.660 - .650
1/4	.268 - .260	11/16	.723 - .713
5/16	.335 - .327	3/4	.787 - .775
3/8	.398 - .390	7/8	.917 - .905
7/16	.468 - .458	1	1.042 - 1.030
1/2	.530 - .520	1-1/8	1.175 - 1.160
9/16	.592 - .582	1-1/4	1.300 - 1.285

A.S.T.M. E 488

TEST STANDARD FOR DETERMINING ANCHOR PERFORMANCE

This test sets the standards by which anchors are tested. It was developed so users and specifiers could feel confident that the performance data shown by different manufacturers was obtained in the same manner. Basically it establishes the following procedures:

1. Hole diameter standards
2. Loading procedures
3. Load rates
4. Concrete Strength (no reinforcement) & Curing.
5. Spacing requirements
6. Averaging of results
7. Interpolation
8. Actual failure point (Load vs. .065" slippage)

CODES & APPROVALS

FM · FACTORY MUTUAL: This approval is almost identical to UL as it applies generally to safety applications which are more prevalent in the industrial roofing market.

GSA · SPECIFICATION FF-S-325: Approval by the General Services Administration for use by various US government agencies. Approval is based upon style and dimensional specifications.

ICBO · INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS: This approval is needed when the anchor will be used in a public building. Approval is difficult to obtain because of stringent requirements. More predominant on the West coast.

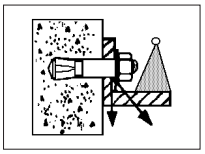
UL · UNDERWRITERS LABORATORIES: Necessary when anchor is used in an electrical, safety or fire prevention system.

SAFETY FACTOR 4:1

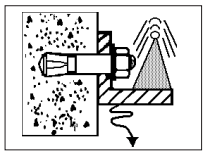
To compensate for variations in base materials, drill diameters and workmanship, a minimum safety factor of 4:1 (25% of the ultimate value) should be applied to all performance data. This is the minimum industry standard for static loads. Critical applications such as vibratory loads and overhead installations may require as much as 10:1 or more.

LOAD CONDITIONS AND SPECIFICATIONS

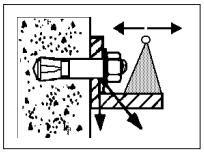
LOAD CONDITIONS: With few exceptions most mechanical anchors do not give maximum performance under all loading conditions. Some function well under dynamic but do poorly under vibratory loads. Plastic and lead stretch and compact under heavy impact loads. Manually expanded cannot be retightened so should not be used under shock loads.



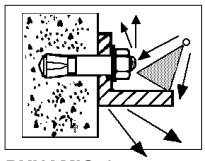
STATIC: No outside force will be applied, as used with flush mounted signs, electrical boxes, etc.



VIBRATORY: High-frequency impact of low intensity as used with compressors and motors.



VARIABLE: Irregular loading as used with suspended signs and handrails.



DYNAMIC: Intense or sharply applied impact as used with dock bumpers and guard rails.

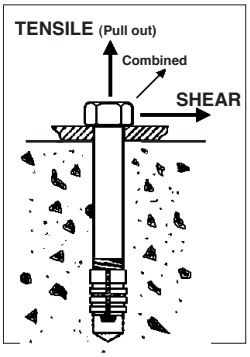
EDGE AND SPACING DISTANCES

Anchoring too close to an edge or placing anchors too close to one another can decrease performance. For 100% use.

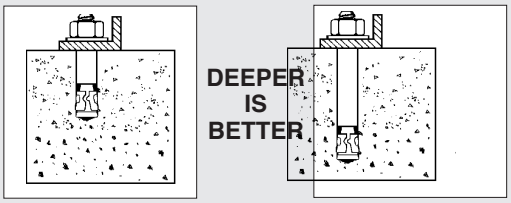
Anchor	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"
Spacing Distance	2-1/2	3-3/4	5	6-1/4	7-1/2	9	10
Edge & End Distance							
Load toward edge	2	3	4	5	6	7	7
Load away from edge	1-1/2	2	3	4	5	6	6

TYPES OF LOADS:

Most loads are a combination of Tensile and Shear. Deeper embedment will increase Tensile strength while high strength steel and full diameter bolts will increase Shear strength.



