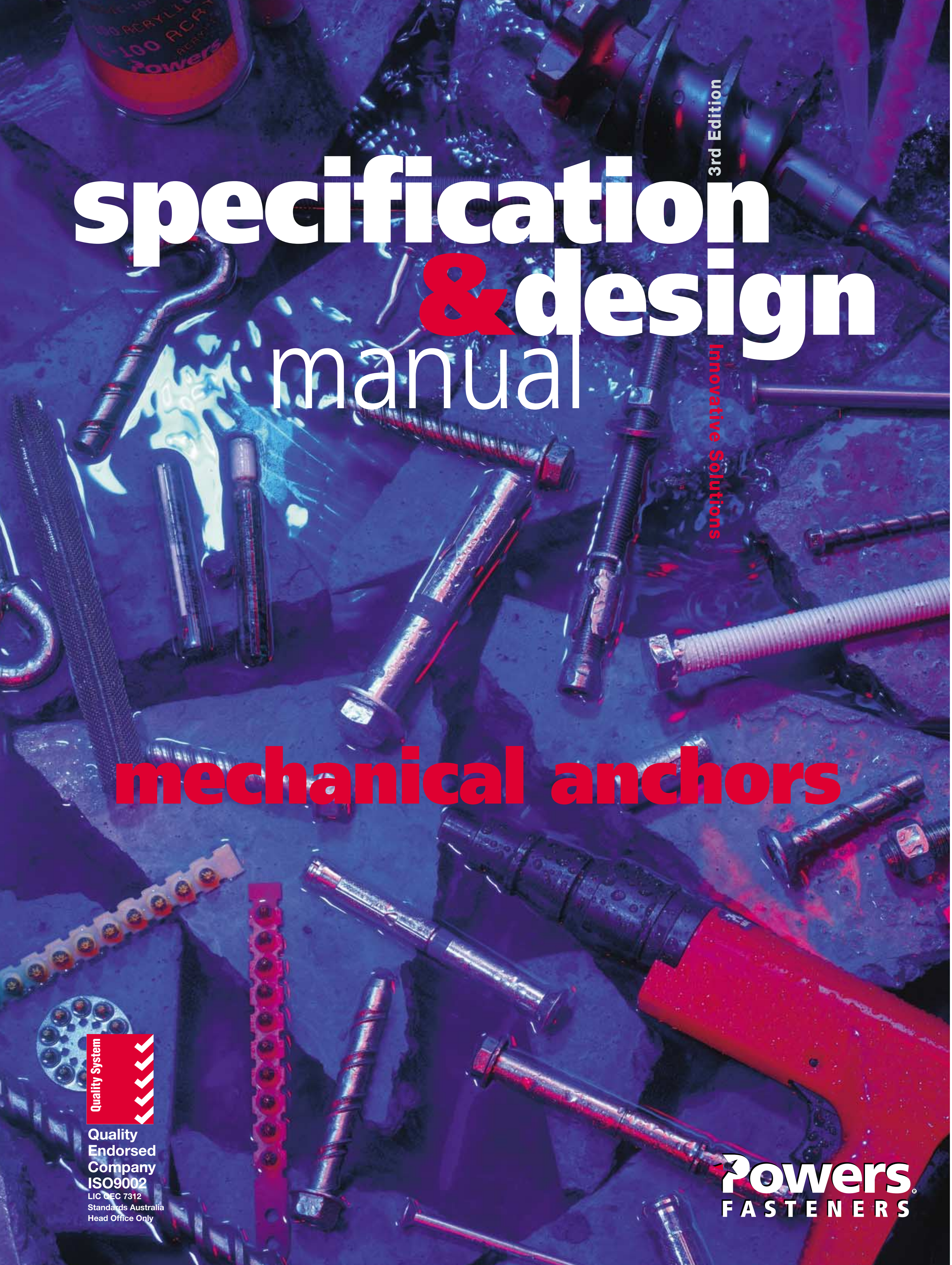
specification & design manual

3rd Edition

Innovative Solutions

mechanical anchors



Quality System

Quality Endorsed Company ISO9002
LIC QEC 7312
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Powers® FASTENERS

www.powers.com.au

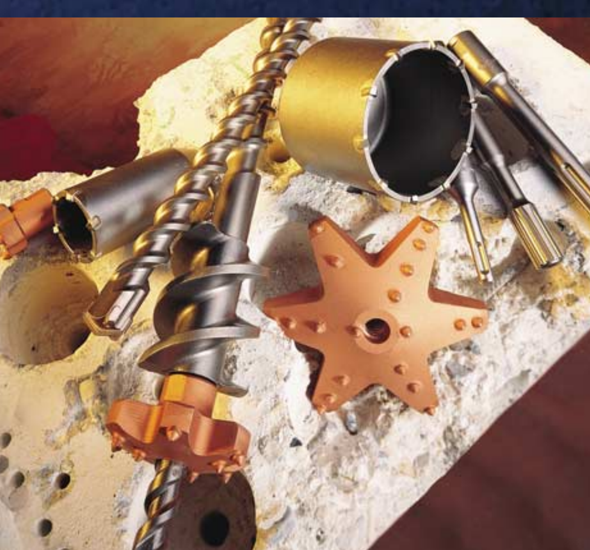
Powers is the leading independent manufacturer of concrete anchors, masonry anchors, adhesive anchors, roofing fasteners, carbide drill bits and accessories. Founded in 1921, the company first began producing it's namesake, the Rawlplug anchor. Today, 75 years later, Powers is the emerging force in fasteners, providing innovative solutions to anchoring and fastening problems such as the Powers Anchor Program, the Adhesive Anchor Program, and the Drill Program.

The Powers Anchor Program features many families of mechanical anchors making it the broadest line in the industry. To suit most application requirements, the Adhesive Anchor Program is comprised of unique dispensing and installation systems along with specialty hardware. Proper product installation is insured with the Powers Drill Bit Program which consists of specially designed matched tolerance carbide drill bits. These products form the basis of the Powers total service commitment to you.

Powers customer support begins with Branch offices strategically located throughout Australia to provide a continuous flow of inventory through our distribution network. Each location has a complete, in depth inventory, providing next day delivery to most major cities. Customer support continues in the area of manufacturing. Powers produces its products in state of the art manufacturing facilities which are monitored at all stages using the latest techniques in statistical process quality control.

Powers products are backed by the industry leader in anchoring technology. When you specify any Powers product, you are supported by an experienced staff of structural, mechanical, and chemical engineers. You have the top anchor research and development facilities at your disposal for special application testing. In addition to support at the corporate level, each Branch location has personnel trained in the selection and field testing of anchoring products.

For top quality solutions to anchoring problems, the leader is Powers!



Powers FASTENERS

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Mechnical Anchors

1.0 Introduction

Since the release of Powers highly acclaimed 'Anchoring Specification and Design Manual' in 1996, a number of innovations and developments have lead to the considerable expansion of our range of drilling and anchoring products. The acquisition of the revolutionary Excalibur Screwbolt range makes our selection of mechanical anchors among the most comprehensive in the industry, and a new family of Powder Actuated tools, pins and charges adds further diversity to our existing product range.

This new manual incorporates these and other new product lines and has been created to assist the design professional in the selection and specification of Powers fastening products. It is based on over 70 years of industry experience combined with the broadest line of products to provide the latest information on anchoring and fastening technology.

Complete design specifications have been updated from the previous manual to reflect recent product developments. These include the addition of a wider range of anchor sizes for some products and the inclusion of data covering the installation of reinforcing bar when used with adhesive systems. All tables and charts have been expanded and revised to incorporate these latest additions, providing a convenient reference for fast assessment of anchor suitability.

Following this introduction you will find a brief product summary, listing factors commonly considered in the selection of anchors, including base materials, working load ranges, sizes and corrosion resistance. Products are organised into anchor families based on typical application requirements.

Product selection criteria is further examined in section 2.0 with detailed information on appropriate base materials, anchor functioning, applied loads, anchor behaviour, materials, corrosion resistance, performance data, design recommendations and installation criteria. Standards and specifications, approvals and conversion factors are all listed in subsequent sections.

Detailed information is provided on all products in sections 6.0 through 20.0 including product descriptions, installation procedures, selection tables, material specifications, performance data, design recommendations and suggested specifications. All sections of the manual should be reviewed by the design professional prior to the selection and specification of any anchoring or fastening product. For additional information, contact your local Powers branch office.

1.1 Product Summary

This summary has been designed to provide the user with an overview of the Powers product line. To aid in selection, the product families are grouped into tables based on common types of applications. A quick scan method lists such factors as suitable base materials, application criteria, maximum working load capacities, size range, and corrosion resistance.

1.1.1 Base Materials

Typical base materials in which a category of anchoring products may be installed are listed in the first columns of the tables. The suitability of a specification base material depends upon the applied loads, spacing, edge distance, and application. The guide notes when materials will usually be suitable and when they may be suitable depending upon the application.

1.1.2 Application Criteria

Certain applications may require a finished hex head, tamper proof head, or countersunk. These features are listed in the table for the one-step style of anchors.

1.1.3 Working Load Ranges

The working load ranges listed are the maximum recommended tension load. In the industry, light duty loads are usually less than 2kN while medium duty loads range from 2 to 18kN. Heavy duty loading is considered to be above 18kN. This also depends on the anchor style, size, and base material, therefore these ranges should be used only as a guide to direct the designer to more detailed product information. Actual allowable loads to be used depend upon such factors as the base material strength, spacing and edge distance, and the type of applied service loads.

1.1.4 Diameter Range

Powers provides the broadest selection of anchors in the industry including the range of sizes available. These sizes range in diameter from mechanical anchors suitable for use with 5mm machine bolts up to the installation of 24mm anchor rods when using adhesives.

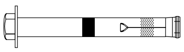
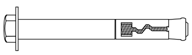
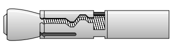
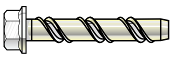
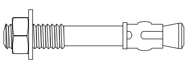
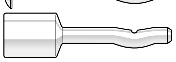
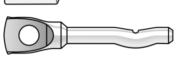
1.1.5 Corrosion Resistance

Various platings, coatings and corrosion resistant materials are offered by Powers to meet many application needs depending upon the corrosive environment. Alternative materials can also be provided on a special order basis for some anchor types.

1.2 Test Results & Standards

This manual is based upon extensive laboratory testing programs carried out on behalf of Powers USA and Rawlplug UK performed to American and British Standards. The presentation of the results therefore, reports upon these standards along with the associated Approvals and Listings of various Research Reports, Underwriters Laboratory Tests and the like. Reference is also made to the Uniform Building Code, Department of Transport and The Department of the Environment, all of these bodies are those of the United States of America.

Although similar Australian Standards are in existence for the performance evaluation of the Powers products referenced in the manual, many comprehensive testing criteria are only covered in the American and British data mentioned above. Powers Fasteners Australasia has taken advantage of this extensive data in the effort to provide the user of this manual with the most comprehensive and consistent data available therefore, this manual, refers to American and British reference documentation. Should the user of the manual require access to any of the referenced documents, contact should be made with the Powers Fasteners Australasia Technical Department in Melbourne.

	BASE MATERIAL								HEAD STYLE							WORKING LOAD			HOLE DIAMETER RANGE																		COATING / PLATING OR MATERIAL							PAGE NO
Anchor Type	Concrete	Stone	Solid Brick	Hollow Brick	Solid Block	Hollow Block	Aerated Block	Plasterboard	Hex Head	Flush Hex Head	Countersunk	Mushroom Head	Removable	Eye & Hook	Tamper Proof	2kN or less	2 to 18 kN	Above 18 kN	5mm	6mm	6.5mm	7mm	8mm	10mm	12mm	13mm	15mm	16mm	18mm	20mm	22mm	24mm	25mm	26mm	28mm	32mm	Coated / Plated Steel	Galvanized Steel	304/316 Stainless Steel	Zamac Alloy	Engineered Plastic	Boron Case Hardened Steel	Natural Rubber	
POWER-BOLT® 	●	○	●	○	●	○				●	●		●			●	●	●						●		●		●		●				●		●	●		●					28
SAFETY+ 	●	●	○		○				●	●			●				●	●							●		●		●			●			●		●		●					31
SOCKET ANCHOR 	●	●	○		○				●	●			●				●	●							●		●		●			●			●		●		●					34
EXCALIBUR SCREWBOLT 	●	●	●	●	●	●				●	●		●	●	●	●	●	●		●			●	●	●			●									●					●		57
THROUGH BOLT 	●	●	●		○				●							●	●	●							●			●		●							●	●	●					36
SLEEVE ANCHORS 	●	○	●	○	●	○			●	●	●			●		●	●				●		●	●	●			●		●							●	●	●					38
SPIKE® 	●	○	○	○	●	○					●	●			●	●	●		●		●			●		●											●		●					46
	●	○	○	○	●	○										●	●		●		●	●															●							46
	●	○	○	○	●	○								●		●			●		●																●							46
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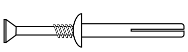
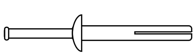
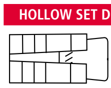
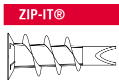
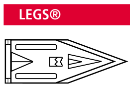
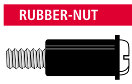
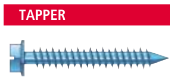
ZAMAC HAMMER-SCREW® 	●	○	●	○	●	○						●	●			●					●																●			●				50
METAL PIN ANCHOR 	●	○	●	○	●	○						●				●			●		●																●			●				52
HOLLOW SET DROP-IN 	●	○	●	○	●	○										●	●							●				●		●				●			●		●	●				44
ZIP-IT® 								●					●			●																								●	●			62
LEGS® 								●					●			●																					●							63
RUBBER-NUT 	●	○	●	●	●	●	●						●			●							●	●		●			●	●		●					●						●	64
WEDGE ANCHOR 	●	○			○											●	●						●	●	●		●			●			●				●		●					42
TAPPER 	●		○	○	●	○				●	●		●			●			●		●																●							54

● Suitable ○ May be Suitable Depending upon Application

2.0 Product Selection Guidelines

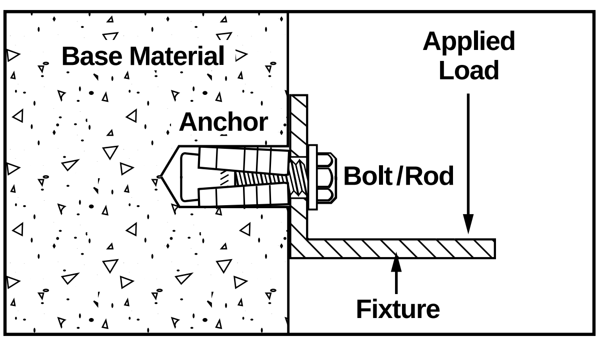
Drilled in anchors have been used since ancient times to secure building components. Originally, the anchor hole was manually drilled using a star type drill and a hammer. An anchor consisted of a wood or lead plug which was carved or molded to size and driven into the drilled hole. As a screw or nail was inserted in the plug, it expanded against the wall of the hole. Commercially manufactured anchors were first made from lead or fiber material in a variety of sizes to match a bolt or screw. The original Rawlplug anchor was developed in 1919. As the materials and techniques used in building construction changed, new anchors were developed to meet application needs.

Today, a wide variety of anchors are available. Although this variety provides the user with the opportunity to select the best anchor for a specific application, it also makes the selection process more difficult. For this reason, prior to selecting the type, size, and number of anchors to be used for any given application, all of the following factors need to be taken into consideration. As in all applications, the load capacity and other criteria used should be reviewed and verified by the design professional responsible for the actual product installation.

2.1 Fastened Assembly

Before selection of an anchor can take place, several factors should be considered and reviewed to determine their effect on the application. First, we need to consider the fastened assembly and the key components of it.

The following diagram shows a typical fastened assembly.



Some critical items to consider in the selection of an anchor include the following:

1. Base material in which the anchor will be installed.
2. Loads applied by the fixture or material to be fastened to the anchor.
3. Anchor material and the bolt / threaded rod to be used in combination with the anchor.
4. Installation procedures including the method of drilling.
5. Effects of corrosion.
6. Dimensions of the base material including the anchor spacing and edge distance.

2.2 Base Materials

The materials used in building construction vary widely. Although fastening can occur in most materials, the base materials are often the weak link in the assembly design. The base material is a critical factor in the selection of an anchor because it must be able to sustain the applied loads. Base material strength can vary widely, and is a key factor in the performance of an anchor. Generally, anchors installed in stone and dense concrete can withstand far greater loads than an anchor installed in softer materials such as lightweight concrete, block, or brick. Medium to heavy loads can not be safely applied to materials such as stucco, grout or plaster. Prior to anchor installation, materials should be fully cured.

The following sections provide a descriptive summary of typical base materials for reference purposes. Consult the individual standards and local codes for complete details.

2.2.1 Concrete

Reinforced concrete is formed using concrete having a certain compressive strength and reinforcing steel. The function of the concrete is to resist compressive forces while the reinforcing steel resists the tensile forces. Two primary factors are workability and strength. For fresh concrete, it must have the proper consistency or workability to enable it to be properly placed. Hardened concrete must be able to achieve the specified performance factors including the required compressive strength. The design and construction requirements for reinforced concrete buildings are published by the American Concrete Institute in document ACI 318, "Building Code Requirements for Reinforced Concrete".

Concrete is a mixture of aggregate, cement, water, and additives. Its strength is achieved through the hydration of the cement component (usually portland) which is used to bind the aggregate together. The type of cement used depends on the properties required for the structure in which the concrete will be placed and is listed in ASTM Specification C 150.

A concrete mix design consists of both fine and coarse aggregates. Fine aggregate is usually particles of sand less than 5mm in diameter while the coarse aggregate is crushed stone or gravel greater than 5mm in diameter as outlined in ASTM Specification C 33 for normal weight concrete. The aggregate used in normal weight concrete ranges in weight from 2,160 to 2,640 kg/m^3. For structural lightweight concrete, the aggregate such as that manufactured from expanded shale, slate, clay, or slag has a weight range of 880 to 1,200 kg/m^3 as listed in ASTM Specification C 330. The unit weight for normal weight concrete ranges from 2,320 to 2,480 kg/m^3 while structural lightweight concrete ranges from 1600 to 1840 kg/m^3. Structural lightweight concrete is used where it is desirable to decrease the weight of the building structure. It also has better fire resistance than normal weight concrete. The strength and hardness of the aggregate will effect drilling speed, drill bit wear, and drill bit life.

Another form of concrete is lightweight insulating concrete. This type of concrete is used for thermal insulating and should not be confused with structural lightweight. ASTM Specification C 332 lists the aggregates used in lightweight insulating concrete in two groups. Group I includes aggregates such as perlite or vermiculite. These aggregates generally produce concrete ranging in weight from 240 to 800 kg/m^3. The aggregates in Group II are prepared by expanding, calcining, or sintering products such as blast furnace slag, fly ash, shale, or slate. Natural materials such as pumice, scoria, or tuff are also included in Group II and produce a concrete with a weight range of 720 to 1,440 kg/m^3. Lightweight insulating concrete typically has compressive strengths ranging from 0.7 to 2.1 MPa. Job site performance tests are always required for anchors or fasteners installed in lightweight insulating concrete.

Admixtures are specified in a mix design to modify the concrete, either for placement characteristics or hardened properties. Air entraining admixtures which disperse tiny air bubbles throughout the concrete mix help to improve the freeze thaw resistance and increase workability. Examples of other admixtures are superplasticizers which allow a reduction in the quantity of mixing water for much lower water-cement ratios or products which accelerate or slow down the curing of the concrete.

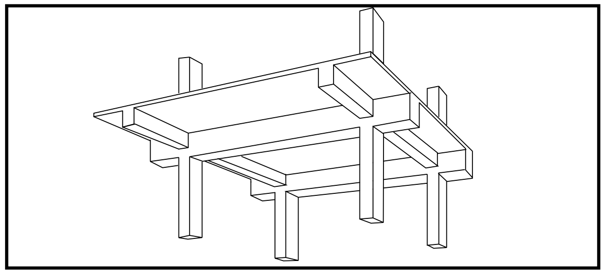
While the type of cement, aggregate, and admixtures have an impact on the compressive strength of the concrete, the water-cement ratio is the primary factor effecting the strength. As the water-cement ratio decreases, the compressive strength of the concrete increases. In order to determine the compressive strength of concrete, test specimens are formed in cylinders approximately 150mm in diameter and 300mm in length according to ASTM Specification C 31. The cylinders are broken according to ASTM Specification C 39 at specified time intervals, usually 7 and 28 days, and the resulting strength is calculated.

The anchor load capacities for installations in normal weight concrete listed in this manual are for concrete which has achieved its designated 28 day compressive strength. In some sections, the anchor load capacities are also listed for installations in structural lightweight concrete. Job site tests are recommended for installations in concrete where the material strength or condition is unknown or questionable. The anchor load capacities listed in this manual were conducted in unreinforced test members to provide baseline data which is usable regardless of the possible benefit of reinforcement near an anchor.

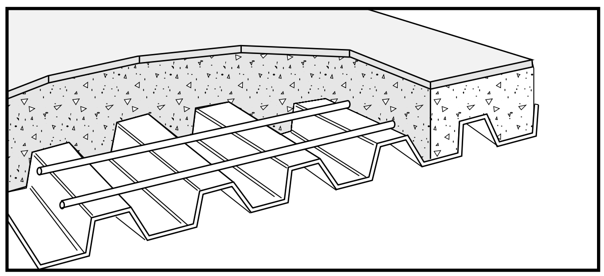
To resist tensile forces, steel reinforcement such as deformed reinforcing bars or welded wire fabric are placed in the forms prior to pouring of the concrete. For prestressed or post-tensioned concrete construction, bars, wire, or strands may be used as the reinforcement. Smooth dowel bars are also used primarily to resist shear loads.The following table lists the dimensions of metric deformed reinforcing bar.

Rebar Size (mm)	Mass Per Metre kg/m	Calculated Area (mm^2)	Nominal Area (mm^2)
12	0.888	113.1	110
16	1.579	201.1	200
20	2.466	314.2	310
24	3.551	452.4	450
28	4.834	615.8	620
32	6.313	804.2	800
36	7.991	1017.9	1020

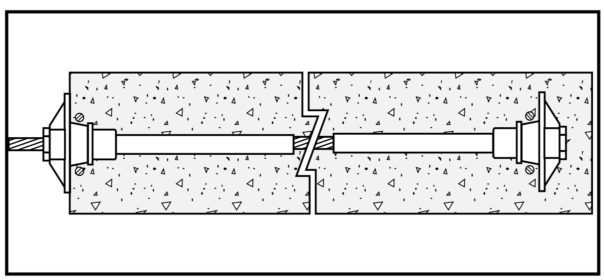
Generally, concrete is capable of sustaining a higher anchor load than brick or block. As the embedment depth of an anchor is increased, the tension load will increase up to a point at which either the capacity of the expansion mechanism or bond is reached or the concrete fails locally. This phenomenon is discussed in Section 2.5 in detail. Common construction methods in which concrete can be used are shown in the following figures.



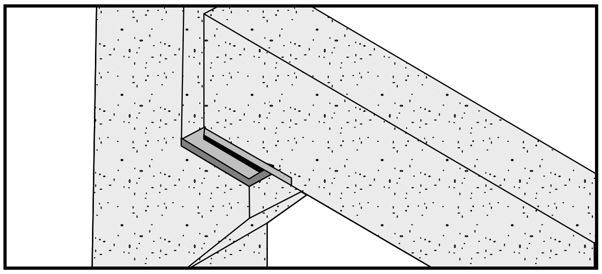
Poured in place concrete using a form system



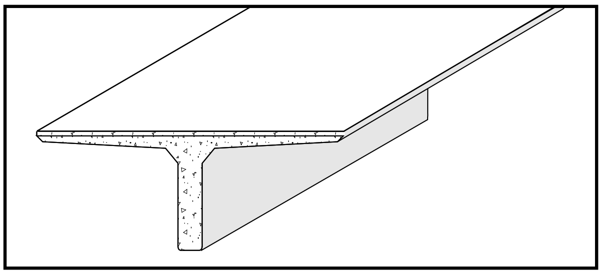
Composite slabs poured on steel deck



Post tensioned slabs and beams



Precast beams and columns



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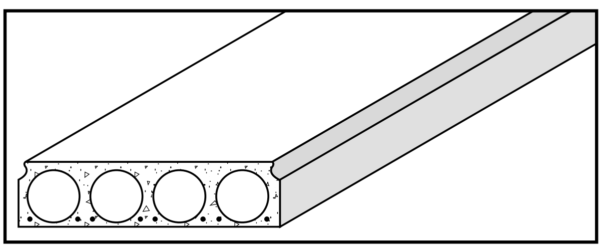
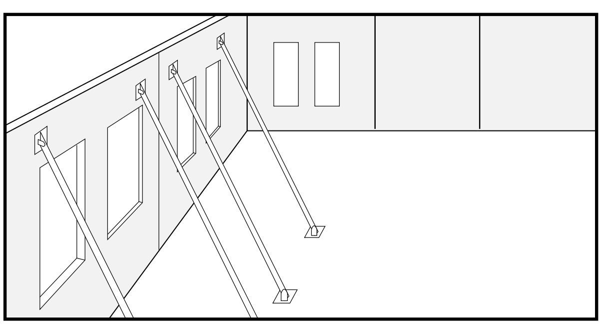


Precast plank



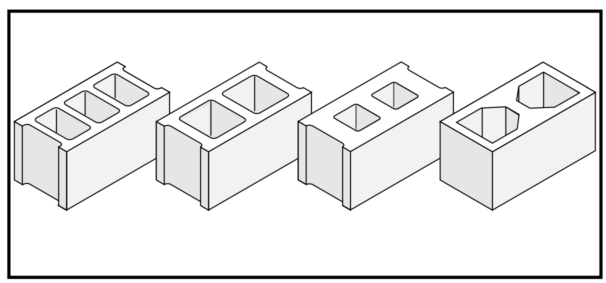
Tilt-up wall panels

2.2.2 Masonry Materials

The strength of masonry walls is usually less than that of concrete and the consistency of these materials can vary on a regional basis. To form a wall, individual masonry units are bonded together with a cement mortar. A horizontal row is called a course and a vertical row is called a wythe. The strength of the mortar is often the critical factor in anchor performance. Anchors may be installed in the horizontal mortar joint or directly in the masonry unit. In field testing, anchors should be installed and loaded to simulate the actual placement. The reaction bridge used should span the joint or unit to provide an unrestrained test. Hollow base materials require special care as the anchor must be properly sized to coincide with the wall thickness or selected to properly expand in the void for toggle type anchors. During the drilling process, spalling can occur further decreasing the wall thickness. Manufacturers of hollow base materials often specify a maximum load that can be applied to the material. Since the strength of masonry materials varies widely, job site tests are recommended for critical applications.

2.2.2.1 Concrete Block

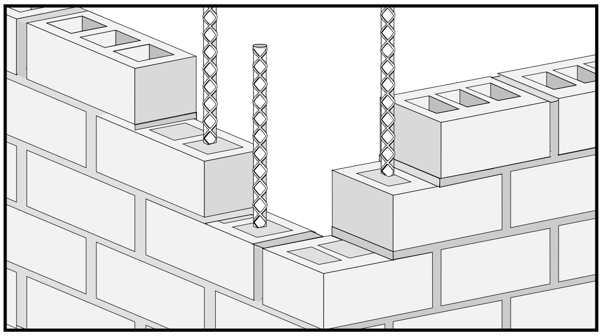
Masonry block is found in a variety of sizes and shapes depending upon the age and location of a building. Both hollow and solid styles which can be classified as load-bearing or non-load bearing are used. Load-bearing block, known as a concrete masonry unit (CMU) is generally suitable for anchoring although job site tests are recommended for critical applications due to the wide variations in these materials. ASTM Specification C 90 describes hollow and solid load-bearing concrete masonry units made from portland cement, water, and mineral aggregates, both normal and lightweight.