MINIMUM EMBEDMENT: The minimum penetration of the anchor into the base material at which it will perform safely and consistently. Shell types are designed to function when set flush with the surface. Stud types are available in various lengths and care must be taken to select the right length. Under predominately tensile (pullout) loads the greater the embedment the better the performance.



CONCRETE ANCHORS - COMMON SENSE, FACT & FAILURE

CONCRETE ANCHORING IS A CRAFT not a science. It can be considered a craft because of the tremendous variables found in concrete, the tolerances of the carbide drills and anchors, the tools used to set them and most importantly the skill of the installer. As a craft, it is imperative that the “craftsman” learn as much as possible about the material, tools and conditions that he has to work with.

ALLOWABLE WORKING LOADS & MATERIAL STRENGTH. A quick look at the catalogs of various anchor manufacturers will have many scratching their heads. Some refer to the "ultimate load" while others use the term "maximum allowable load". Shown below are the performance charts on Drop-In anchors from three major manufacturers, which at first glance could be confusing, and if not properly understood, the cause of a costly anchor failure.

	2000 PSI Concrete		4000 PSI Concrete		6000 PSI Concrete	
Anchor Size	Tension	Shear	Tension	Shear	Tension	Shear
1/4″	480	430	560	450	770	760
3/8″	790	990	1240	1060	1410	1480
1/2″	1000	1470	1690	1560	2550	2340
5/8″	1390	2220	2420	3050	2600	3400
3/4″	2210	3800	4010	4400	4100	5300

BOLT SIZE	NOMINAL DRILL BIT SIZE	COMPRESSIVE STRENGTH OF CONCRETE			
		2000 PSI		5000 PSI	
		LBS. TENSILE	LBS. SHEAR	LBS. TENSILE	LBS. SHEAR
1/4	3/8	1560	1600	2,400	2,177
3/8	1/2	3024	3640	4,200	3,950
1/2	5/8	3634	6500	6,990	6,422
5/8	7/8	--	--	9,750	12,500
3/4	1	--	--	11,500	16,590

Bolt Size/ Threads Per Inch	Drill Bit Size	A Thread Depth	B Min. Hole Depth	Ultimate Pullout* Lbs.[1]	Ultimate Shear* Lbs.[1]
1/4″/20	3/8″	3/8″	1″	3,204	1,986
3/8″/16	1/2″	1/2″	1-5/8″	6,350	3,968
1/2″/13	5/8″	3/4″	2″	8,544	6,502
5/8″/11	7/8″	1″	2-1/2″	15,218	10,380
3/4″/10	1″	1-1/4″	3-3/16″	17,255	13,962

Before geginning it is imperative that the Allowable Working Load be determined with regard to the strength of the concrete and the particular cutting or drilling operation. If the ultimate load is published, the safe working load is 25% of the ultimate load (4:1) and this value must be matched with the strength of the concrete, which can affect the performance of the anchor by another factor of almost 3:1

ANCHOR FAILURE - With rare exception most anchor failures are caused by the operator, not the anchor. Some of the most prevalent mistakes made are:

1. Not fully expanding a drop-in anchor because the wrong setting tool was used or the operator simply "felt” that the anchor was set.
2. Setting a stud anchor at too shallow a depth because it was on top of a rebar.
3. Setting a capsule anchor by simply driving the threaded stud into the capsule and not spinning it. As the adhesive has not been mixed with the catalyst it will not set fully or not at all.
4. Leaving an inordinate amount of dust in the hole when using an adhesive anchoring system.The adhesive bonds to the dust and the dust is bonded to nothing.
5. Using an anchor which does not have the capacity for the job. A particular anchor may be adequate on a horizontal surface but totally inadequate when used on a vertical one with the exaggerated component loads on equipment in this position.
6. Using the wrong size carbide bit to drill the hole. The best example of this is using an old worn 5/8” bit for 1/2” anchors. The anchor is quick to install and just as quick to fail.