Typical CMU shapes

The difference between hollow and solid block is based on the cross sectional bearing area of the block. Solid block is defined as having a cross sectional bearing area which is not less than 75% of the gross area of the block measured in the same plane.

To provide greater resistance to lateral loads, concrete masonry units are often strengthened with steel reinforcing bars. This is required by the Uniform Building Code in Seismic Zones 2, 3, and 4. In this case, hollow units are grout filled to allow them to act together with the reinforcing bars.



Grout filled CMU

In this manual, guide load capacities are published for anchors installed in the face shell of hollow load-bearing concrete masonry units and at various embedments into grout filled units.

For hollow units, the anchors were tested in walls constructed using normal weight concrete block meeting the requirements of ASTM C 90, Grade N, Type I. Grade N signifies that it is suitable for use in exterior walls above or below grade which may or may not be exposed to moisture while Type I indicates that the moisture content of the block is controlled. The minimum compressive strength from the ASTM specification is 5.5 to 6.7 MPa, however, actual strengths typically range from 8.3 to 12.4 MPa. Typical dimensions are nominally 200mm x 200mm x 400mm with a face shell thickness of 30mm to 40mm. For 75% solid block, typical face shell thickness is 60mm. Anchors were installed in the center of the block cell. During the drilling operation, the face shell thickness may be decreased by as much as 10-15mm due to spalling on the back side of the face shell.

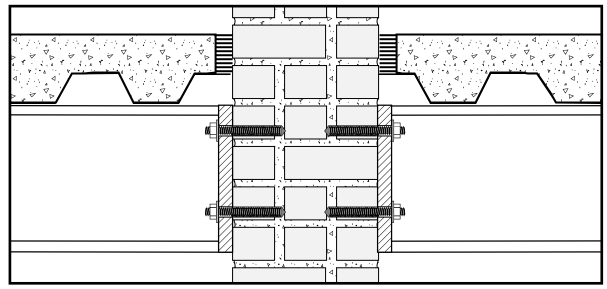
Grout filled block walls were constructed using the hollow block described above which was then filled with fine grout as described in ASTM Specification C 476. Both grout filled walls and hollow block walls used a Type S cement-lime mortar meeting ASTM C 270. Experience has shown that the consistency of grout filled block varies widely. Voided areas are often a problem, therefore, job site performance tests for anchors are recommended.

2.2.2.2 Brick

Brick units are found in a variety of shapes, sizes, and strengths depending upon the age and location of a building. Brick is manufactured from clay or shale which is extruded / wire-cut, machine molded, or handmade to shape then hardened through a firing process. In the natural state, a buff colored finish is obtained when using clay while shale produces a red shade. The addition of mineral pigments, glazes, or other compound is used to change the visual impact of brick.

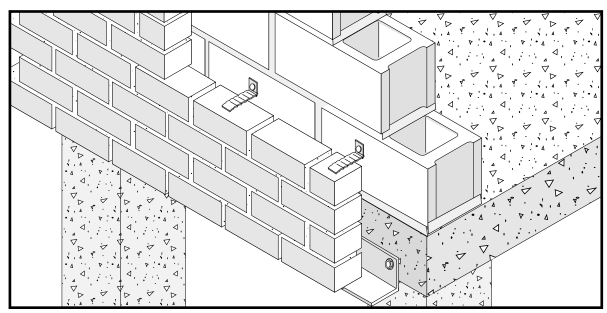
Brick is produced as a solid masonry unit or with cores during extrusion. The cores reduce the weight of the brick and help it to lay better. ASTM Specification C 652 describes hollow brick masonry units. Hollow brick is defined as having a cross sectional bearing area which is less than 75% of the gross area of the brick measured in the same plane. Hollow brick units have stricter physical property requirements than those for structural clay tile. The cores often create a problem when attempting to install anchors because the resulting thin walls cannot sustain the high bearing stresses applied by a mechanical anchor. In this case, an adhesive anchor is recommended.

Brick can be used to form a load bearing wall and as a veneer or facade. ASTM Specification C 62 describes solid building brick while Specification C 216 describes solid facing brick. To provide greater resistance to lateral loads, walls are often strengthened with steel reinforcing bars. This is required by the Uniform Building Code in Seismic Zones 2, 3, and 4. The wythes of brick are tied together and then grout filled to allow them to act together with the reinforcing bars.



Typical brick bearing wall

When brick is used as a building facade, it is important to properly tie it to the backup wall and structure using anchors manufactured from a non-corrosive material such as stainless steel. During the drilling operation, the face shell thickness may be decreased by as much as 12mm due to spalling on the back side of the face shell.

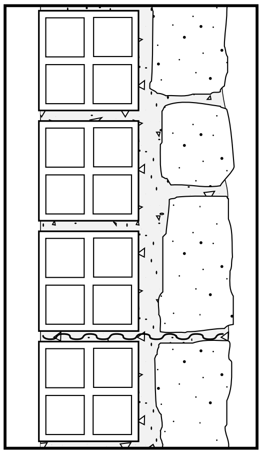


Brick facade with ties

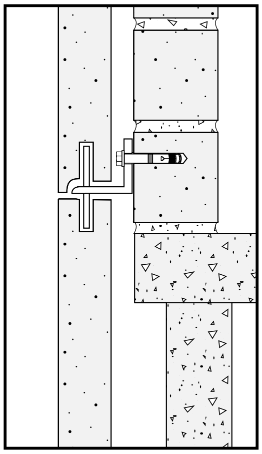
In this manual, guide load capacities are published for anchors installed in solid brick and in multiple wythe brick walls. Anchors were tested in walls constructed using brick meeting the requirements of ASTM C 62, Grade SW. Grade SW signifies that it is suitable for use in exterior walls exposed to severe weathering. The minimum compressive strength from the ASTM specification is 8.6 to 20.7 MPa, however, actual strengths typically range as high as 41.4 to 55 MPa. Both single and multiple wythe brick walls were constructed using a Type S cement-lime mortar meeting ASTM C 270.

2.2.2.3 Stone

Natural stone is available in a variety of types, colors, and textures for use in many building applications. Naturally occurring rock which has been fabricated to a specific size and shape is referred to as dimension stone as opposed to broken or crushed stone such as that used for aggregate in concrete. The three common classes of rock used to fabricate dimension stone are igneous, metamorphic, and sedimentary. Granite is an igneous material while marble building is metamorphic. Both of these stones tend to be harder than limestone or sandstone which are sedimentary materials. The strength and the quality of stone can vary dramatically from each stone quarry and for different geological locations. Generally, anchors installed in softer material such as limestone or sandstone will have capacities similar to those obtained in 15 MPa concrete. In harder stone such as granite or marble, the capacities will be similar to 30 to 40 MPa concrete. Job site tests are recommended because of the wide variation in the strengths of natural stone.



Stone with tile back-up

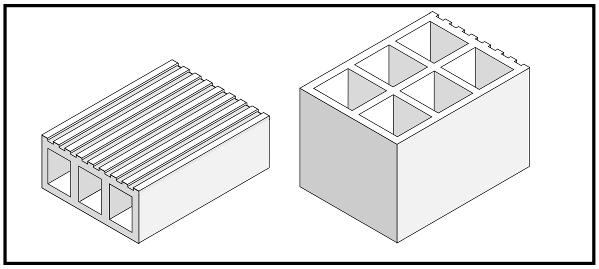


Stone facade

Dimension stone units can be used to form a load bearing wall and as a veneer or facade. Masonry constructed using stone with little or no shaping is referred to as rubble while that using precisely cut stone is called ashlar. When used as a building facade, it is important that the stone be properly tied to the backup wall using anchors manufactured from a non-corrosive material such as stainless steel. ASTM Specification C 119 describes dimensional stone for use in building construction. Specifications for individual stone types include C 503 for marble, C 568 for limestone, C 615 for granite, and C 616 for quartz-based material.

2.2.2.4 Structural Clay Tile

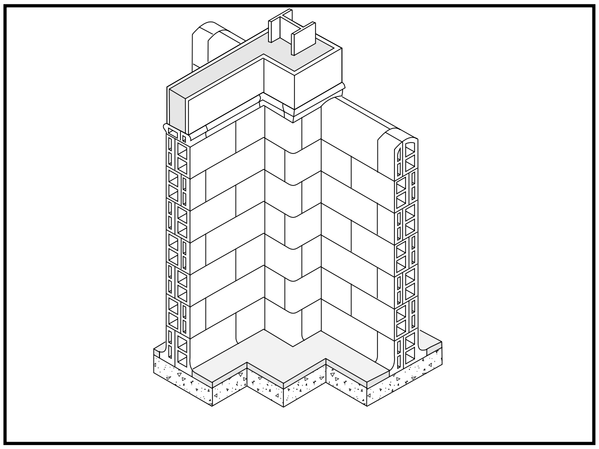
Structural clay tile units are found in a variety of shapes, sizes, and strengths for use primarily in walls. The tile units are manufactured from clay, shale, or fire clay which is extruded to shape then hardened through a firing process. Finished units may have a natural finish or may be glazed. During the extrusion process, several continuous cells or hollow spaces are formed within the exterior shell of the tile. The typical thickness of the outer shell is 20mm with a 12mm thick interior web. End-construction tile is designed to be placed in a wall with the axes of the cells vertical while side-construction tile is placed with the axes of the cells horizontal.



Typical clay tile shapes

These materials present a problem when attempting to install anchors because the resulting thin walls cannot sustain the high bearing stresses applied by a mechanical anchor. For light duty loads, a hollow wall anchor which opens behind the face shell may be used. For heavier loading, an adhesive anchor installed using a screen tube inserted through the face shell and interior webs is recommended. In all cases, job site tests are recommended.

Structural clay tile units can be used to form a load bearing wall and as a veneer or facade. ASTM Specification C 34 describes structural clay tile for load bearing walls. Tile of Grade LBX is suitable for exposure to weather while Grade LB is normally used in a protected environment. The minimum compressive strength for this type of unit ranges from 3.4 to 9.6 MPa depending upon the orientation and grade. Structural clay facing tile is described in ASTM C 212.



Structural clay partition

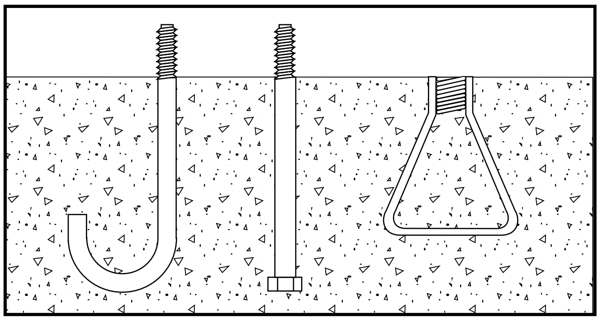
For non load bearing applications, Specification C 56 describes structural clay tile used primarily for partitions. This type of tile is sometimes referred to as architectural terra cotta although this term is more appropriately applied to ornamental building units. No minimum compressive strength is specified for this type of tile.

2.3 Anchor Functioning

The manner in which the applied load is transferred by an anchor to the base material is determined by the method in which an anchor functions. Anchor functioning can generally be described by one of the following categories: cast in place, drilled-in, or forced entry .

2.3.1 Cast-In-Place Anchors

These anchors are inserts that are placed in the concrete formwork prior to the placement of the concrete or in a masonry wall as it is constructed. Typical cast-in-place anchors include male units such as headed bolts or J bolts, and female style inserts .



Typical cast-in-place anchors

High loads can usually be obtained from this type of anchor but placement is difficult and expensive both in design and fabrication. Experience has shown that typically, 25 to 30% of the inserts are left out or misplaced.

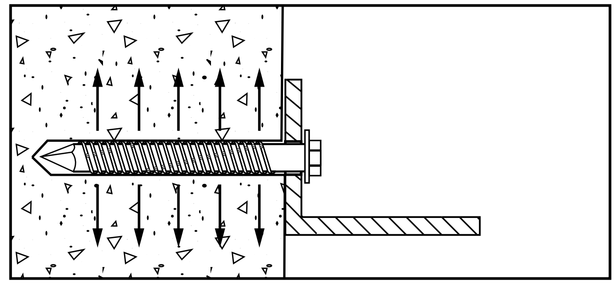
2.3.2 Drilled in Anchors

Drilled in anchors provide the user the flexibility to install an anchor exactly where it is required without the intricate advanced planning associated with cast-in-place anchors. Anchors of this type are also referred to as post-installed because they are installed in holes which are drilled after the base material has been placed and cured. Although drilled-in anchors are supplied in a variety of styles, they can be grouped into two categories, mechanical expansion and bonded anchors.

Mechanical expansion anchors can usually be loaded immediately after installation which may be an advantage in some applications as compared to bonded anchors which must be allowed to cure prior to loading. Steel expansion anchors generally have a greater resistance to the effects of elevated temperature when compared with ester based resins or epoxies. Bonded anchors such as those which use epoxy tend to have higher load capacities than mechanical expansion anchors. These anchors can also be described by their style, either male or female. Male style anchors are also referred to as stud type anchors such as a SPIKE or Power-Bolt. Female anchors are often called shield or shell type anchors such as a steel drop-in. The following sections describe four types of mechanical expansion anchor functioning and two types of bonded anchors.

2.3.2.1 Friction Anchors

Anchors of this type develop their load capacity by creating a friction force between the anchor and the base

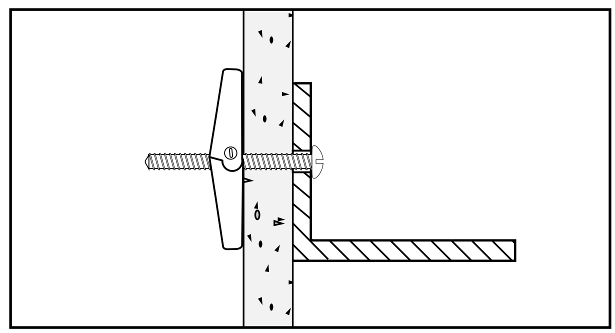


Friction anchor

material. In the most common systems, an undersized hole is drilled into the base material. As the anchor is driven in, a friction force is developed between the shank of the anchor and the base material. This type of anchor is suitable for sustaining light to medium duty static loads. Examples of this are concrete screw anchors such as the TAPPER™.

2.3.2.2 Clamping Anchors

Clamping describes a type of anchor which is used for fastening to hollow base materials. Resistance to load is



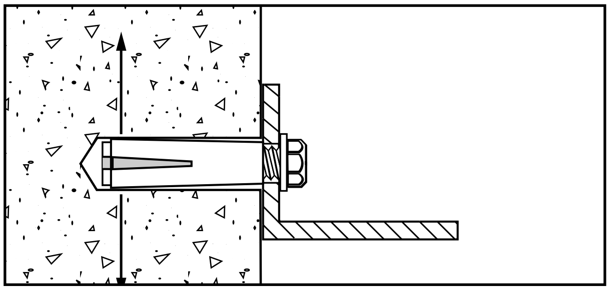
Clamping anchor

achieved by clamping the material to be fastened to the base material. The tension load is developed by spreading the load over a large bearing surface in the hollow base material while shear is resisted by the friction developed between the fixture and the base material. Examples of this type of anchor are Toggle or Rawly anchors.

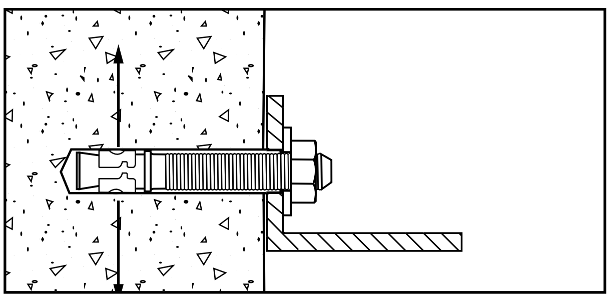
2.3.2.3 Compression Anchors

The term compression anchor can be used to describe the majority of concrete and masonry expansion anchors. Anchors of this type are designed with an expansion mechanism that compresses against the base material. The expansion mechanism may be a sleeve, slotted shell, slotted stud, or wedge assembly which is actuated by a tapered cone, tapered plug, nail, bolt, or screw depending upon the anchor style. The compression of the expansion mechanism against the wall of the drilled hole allows the anchor to transfer the load to the base material.

Compression anchors which are expanded by tightening a bolt or nut are considered to be torque controlled while those that are actuated by driving a nail or plug are considered to be deformation controlled. Examples of torque controlled anchors are the Power-Bolt or Safety+. The Steel Drop-In is an example of a deformation controlled anchor. A deformation controlled anchor can develop a higher initial compression force when compared to a torque controlled anchor. Compression anchors may also be pre-expanded. The expansion mechanism on an anchor of this style is actuated as it is compressed during the driving operation into the anchor hole. An example of this style of anchor is the SPIKE®.



Fixed compression anchor

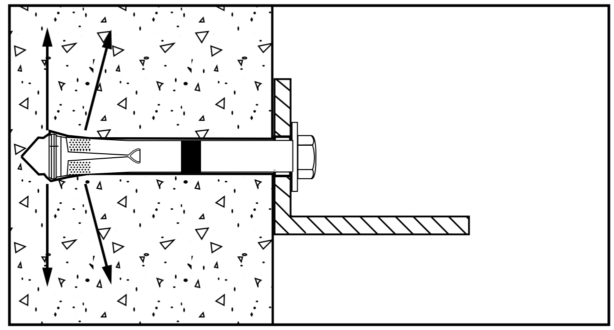


Self-energizing anchor

The expansion mechanism on a compression type anchor can be fixed or self energizing. An anchor with a fixed mechanism is usually deformation controlled with the amount of expansion being limited, such as a drop-in anchor where an internal plug is set with a tool. If an overload condition occurs, an anchor with fixed mechanism will not expand any further. A self energizing mechanism is often found on torque controlled anchors which will continue to expand if an overload condition occurs, such as a Power-Bolt or Safety+. When the applied load exceeds the pre-load in the anchor, it will expand or reset to take up the additional load. Some deflection or movement will usually occur providing a visual indication of a potential problem. This type of performance is also typical of a pre-expanded anchor such as the SPIKE®.

2.3.2.4 Undercut Anchors

Undercut anchors expand at the bottom of the drilled hole similar to a compression type anchor except that the actual diameter of the expanded area is wider than the drilled hole, undercutting the base material similar to a dove tail slot. Anchors of the type can be self undercutting or may require a secondary operation to form the undercut at the bottom of the drilled hole. During installation, as the expansion mechanism undercuts the base material, it forms a large bearing area which can transfer greater load to the base material. This design also allows undercut type anchors to be used in cracked concrete. An example of a self undercutting anchor is the Power-Bolt.

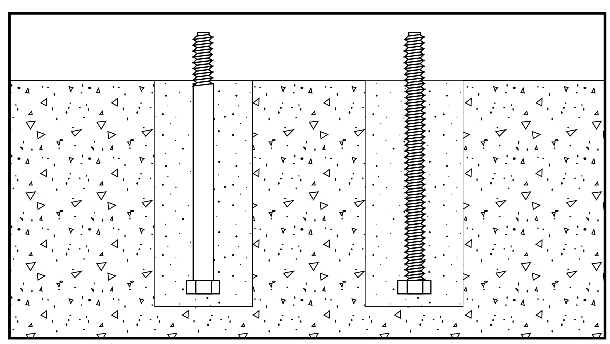


Undercut anchor

2.3.2.5 Bonded Anchors

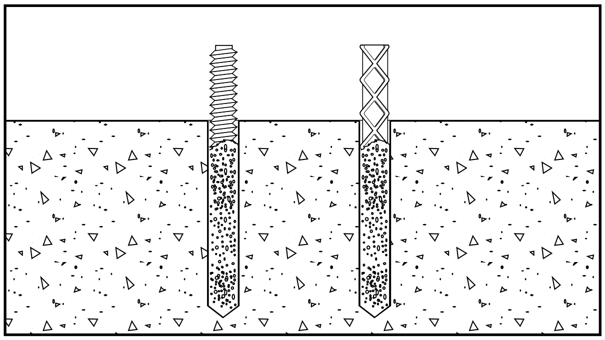
This type of anchor bonds threaded rods, bolts, and reinforcing bars to the base material using cementitious materials or chemical adhesives. Loads are transferred to the base material by the bond formed between both the anchor rod and the walls of the drilled hole. Anchors of this type normally have the highest load capacities because the base material does not have to withstand the high point load stresses often associated with mechanical expansion anchors. Performance when subjected to dynamic or shock loads is usually superior.

Grouted anchors require the drilling of a large diameter anchor hole to accommodate the placement of the grout around the anchor. Headed bolts or threaded rods with pre-mounted nuts are inserted into the holes which are filled with a portland cement / sand grout or other types of premixed grouts.



Grouted anchors

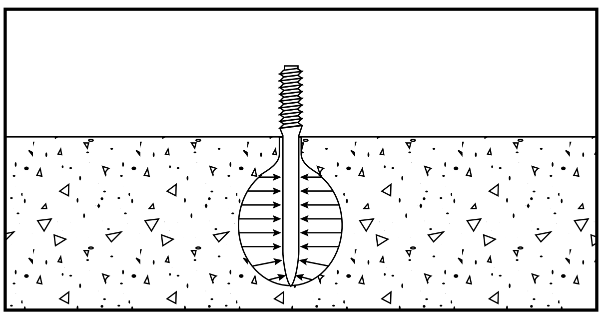
Chemical or adhesive anchors use an ester based resin (poly / vinyl) or an epoxy to bond threaded rods or reinforcing bars into the anchor hole. Normally, the hole size is only slightly greater than the rod or bar size. Typical two part systems include an encapsulated glass design such as the Kemfix Capsule or Hammer-Capsule, plastic cartridges in various configurations such as the Powerfast or KF2 Cartridge Systems, and pre-measured foil packs such as the Powerfast Sausage Systems.



Chemical / adhesive anchors

2.3.3 Forced Entry Fasteners

Fasteners of this type can be hand driven, power driven using a pneumatic tool, or power driven using a powder actuated tool. As a fastener of this type is driven into concrete or masonry, the shank of the fastener displaces the base material. The displaced material compresses



Forced entry anchor

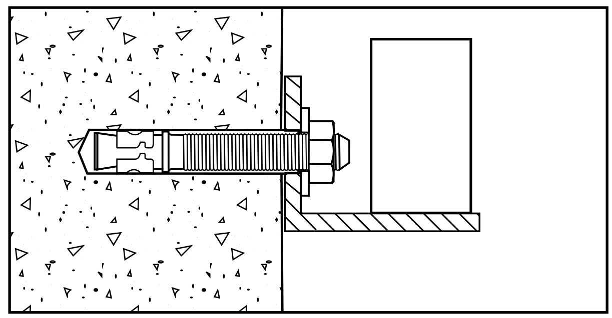
against the shank of the fastener to create a friction grip. In concrete and masonry base materials, their use is normally limited to light duty, static loads.

2.4 Applied Loads

The type of load and the manner in which it is applied by the fixture or other attachment is a principle consideration in the selection of an anchor. Applied loads can be generically described as static, dynamic, or shock. Some anchor types are suitable for use with static loads only, while others can be subjected to dynamic or shock loads. The suitability of an anchor for a specific application should be determined by a qualified design professional responsible for the product installation.

2.4.1 Static Loads

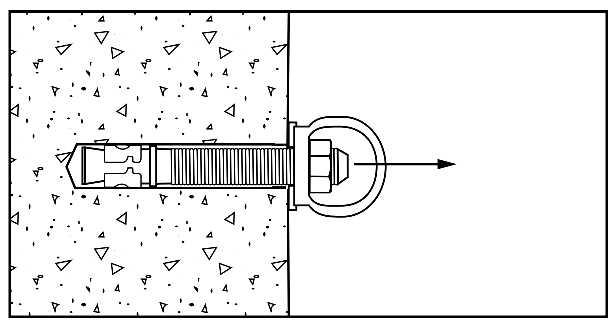
These are non-moving, constant loads such as those produced by an interior sign, cabinet, equipment, or other. A static load can be a combination of the dead load (weight of fixture) and the live load a fixture must support. Basic static load conditions are tension, shear, or a combination of both.



Static load

2.4.1.1 Tension Load

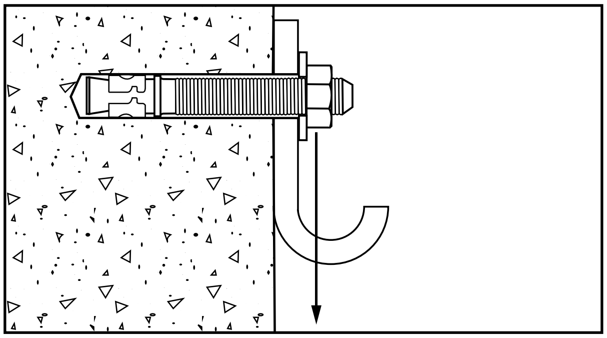
A tension load is applied directly in line with the axis of the anchor.



Tension load

2.4.1.2 Shear Load

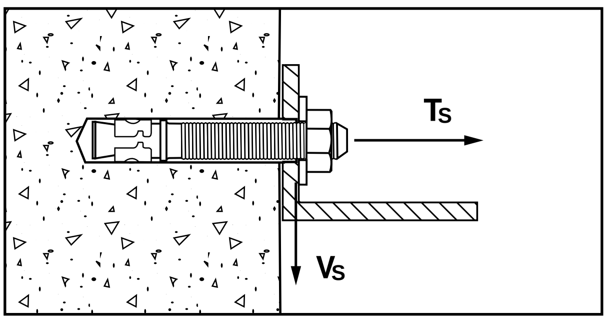
A shear load is applied perpendicular across the anchor directly at the surface of the base material.



Shear load

2.4.1.3 Combined Load

Most anchor installations are subjected to a combination of shear and tension loads.



Combined load

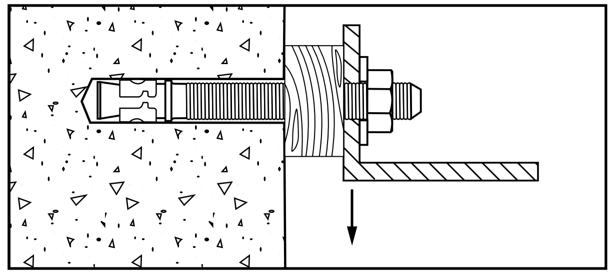
For anchors loaded in both shear and tension, the combination of loads should be proportioned as follows based on the Uniform Building Code:

$$\left(\frac{T_S}{T_A}\right)^{5/3} + \left(\frac{V_S}{V_A}\right)^{5/3} \le 1$$

Where: T_S = Applied Service Tension Load
T_A = Allowable Tension Load
V_S = Applied Service Shear Load
V_A = Allowable Shear Load

2.4.2 Bending Load

One often overlooked result of static load is bending. It is frequently necessary to place shims or spacers between the fixture and the material for alignment or leveling. When this occurs, it is often the strength of the anchor material or bolt material that determines the capacity of the connection. The load is applied at a distance from the surface of the base material creating a lever type action on the anchor. Typical examples of this type of loading are the installation of windows using plastic horse shoe shims or machinery installations with shims below the base plate. In loading such as this, it is often the physical strength of the anchor material, not the tension and

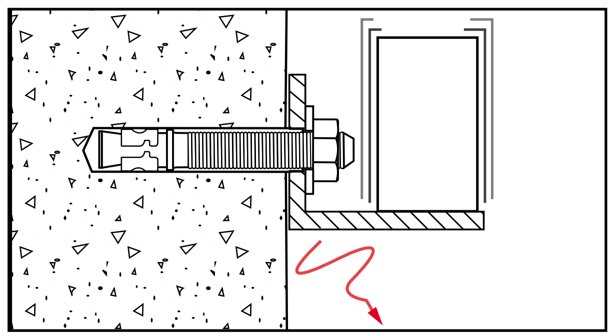


Bending load

shear load capacities, that limit the strength of the anchorage. The allowable bending load should be calculated by a design professional based on the material from which an anchor is manufactured. In concrete or masonry materials, the bending arm used in the calculation should be increased to allow for spalling around the top of the anchor hole, usually by 1/2 to 1 anchor diameter.

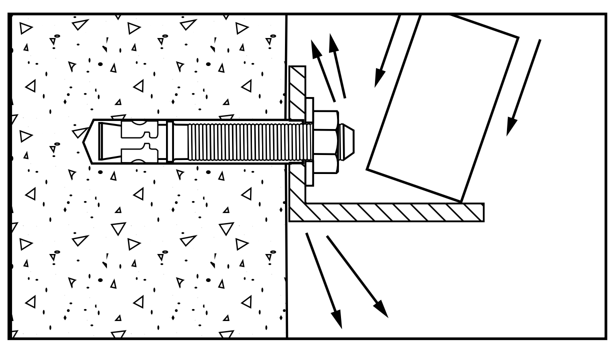
2.4.3 Dynamic Loads and Shock Loads

Dynamic loads are intermittent and varying loads such as those imposed by a central air conditioning unit, manufacturing machinery, or earthquakes. They are normally the alternating or pulsating loads associated with vibration.



Dynamic load

Shock loads are instantaneous, periodic loads of high intensity such as those applied by an automobile striking a guard rail support or a truck hitting a dock bumper.



Shock load

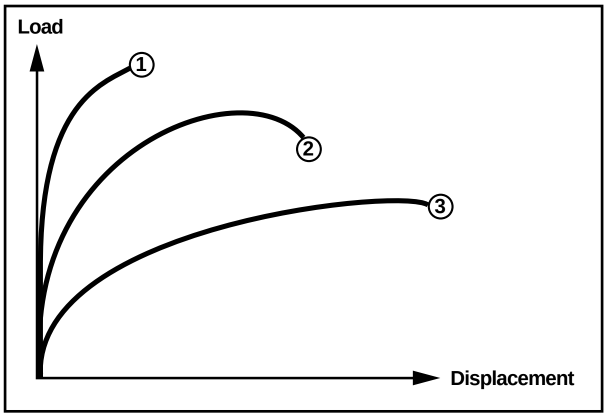
Standard industry practice with regard to safety factors varies depending upon the frequency and intensity of the load. However, safety factors for dynamic or shock load conditions may be as high as 10:1.

2.5 Anchor Behavior

The selection and specification of an anchor requires an understanding of basic anchor behavior or performance. A variety of performance attributes can be expected depending upon the type or style of anchor.

2.5.1 Displacement

As an anchor is loaded to its ultimate (failure) load capacity, displacement or movement of the anchor relative to the base material will occur. The amount of displacement will be effected by the anchor preload, the anchor material strength, the design of the expansion mechanism, and the strength of the base material. Typical load versus displacement curves are shown in the following diagram for three anchor types.



Curve 1 shows the typical performance of an adhesive type anchor. These anchors normally exhibit elastic behavior up to the ultimate load capacity. Performance will vary depending upon the type of adhesive used, the base material strength, and the strength of the anchor rod. A deformation controlled anchor such as a steel drop-in anchor may also exhibit this type of behavior although the ultimate load capacity will normally be much less than that of an adhesive anchor. The compression force developed by a steel drop-in is usually very high when compared to a torque controlled anchor resulting in low displacement characteristics.

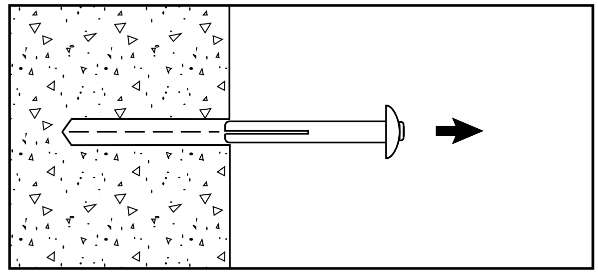
Typical performance of a torque controlled anchor such as the Power-Bolt is shown in Curve 2. Displacement begins to occur after the initial preload in the anchor has been exceeded until the ultimate load capacity is achieved.

Anchors for use in light duty applications often exhibit the behavior shown in Curve 3. Once the working load has been exceeded, the anchor begins to displace or stretch until failure occurs.

2.5.2 Modes Of Failure

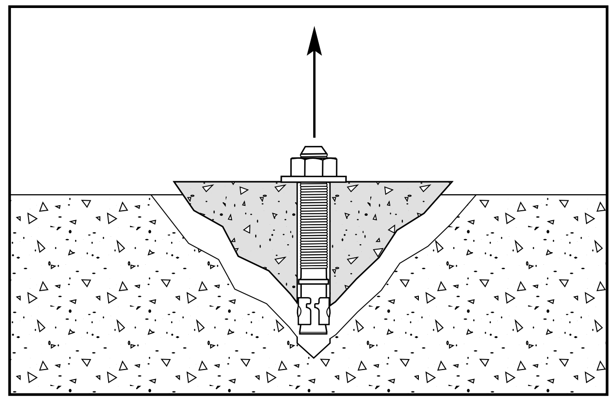
As an anchor is loaded to its ultimate capacity, the following modes of failure can occur.

2.5.2.1 Anchor Pullout



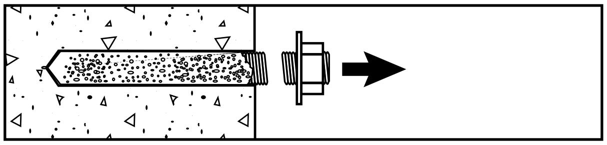
This type of failure occurs when the applied load is greater than the friction or compressive force developed between the anchor body and the base material. The anchor is unable to fully transfer the load to develop the strength of the base material. For adhesive anchors, this can occur with products which have a low bond strength.

2.5.2.2 Base Material Failure



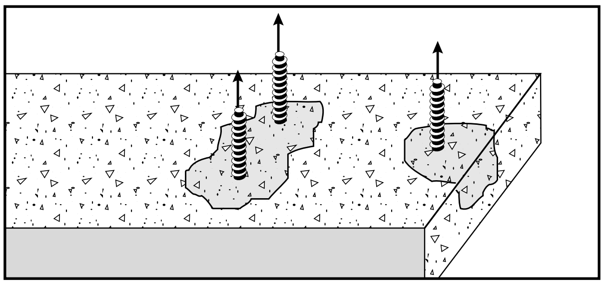
When the applied load is greater than the strength of the base material, the material pulls out or fails. In concrete, a shear cone will be pulled, usually for anchors installed at a shallow embedment in the range of 4 to 5 anchor diameters of depth. The angle of the shear cone has been assumed to be 45°, however, this can vary up to 60° depending upon the anchor style and embedment depth. As the embedment of some anchor styles is increased to six diameters or beyond, the concrete can sustain the applied compression force and the load capacity of the anchor will increase up to a point at which either the capacity of the expansion mechanism or the bond is reached. At deeper embedments, the high compressive forces developed by the expansion mechanism of some anchors may cause localized failure of the concrete. In masonry, the individual unit may be pulled from the wall, especially in cases where the strength of the mortar may be low.

2.5.2.3 Anchor Material Failure



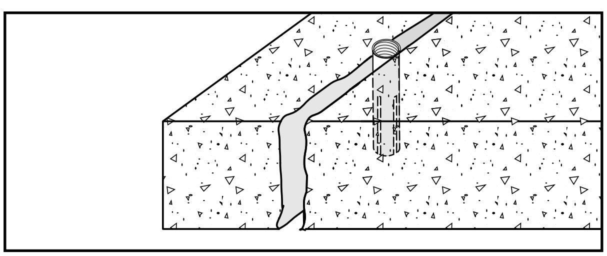
A failure of the anchor body or rod will occur when the applied load exceeds the strength of the material from which the anchor is manufactured. For mechanical anchors, this usually occurs for anchors which are embedded deep enough to develop the full strength of the expansion mechanism and the base material. For adhesive anchors, this will occur when the bond strength of the adhesive is greater than the strength of the anchor rod.

2.5.2.4 Spacing or Edge Failure



The spacing and edge distance of installed anchors will affect the mode of failure along with the resulting ultimate load capacity. Anchors which are spaced close together will have a compound influence on the base material resulting in lower individual ultimate load capacities. For anchors installed close to an unsupported edge, the load capacity will be affected by both the direction of the load and the distance from the edge. As load is applied, a concrete cone type of failure will occur. This can be caused by the compressive forces generated by the expansion mechanism or by the stresses created by the applied load.

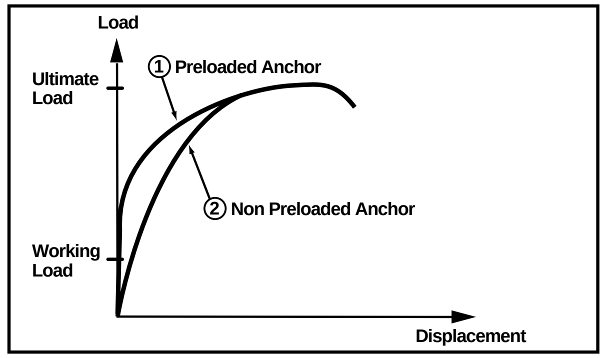
2.5.2.5 Base Material Splitting



Concrete and masonry units must be of sufficient size to prevent cracking or splitting during anchor installation and as load is applied. The critical dimensions include the thickness and the width.

2.5.3 Anchor Preload

Anchor preload is developed by the setting action in a deformation controlled anchor or the tightening of a bolt / nut in a torque controlled anchor. When a load is applied to an anchor, significant displacement will not occur until the preload in the anchor has been exceeded. The amount of preload normally does not have any effect on ultimate load capacity provided the anchor is properly set. By tightening a torque controlled anchor a particular number of turns or to a specific torque level, the anchor is initially preloaded. This action will reduce the overall displacement of the anchor and normally insures that elastic behavior will occur in the working load range. A preload may also be applied to achieve a clamping force between the fixture and the base material. The diagram below shows the effect of preload on the performance characteristics of two anchors such as a Through-Bolt.



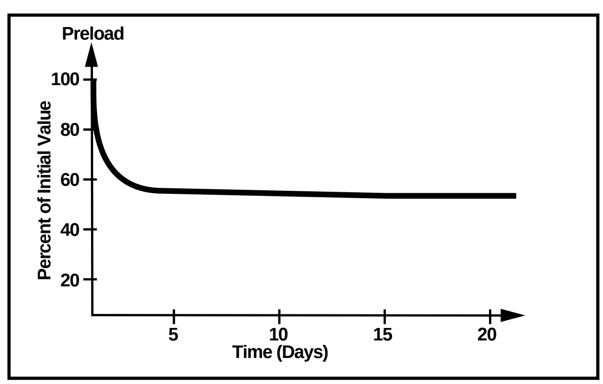
Effect of preload on anchor performance

In curve 1, the tightened anchor does not experience significant displacement until well above the working load. Curve 2 shows the performance of the anchor not tightened which experiences marked displacement in the working load range.

2.5.4 Preload Relaxation

In concrete, anchors which have been preloaded by tightening or the application of an installation torque will experience a phenomena called preload relaxation. This will also occur in masonry base materials. In a typical anchor installation, high bearing stresses against the concrete base material are created around the expansion mechanism of the anchor as it is preloaded.

These high bearing stresses cause the concrete in the area of the expansion mechanism to creep which results in a slight movement of the anchor. This slight movement causes a reduction of preload and a corresponding reduction in the measured torque. Industry experience has shown that a decrease in preload in the range of 40 to 60 percent can be expected in normal weight concrete. This will vary depending upon the modulos of elasticity of the concrete. The final preload is typically 1.5 to 2.0 times the working load based on the use of a safety factor of 4. Typical load relaxation is shown in the following diagram.



Typical preload relaxation

Relaxation begins immediately after tightening with most of the relaxation occurring during the first few hours after installation. For example, in an application where an installation torque of 80Nm is applied, a decrease in the torque measured 24 hours later to a level of 40Nm due to preload relaxation would be considered normal. Retorquing of the anchors may slightly increase the final value of the preload, however, this is not normally recommended as repeated tightening may eventually jack the anchor out of the base material.

2.5.5 Slip Loading

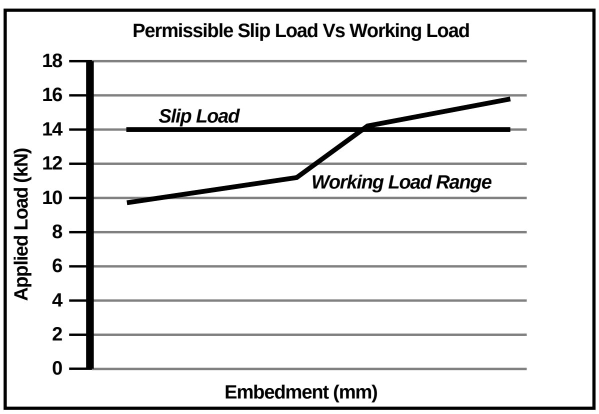
Anchor slip will not occur, provided the applied load is less than the final preload. The applied load will act as a reduction in the elastic performance of the fixing, if loaded below the final preload point. Where the applied load exceeds the final preload, slippage of the anchor and separation of the fixture to the base material, will occur.

Expansion Anchor-Design:

Where it is necessary in fixing applications to design around a slip load (0.1 mm displacement) it is critical that the Recommended Assembly Torque be precisely applied, to ensure accurate performance characteristics from the fixing. The Final Preload of an anchor is considered to be the point at which negligible slip occurs (0.1mm)

Final Preload = Slip Load

To achieve the Permissible Slip Load of a fixing, it is recommended that the applied load be limited to 65% of the Final Preload, as described in AS 3850.1-1990 (Tilt-up concrete and precast concrete elements for use in buildings).



Example: 16mm Power-Bolt

Permissible Slip Load = 65% Of Final Preload

NB: The Working Load Conditions of an anchor should never be exceeded.

2.6 Anchor Material Selection

The material from which an anchor is manufactured is generally capable of sustaining the published tension and shear loads. However, other conditions such as bending loads should be checked. In certain loading situations, the material strength may be the weak link. Bolts or other materials used in conjunction with an anchor should be capable of sustaining the applied load and should be installed to the minimum recommended thread engagement.

For reference purposes, the minimum expected mechanical properties of commonly used carbon steel and stainless steel materials are listed in the following table. The designations used are for externally threaded parts as assigned by the Society of Automotive Engineers (SAE), American Iron and steel Institute (AISI), the American Society for Testing and Materials (ASTM), or Australian Standards (AS). Variations in strength will occur due to heat treating, strain hardening, or cold working. Consult the individual standards for details.

2.6.1 Material Specification:

Grade Designation	Yield Strength 0.2% Offset (MPa)	Ultimate Tensile Strength (MPa)
AS1111 Property Class 4.6	240	400
AS1110 Property Class 8.8	640	800
SAE Grade 5	634	827
SAE Grade 8.2	896	1034
Stainless Steel Type 316	450	700

In addition to the load capability of the material, an anchor should be manufactured from material which is compatible with its intended use. For example, anchors manufactured from a material with a melting point of less than 540˚C. are not normally recommended for overhead applications due to fire code regulations unless specific fire rating tests have been performed. Special materials may be required for corrosive environments and galvanic reactions.

Powers reserves the right to use alternate anchor materials which will perform in a similar manner depending upon production requirements.

2.7 Corrosion Resistance

The corrosive environment in which an anchor will be installed should be considered. Corrosion can be described broadly as the destruction of a material due to chemical or electrochemical reactions based upon the application environment. Industry estimates of the annual cost of corrosion place it in billions of dollars. The subject of corrosion is very complex and knowledge is constantly being gained based on industry experience. Chemical and electrochemical corrosion are described in the following two sections to provide a basic understanding of the process.

2.7.1 Chemical Corrosion

Direct chemical attack occurs when an anchor is immersed in the corrosive substance, typically a liquid or a gas. For example, an anchor used to restrain equipment in a water treatment tank would have to be made from a material which would be resistant to chlorine or other corrosive liquids present. This type of corrosion can also occur when a stone facade is attached to a backup wall. Mild acids can be formed in the wall cavity due to reaction of condensation with the attached stone. The anchor selected would have to be resistant to the type of acid formed.

2.7.2 Electrochemical Corrosion

All metals have an electrical potential which has been measured through research and ranked into an electromotive force series. When two metals of different electric potential are brought into contact in the presence of an electrolyte, the metal with the lower potential (least noble) will form the anode while the metal with the higher potential (most noble) will form the cathode. As current flows from the anode to the cathode, a chemical reaction will take place. The metal forming the anode will corrode and will deposit a layer of material on the metal forming the cathode. As the electric potential between two dissimilar metals increases, the stronger the current flow and corresponding rate of corrosion. The rate of corrosion will also be influenced by the conductivity of the electrolyte.

In order to provide a more practical approach to understanding the electromotive force series, testing was conducted on commercial alloys and metals in sea water to develop a chart called the Galvanic Series. One of the reasons sea water was used as the electrolyte was because it has a high conductivity rate. The following chart lists a representative sample of dissimilar metals and indicates their relative potential for galvanic corrosion. When two dissimilar metals are in contact (coupled) in the presence of a conductive solution or electrolyte (i.e. water) electric current flows from the less noble (anodic) metal to the more noble (cathodic) metal. In any couple, the less noble metal is more active and corrodes while the more noble metal is galvanically protected.

+Corroded End (anodic, or least noble)
Magnesium Magnesium alloys Zinc
Aluminum 1100 Cadmium Aluminum 2024-T4 Steel or Iron Cast Iron Chromium-iron (active) Ni-Resist cast iron
Type 304 Stainless (active) Type 316 Stainless (active)
Lead tin solders Lead Tin
Nickel (active) Inconel nickel-chromium alloy (active) Hastelloy Alloy C (active)
Brasses Copper Bronzes Copper-nickel alloys Monel nickel-copper alloy
Silver solder Nickel (passive) Inconel nickel-chromium alloy (passive)
Chromium-iron (passive) Type 304 Stainless (passive) Type 316 Stainless (passive) Hastelloy Alloy C (passive)
Silver Titanium Graphite Gold Platinum
-Protected End (cathodic, or most noble)

To prevent galvanic corrosion, the following precautions can be used:

1. Use the same or similar metals in an assembly. Select metals which are close together in the Galvanic Series.
2. When dissimilar metals are connected in the presence of a conductive solution, separate them with dielectric materials such as insulation or a coating. Coatings should be kept in good repair to prevent accelerated attack at any imperfection.
3. Avoid combinations where the area of the less noble material is relatively small. It is good practice to use anchors or fasteners made from a metal which is more noble than that of the material being fastened.

In critical applications, testing should be conducted to simulate actual conditions.

Other types of electrochemical corrosion such as stress corrosion may need to be considered depending upon the application.

2.7.3 Coatings And Platings

Powers offers a variety of coatings and platings to resist various extremes of corrosion. A plating metal which is less noble (lower electric potential) than the base metal it is designed to protect is usually selected. When subjected to an electrochemical reaction, the plating will corrode or sacrifice while the base metal remains protected. Once the plating has been reduced significantly, the base material will then begin to corrode. If a plating metal which is more noble is selected, the base metal would begin to corrode immediately if the plating is damaged.

For carbon steel anchors and fasteners, zinc is one of the most common plating materials used because it can be applied in a broad thickness range and because it is less noble than carbon steel. Zinc may be applied by electroplating, mechanical galvanizing, or hot dip galvanizing. The following table shows the typical mean corrosion rate of zinc based on data compiled by ASTM. Theoretically, the life expectancy of a zinc plating would be the thickness of the plating divided by the corrosion rate. These values should only be used as a guide since actual performance will vary with local conditions.

Atmosphere	Mean Corrosion Rate
Industrial	5.6 microns (0.0056mm) per year
Urban non-industrial or marine	1.5 microns (0.0015) per year
Suburban	1.3 microns (0.0013mm) per year
Rural	0.8 microns (0,0008mm) per year
Indoors	Considerably less than 0.5 microns (0.0005mm) per year

The standard zinc plating used on Powers carbon steel anchors is applied using electroplating. The anchor components are immersed in a water based solution containing a zinc compound. An electrical current is then induced into the solution causing the zinc to precipitate out, depositing it onto the components. Powers carbon steel products are electroplated according to BS1706 Class C/ASTM Specification B 633, SC1, Type III. SC1 signifies Service Condition 1 which is for a mild environment with a minimum coating thickness of 5 microns (0.005mm). This condition is also classified as Fe/Zn 5. Class III indicates that a supplementary clear chromate treatment is applied over the zinc plating. Prior to applying the chromate treatment, heat treated products which are electroplated are normally baked to reduce the possibility of hydrogen embrittlement.

Heavier zinc platings or coatings are often described using the term galvanized. Another zinc coating which is available is mechanical galvanizing. To apply this coating, the anchor components and glass beads are placed in a chamber on an agitating machine. As the chamber is agitated, powdered zinc compound is gradually added allowing the glass beads to pound the zinc onto the surface of the anchor components.

2.7.4 Corrosion Resistant Materials

In addition to coatings and platings, Powers offers a variety of materials which provide varying degrees of corrosion resistance.

2.7.4.1 Stainless Steel

Stainless steels were originally named according to their chromium and nickel content. One of the first types developed contained 18% chromium and 8% nickel and was therefore called 18-8 stainless steel. As newer types of stainless steel were developed with properties to meet specific application needs, the American Iron And Steel Institute (AISI) established a standard numbering system to classify the various types of stainless steel. In order to be considered a stainless steel in the AISI system, an alloy must contain at least 11.5% chromium. Chromium-nickel alloys became the 300 series stainless steels while chromium alloys became the 400 series.

Stainless steels develop their resistance to corrosion by forming a thin, self healing, passive film of chromium oxide on their surface. During the forming or machining process, the surface of components made from stainless steel may become contaminated with small particles of foreign matter. In order to maintain the optimum performance of the stainless steel, Powers passivates the components after manufacturing. The basic passivation process involves cleaning or degreasing the components, immersion in a nitric acid bath, rinsing and drying. Once the process is complete, the oxide film is formed again without the entrapment of foreign particles.

The 300 series of stainless steels are austenitic alloys which are non magnetic and are not heat treatable although they can be annealed. In order to achieve higher tensile strengths, this series of stainless must be cold worked. For some components, a minimum yield strength is specified based on the work hardening which occurs during the cold forming process. In the industry, the term 18-8 is still used to generically describe the 300 series of alloys, especially Types 302, 303, and 304. Powers provides anchors formed from Types 303, 304, 304 Cu, and 316 stainless steel.

Type 303 is used where machinability is required for products such as a steel drop-in anchor. This type of stainless steel has a higher sulfur content than Type 304 which reduces drag on cutting tools, especially when forming internal threads. This type of stainless is one of the most widely specified and is commonly used for applications in the food processing industry. For more severe corrosive environments, Type 316 stainless steel is available. Type 316 has a higher nickel content than Type 304 and the addition of molybdenum. This provides increased resistance to pitting caused by chlorides and corrosive attack by sulfurous acids such as those used in the paper industry.

2.7.4.2 Other Materials

Depending upon the corrosive environment, Powers also provides several alternate materials which may be used instead of stainless steel. These materials include lead, Zamac 7 alloy, jute fiber, and engineered plastic.

2.7.5 Corrosion Test Methods

Two common methods which are used to evaluate relative corrosion resistance are salt spray (fog) testing and a European test method, DIN Standard 50018, 2.0S, sometimes called a Kesternich Test.

2.7.5.1 Salt Spray Testing

Salt spray testing, also known as salt fog testing, is conducted according to ASTM Standard B 117. The components to be tested are prepared and suspended in a sealed chamber where they are subjected to a spray or fog of a neutral 5% salt solution which is atomized at a temperature of 35° C. Testing of this type is considered useful when evaluating the behavior of materials when subjected to a marine environment.

2.7.5.2 Kesternich Test

This test method is a far more severe measure of corrosion resistance when compared to the salt spray method. The components to be tested are prepared and placed in a special unit called a Kesternich Test Cabinet. Corrosion testing is conducted according to DIN Standard 50018, 2.0S. Two liters of distilled water are placed in the bottom of the cabinet and it is then sealed. Once sealed, two liters of sulfur dioxide are injected into the cabinet and the internal temperature is set to 40° C. for the cycle. Each 24 hour cycle begins with 8 hours of exposure to the acidic bath created in the cabinet. The cabinet is then purged and opened, the test specimens are rinsed with distilled water then allowed to dry at room temperature for 16 hours. The test specimens are examined for surface corrosion (red rust) at the end of each cycle.

The following table compares the relative surface corrosion (red rust) of various coatings, platings, and materials after 30 cycles of exposure in a Kesternich Test Cabinet.

Coating / Plating / Material	% Surface Corrosion
Cadmium	100% after 4 cycles
Stainless steel - Type 304	None after 30 cycles
Stainless steel - Type 316	None after 30 cycles
Stainless steel - Type410	100% after 30 cycles
Zinc with clear chromate (ASTM B 633)	100% after 6 cycles
Zinc with yellow dichromate (ASTM B 633/BS1706 Class C)	100% after 6 cycles
Mechanically galvanized (ASTM B 633)	100% after 6 cycles
Zamac 7 alloy	None after 30 cycles

2.8 Performance Data

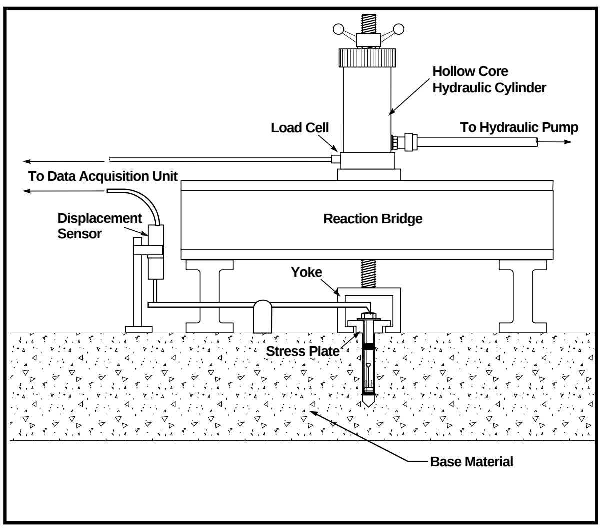
The fundamentals of mechanical expansion and adhesive anchor design include the calculation of allowable working load capacities based on laboratory test data conducted to simulate typical field conditions. Powers publishes ultimate load capacities for anchors installed in concrete and masonry units along with other appropriate base materials.

2.8.1 Test Procedures and Criteria

The test data for anchors published in this manual was developed according to ASTM Standard E 488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements. Published load values are average ultimate (failure) loads based on actual testing in the base materials listed in the individual anchor sections. Each individual data point is typically the average of five individual tests. Since the compressive strength of concrete will influence the strength of an anchor, testing is usually conducted in several different strengths. Normally, the base materials are unreinforced to provide a worst case simulation.

2.8.2 Tension Test Data

Tension test data is sometimes referred to as pullout or tensile test data. A typical hydraulic test assembly used to perform a tension test on an anchor is shown in the following diagram.



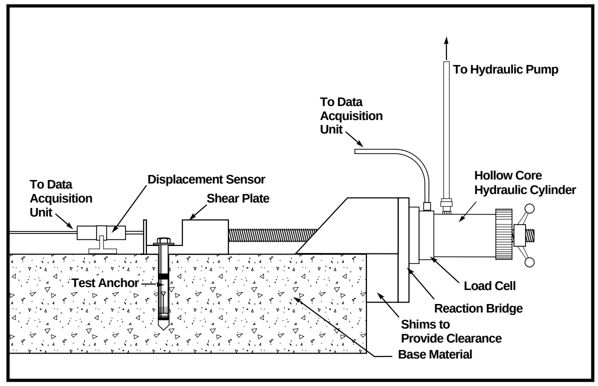
Typical static test assembly

The test equipment frame is designed to support the hydraulic test unit and span the test area so that reaction loading does not influence the test results. During testing, load is gradually applied to the anchor in an axial direction by a hydraulic cylinder while the displacement is measured using an electronic displacement sensor. The load is measured by a hollow core load cell and the resulting performance is recorded by a data acquisition unit. Loading of the anchor is continued until the ultimate (failure) load is achieved. The ultimate load capacity recorded may be based on any one of the failure modes shown in Section 2.5.2 or a combination thereof.

During testing, the tension capacity of mechanical expansion anchors and adhesive anchors will increase with deeper embedments. This is due to the increased amount of base material available to resist the compressive forces applied by a mechanical expansion anchor or the increased surface area available for bonding with an adhesive type anchor. In some anchors, the capacity of the expansion mechanism may have been reached at the shallowest embedment and the load will not increase.

2.8.3 Shear Test Data

The typical setup for a hydraulic test unit used for applying a shear load to an anchor is shown in the following diagram.



Typical shear test assembly

The test load is applied perpendicular to the anchor using the hydraulic equipment previously described. During testing of mechanical anchors, the shear capacity will increase as the embedment of the anchor increases, however, the increase may not be as significant as in tension. When a shear load is applied to a mechanical anchor, the anchor body resists the applied load by placing a bearing stress against the base material. Increasing the embedment will increase the area over which this stress is applied which in turn increases the resistance of the base material to the applied load. In addition, a mechanical anchor will tend to bend as a shear load is applied as the base material begins to crush. The applied load will actually be resisted by a combination of the bearing strength of the base material and the tension capacity of the anchor. Adhesive type anchors can usually develop the shear capacity of the anchor rod material at a shallow embedment when installed in concrete.

Since the applied shear in most applications is through the threaded portion of an anchor or bolt, Powers conducts all shear testing to simulate this situation. For bolt or screw style anchors, the design load should be the lesser of the allowable anchor load or load for the actual bolt or screw used.

2.9 Design Recommendations

2.9.1 Allowable Load Capacities

The allowable load which may be applied to an anchor is calculated based upon applying a safety factor to the average ultimate load capacity obtained from testing. One purpose of a safety factor is to allow for field variations which may differ from the testing conditions in the laboratory. Examples of these variations include differences in the type and strength of base material, the setting method used, and long term performance factors. The standard established by the industry is to reduce the ultimate load capacity by a minimum safety factor of 4 to calculate the allowable working load. For example, an anchor which has an average ultimate tension load capacity of 60kN would have a maximum allowable working load of 15kN. Critical applications such as overhead applications or dynamic loading may require safety factors of 10 or higher. The allowable loads are recommendations, however, local building codes should be consulted to determine the required safety factors.

2.9.2 Combined Loading

The combination of loads for anchors loaded in both tension and shear should be proportional as follows based upon the Uniform Building Code:

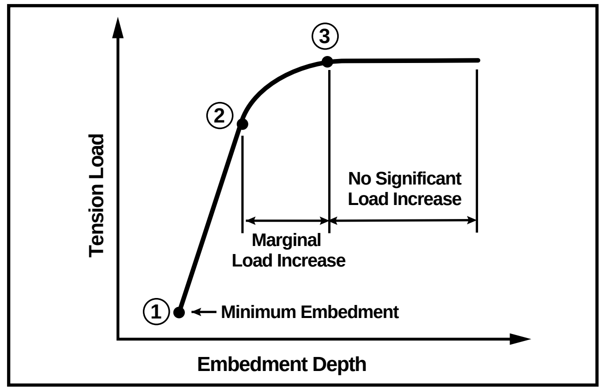
$$\left(\frac{T_S}{T_A}\right)^{5/3} + \left(\frac{V_S}{V_A}\right)^{5/3} \leq 1$$

Where: T_S = Applied Service Tension Load
T_A = Allowable Tension Load
V_S = Applied Service Shear Load
V_A = Allowable Shear Load

2.9.3 Depth Of Embedment

The depth of embedment published for each anchor in the load capacity charts is critical to achieving the expected load capacities. This depth is measured from the surface of the base material to the bottom of the anchor. For mechanical expansion anchors, this would be the depth measured to the bottom of the anchor prior to actuation. For each anchor type, a minimum embedment depth is specified. This depth is typically the minimum required for proper anchor installation and reliable functioning. Attempting to install an anchor at less than the minimum required may overstress the base material causing it to fail when the anchor is expanded. In some masonry materials, the minimum depth may be decreased depending upon the anchor style as noted in the load tables.

As noted in Section 2.8, the load capacity of some anchor types will increase with deeper embedments. For anchors which exhibit this behavior, multiple embedment depths and the corresponding load capacity are listed. As the embedment depth is increased, the load capacity will increase up to a transition point. This point is usually the maximum embedment depth listed. At this point, mechanical anchors may experience material failure or localized failure of the base material around the expansion mechanism. Adhesive type anchors may reach the capacity of the bond, the anchor rod material, or the capacity of the base material. The following diagram shows the typical performance of a mechanical anchor installed in concrete.



At the minimum embedment depth, the mode of failure at the ultimate load capacity is typically a concrete shear cone. As the anchor is installed at a deeper embedment depth, the size of the theoretical concrete shear cone increases, resulting in an increased load capacity. As the embedment depth is increased towards point 2, the mode of failure changes from a concrete shear cone to localized failure around the expansion mechanism. Beyond this point, marginal load capacity increases can be expected until the capacity of the expansion mechanism or anchor material is reached at embedment depths corresponding to point 3. The load capacity will not increase significantly for anchors installed at embedment depths beyond this point. This point is usually the deepest embedment listed in the anchor load capacity tables and is the maximum recommended. Applications which require an embedment deeper than those published should be tested to verify proper anchor performance. For applications requiring installation at embedment depths between those published, linear interpolation is permitted.

2.9.4 Base Material Strength

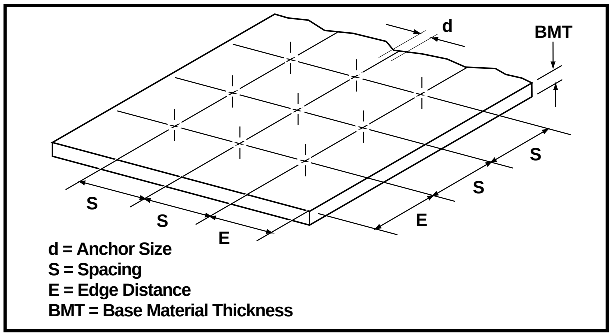
As discussed in Section 2.2, the strength of the base materials in which anchors may be installed varies widely and is a key factor in the performance of an anchor. Powers publishes the average ultimate load capacities for anchors installed in concrete and masonry units along with other appropriate base materials depending upon the product.

For installations in concrete, the load capacity of an anchor usually increases as the compressive strength increases. The load capacities for anchors installed in concrete are published for compressive strengths of 15, 30, and 40 MPa. In some cases, data is available only for 30 MPa concrete. Linear interpolation of the data for intermediate compressive strengths is permissible.

For masonry unit base materials, the published load capacities should be used as a guide since the consistency of these materials varies widely. Job site tests are recommended for critical applications in these materials.

2.9.5 Base Material Thickness

The minimum recommended thickness of solid concrete or masonry base material, BMT, when using a mechanical or adhesive anchor is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material should be at least 125mm thick. Conversely, the maximum embedment should be 80% of the base material thickness. If a concrete slab is 250mm thick, an 200mm depth would be the maximum recommended anchor embedment. This does not apply to products designed for installation in hollow base materials as noted in the individual anchor sections.



2.9.6 Spacing and Edge Distance for Mechanical Anchors

The published ultimate load capacities for mechanical anchors are based on testing conducted at the spacing and edge distance required to obtain the maximum load. For reduced spacing or edge distance, the following factors should be applied. These factors are cumulative as shown in the design example in Section 2.9.8.

2.9.6.1 Spacing Between Mechanical Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used for mechanical anchors. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor, Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacing, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
5	50	45	40	35	30	25
6	60	54	48	42	36	30
6.5	65	59	52	46	39	33
7	70	63	56	49	42	35
8	80	72	64	56	48	40
10	100	90	80	70	60	50
12	120	108	96	84	72	60
15	150	135	120	105	90	75
16	160	144	128	112	96	80
18	180	162	144	126	108	90
20	200	180	160	140	120	100
24	240	216	192	168	144	120
28	280	252	224	196	168	140
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

2.9.6.2 Edge Distance for Male Style Anchors

Edge Distance - Tension Loads

For a male style anchor, an edge distance E of, 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
5	60	55	50	45	40	35	30	25
6.5	78	72	65	59	52	46	39	33
7	84	77	70	63	56	49	42	35
8	96	88	80	72	64	56	48	40
10	120	110	100	90	80	70	60	50
12	144	132	120	108	96	84	72	60
15	180	165	150	135	120	105	90	75
16	192	176	160	144	128	122	96	80
18	216	198	180	162	144	126	108	90
20	240	220	200	180	160	140	120	100
24	288	264	240	216	192	168	144	120
28	336	308	280	252	224	196	168	140
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear Loads

For shear loads when using male style mechanical anchors, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
5	60	55	50	45	40	35	30	25
6.5	78	72	65	59	52	46	39	33
7	84	77	70	63	56	49	42	35
8	96	88	80	72	64	56	48	40
10	120	110	100	90	80	70	60	50
12	144	132	120	108	96	84	72	60
15	180	165	150	135	120	105	90	75
16	192	176	160	144	128	122	96	80
18	216	198	180	162	144	126	108	90
20	240	220	200	180	160	140	120	100
24	288	264	240	216	192	168	144	120
28	336	308	280	252	224	196	168	140
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

2.9.6.3 Edge Distance for Female Style Anchors

Edge Distance - Tension Loads

Female style expansion anchors, especially deformation controlled types, usually develop a higher initial compressive force when compared to male style anchors. These anchors apply this load over a larger bearing area, therefore, a greater minimum edge distance must be used to prevent cracking of the base material during installation and as load is applied.

To obtain the maximum tension load, an edge distance E, of 12 anchor diameters (12d) should be used. The minimum recommended edge distance, E, is 8 anchor diameters (8d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only				
d (mm)	12d	11d	10d	9d	8d
6	72	66	60	54	48
8	96	88	80	72	64
10	120	110	100	90	80
12	144	132	120	108	96
16	192	176	160	144	128
20	240	220	200	180	160
24	288	264	240	216	192
Re	**1.00**	**0.95**	**0.90**	**0.85**	**0.80**

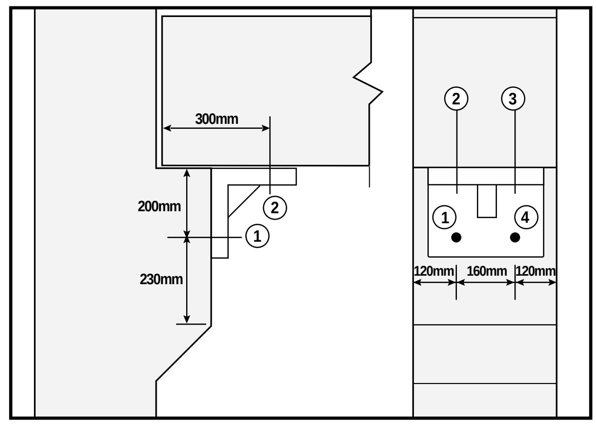
Edge Distance - Shear Loads

For female style anchors, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum shear load. The minimum recommended edge distance, E, is 8 anchor diameters (8d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance E (mm) Shear Only				
d (mm)	12d	11d	10d	9d	8d
6	72	66	60	54	48
8	96	88	80	72	64
10	120	110	100	90	80
12	144	132	120	108	96
16	192	176	160	144	128
20	240	220	200	180	160
24	288	264	240	216	192
Re	**1.00**	**0.88**	**0.75**	**0.63**	**0.50**

2.9.7 Design Example

The following example is provided as a reference to familiarize the designer with the use of spacing and edge distance reduction factors. In this application, a steel angle is to be fastened to a 40MPa precast structure to reinforce the existing column and beam connections as shown in the following diagram. The designer has previously calculated the service loads and would prefer to use 4 anchors. Based on the calculations, the required service loads for an anchor at location No. 1 would be 6.7 kN in tension and 9.8 kN in shear. The Power-Bolt anchor has been selected because of the finished appearance and its resistance to vibratory loads.



For an installation in 40MPa concrete, the following information is obtained from the load capacity chart for the carbon steel Power-Bolt anchor.

Anchor diameter:	20mm
Embedment depth:	125mm
Ultimate Tension Load:	80.3 kN
Ultimate Shear Load:	137.5 kN

If a safety factor of 4 is used, then the maximum allowable working load would be calculated as follows:

Maximum Allowable Tension = 80.3 ÷ 4 = 20.08 kN

Maximum Allowable Shear = 137.5 ÷ 4 = 34.38 kN

The spacing and edge distance factors would be applied as follows. For anchor No. 1, the reductions which should be applied are for the influence of the spacing from anchor No. 4 and two edge distance influences.

Allowable Tension Load

From the spacing table for **Tension and Shear**, the reduction factor, Rs = 0.80 for a 160mm spacing.

For edge distance the factors are taken from the table labeled **Tension Only**. For the 200mm edge distance, Re = 0.94 while Re = 0.83 for the 120mm edge distance.

The allowable tension load based on the reduction factors is calculated as follows:

Allowable Load = 20.08 x 0.80 x 0.94 x 0.83 = 12.52 kN

Allowable Shear Load

From the spacing table for **Tension and Shear**, the reduction factor, Rs = 0.80 for a 160mm spacing.

For edge distance, the reduction factors are taken from the table labeled **Shear Only**. For the 200mm edge distance, Re = 0.86 while Re = 0.57 for the 120mm edge distance.

The allowable shear load based on the reduction factors is calculated as follows:

Allowable Shear = 34.38 x 0.80 x 0.86 x 0.57 = 13.48 kN

Combined Loading

Once the allowable load capacities are established including the effects of spacing and edge distance, the combined loading formula should be checked.

$$\left(\frac{6.7}{12.52}\right)^{5/3} + \left(\frac{9.8}{13.48}\right)^{5/3} < 1$$

0.35 + 0.59 = 0.94 < 1 , OK.

The design approach would be similar for the remainder of the anchors.

2.9.8 Anchors For Use In Seismic Design

Seismic design requires that building structures resist the effects of ground motion induced by an earthquake.

Seismic design is complex as it considers several influencing factors some of which are: site geology and soil characteristics, building occupancy categories, building configuration, structural systems, and lateral forces. Lateral forces are critical because of an earthquakes tendency to shake the building structure from side to side.

Anchors to be used for seismic loads will not be fully loaded in place until an earthquake occurs. There are no “seismic approvals" for anchoring products due to the many different application situations.

2.10 Installation Criteria

As with any building component, proper installation is the key to a successful application once the anchor has been properly selected.

2.10.1 Drilled Hole

A properly drilled hole is a critical factor both for ease of installation and optimum anchor performance. The anchors selected and the drill bits to be used should be specified as part of the total anchoring system. Powers anchors are designed to be installed in holes drilled with carbide tipped bits meeting the requirements of ISO/DIN Standard 8035 unless otherwise specified. If alternate bit types are used, the tip tolerance should be within the ISO/DIN range. The following table lists the nominal drill bit diameter along with the tolerance range established by ISO/DIN for the carbide tip.

Normal Drill O.D.	ISO/DIN Standard	Normal Drill O.D.	ISO/DIN Standard
5.0	5.15 - 5.40	18.0	18.20 - 18.50
5.5	5.65 - 5.90	19.5	19.21 - 19.55
6.0	6.15 - 6.40	29.0	20.21 - 20.55
6.5	6.65 - 6.90	21.0	21.21 - 21.55
7.0	7.20 - 7.45	22.0	22.21 - 22.55
8.0	8.20 - 8.45	23.0	23.21 - 23.55
8.5	8.70 - 8.95	24.0	24.21 - 24.55
9.0	9.20 - 9.45	25.0	25.21 - 25.55
10.0	10.20 - 10.45	26.0	26.21 - 26.55
10.5	10.70 - 10.95	28.0	28.21 - 28.55
11.0	11.20 - 11.50	30.0	30.21 - 30.55
12.0	12.20 - 12.50	32.0	32.25 - 32.70
13.0	13.20 - 13.50	35.0	35.25 - 35.70
14.0	14.20 - 14.50	38.0	38.25 - 38.70
15.0	15.20 - 15.50	40.0	40.25 - 40.70
16.0	16.20 - 16.50	44.0	44.25 - 44.80
17.0	17.20 - 17.50	50.0	50.25 - 50.80

When drilling an anchor hole using a carbide tipped bit, the rotary hammer or hammer drilled used transfers impact energy to the bit which forms the hole primarily due to a chiseling action. This action forms an anchor hole which has roughened walls. If diamond tipped core bits are used, the expansion portion of mechanical anchors should not be installed in holes drilled with this type of bit unless testing has been conducted to verify performance. Adhesive anchors should also be tested. A diamond tipped bit drills a hole which has very smooth walls causing some anchor types to slip and fail prematurely.

During the drilling operation, bit wear should be monitored to insure that the carbide tip does not wear below the following limits to insure proper anchor functioning. This is especially important when using mechanical anchors. Generally, mechanical anchors can be installed in holes drilled with bits which have worn to the lower limit and proper functioning can be expected. However, this may vary depending upon the base material so these values should be used as a guide.

Normal Drill O.D.	Lower Wear Limit
5.0	4.95
6.0	5.95
6.5	6.45
7.0	6.97
8.0	7.97
10.0	9.97
11.0	10.97
12.0	11.97

Normal Drill O.D.	Lower Wear Limit
13.0	12.95
15.0	14.95
16.0	15.45
18.0	17.95
20.0	19.96
24.0	23.88
25.0	24.88
28.0	27.83

Anchor holes should be drilled to the proper depth which is based on the anchor style. The recommended drilling depth is listed in the installation instructions for the individual products. For one-step style anchors such as the Power-Bolt or SPIKE, the depth of the hole should be at least 12mm or one anchor diameter deeper than the embedment depth to which the anchor will be installed. For example, the hole depth for a 20mm diameter Through Bolt anchor which will be installed at a 100mm embedment should be drilled at least 120mm deep. When a one-step anchor such as a wedge style is installed, the expansion mechanism scrapes the walls of the anchor hole. This scraping action pushes concrete dust particles ahead of the anchor. When using this style of anchor, the purpose of drilling the anchor hole to the recommended depth is to allow a place for the dust to settle as the anchor is installed.

Anchor holes should be thoroughly cleaned prior to installation of the anchor. This procedure is easily accomplished using compressed air or a vacuum. Dust and other debris must be removed from the hole to allow an anchor to be installed to the required embedment and to insure that the expansion mechanism can be properly actuated. Extra care should be taken when using adhesives including brushing of the anchor hole to insure that a proper bond is developed.

2.10.2 Clearance Holes

Powers anchors are designed to be installed in holes drilled in concrete and masonry base materials with carbide tipped drill bits meeting the requirements of ISO/DIN Standard 8035 as listed in the previous section. The actual hole diameter drilled in the base material using an ISO/DIN Standard carbide tipped bit is larger than the nominal diameter. For example, a 12mm nominal diameter drill bit has an actual O.D. of 12.20mm to 12.50mm. When selecting the diameter of the hole to be pre-drilled in a fixture, the diameter of the hole selected should allow for proper anchor installation. For through fixture installations, it is necessary to pre-drill a minimum clearance hole in the fixture which is large enough to allow the carbide tipped bit and the anchor to pass through. As in all applications, the design professional responsible for the installation should determine the clearance hole to be used based on the anchor selected and relevant code requirements.

2.10.3 Installation Torque

Certain anchor styles, sometimes referred to as torque controlled anchors, are actuated by tightening a bolt or nut. For typical field installations, the commonly recommended tightening procedure for anchors such as the Through Bolt or Power-Bolt is to apply 3 to 4 turns to the head of the bolt or nut from the finger tight position. This is usually sufficient to initially expand the anchors and is standard industry practice.

In some cases, it may be desirable to specify an installation torque for an anchor. The frictional characteristics which govern the torque-tension relationship for an anchor will vary depending upon the anchor type and the base material. Other factors which may effect the relationship are the effects of fixture coatings or platings, lubrication of the anchor components due to the use of sealants around the anchor hole, and the anchor material. Powers publishes guide installation torque values for anchors which must be actuated by tightening a bolt or nut. These values are based on standard product installations and should be used as a guideline since performance may vary depending upon the application. For other anchor types, a maximum torque may be published for use as a guide to prevent overloading when applying a clamping force to a fixture. These values may have to be reduced for installations in masonry materials.

To establish application specific installation torque values, a job site test is recommended. A typical procedure includes the following. Install the anchor duplicating the actual application. Using a torque wrench, apply the recommended number of full turns from the finger tight position. The number of turns may vary depending upon the base material strength. Upon completion of the final turn, record the torque reading from the wrench. This should be performed on a minimum sample of 5 anchors averaging the results to establish an installation torque range.

If previously installed anchors are to be inspected using a torque wrench, it should be noted that anchors experience a relaxation of preload which begins immediately after tightening due to creep within the concrete or masonry material. This phenomena is discussed in Section 2.5.4. The torque value measured after installation is typically 50% of that initially applied to set the anchor.

3.0 Standards And Specifications

The following listings are provided for reference purposes and contain some of the standards and specifications commonly referenced in this manual and in the industry.

American Concrete Institute (ACI)

P.O. Box 19150
22400 West Seven Mile Road
Detroit, MI 48219
313-532-2600

Manual of Concrete Practice

ACI 318 Building Code Requirements For Reinforced Concrete

American Institute Of Steel Construction (AISC)

One East Wacker Drive, Suite 3100
Chicago, Il 60601-2001
312-670-5402

Manual Of Steel Construction

American Iron And Steel Institute (AISI)

1133 15th Street, N.W.
Washington, D.C. 20005-2701
202-452-7100

Specification For The Design Of Cold-Formed Steel Structural Members

American Society of Testing And Materials (ASTM)

1916 Race Street
Philadelphia, PA 19103-1187
215-299-5400

A 36	Structural Steel
A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
A 193	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
A194	Carbon and Alloy Steel nuts for Bolts for High-Pressure and High-Temperature Service
A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile
A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 446	Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
A 449	Quenched and Temperature Steel Bolts and Studs
A 493	Stainless and Heat-Resisting Steel for Cold Heading and Cold Forging Bar and Wire
A 525	General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process
A 563	Carbon and Alloy Steel Nuts
A 611	Steel, Sheet, Carbon, Cold-Rolled, Structural Quality
A 615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
B 86	Zinc-Alloy Die Casting
B 117	Method Of Salt Spray (Fog) Testing
B 633	Electrodeposited Coatings of Zinc on Iron and Steel
B 695	Coatings of Zinc Mechanically Deposited on Iron and Steel
C 31	Making and Curing Concrete Test Specimens in the Field
C 33	Concrete Aggregates
C 34	Structural Clay Load-Bearing Wall Tile
C 36	Gypsum Wallboard
C 39	Compressive Strength of Cylindrical Concrete Specimens
C 56	Structural Clay Non-Load-Bearing Tile
C 62	Building Brick (Solid Masonry Units Made from Clay or Shale)
C 90	Load-Bearing Concrete Masonry Units
C 150	Portland Cement
C 119	Terminology Relating to Dimensional Stone
C170	Compressive Strength of Dimensional Stone
C 212	Structural Clay Facing Tile
C 216	Facing Brick (Solid Masonry Units Made from Clay or Shale)
C 317	Gypsum Concrete
C 330	Lightweight Aggregates for Structural Concrete
C 332	Lightweight Aggregates for insulating Concrete
C 476	Grout for Masonry
C 503	Marble Dimension Stone (Exterior)
C 568	Limestone Dimension Stone
C 615	Granite Dimension Stone
C 616	Quartz-Based Dimension Stone
C 652	Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
C 881	Epoxy-Resin-Base Bonding Systems for Concrete
E 380	Use of The International System of Units (SI)
E 488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
E 1512	Methods of Testing Bond Performance of Adhesive-Bonded Anchors
F 436	Hardened Steel Washers
F 593	Stainless Steel Bolts, Hex Cap Screws, and Studs
F 594	Stainless Steel Nuts
F 844	Washers, Steel, Plain (Flat), Unhardened for General Use

Factory Mutual Research Corporation (FMRC)

1151 Boston-Providence Turnpike
Norwood, MA 02062
(617) 762-4300

FMRC Approval Standard 4450, Class I Insulated Steel Deck Roofs

FMRC Approval Standard 4470, Class I Roof Covers

FMRC Approval Standard for Pipe Hanger Components

for Automatic Sprinkler Systems.

International Conference Of Building Officials (ICBO)

5360 South Workman Mill Road
Whittier, CA 90601
(213) 699-0543

AC 01 Acceptance Criteria For Expansion Anchors In Concrete and Masonry Elements

Uniform Building Code - 1994 Edition

Underwriters Laboratories (UL)

333 Pfingsten Road
Northbrook, IL 60062-2096
(708) 272-8800

UL 203 Pipe Hanger Equipment for Fire Protection Service

British Board of Agrément

(BBA) Approved Rawlplug Test Procedures.

Rawlplug structural fixings have been tested in accordance with;

1 British Board of Agrément M.O.A.T. No.19 1981. “The Assessment of Torque Expanded Anchor Bolts when used in Dense Aggregate Bolts Concrete”.

2 UEAtc M.O.A.T. No.42 1986 “Directives for Assessment of Anchor Bolts”.

3 EEAtc M.O.A.T. No.49 1992: UEAtc Technical Guide on anchors for use in cracked and non-cracked concrete.

4 British Standard 5080 Part 1 and 2 1982, “Methods of Test for Structural Fixings in Concrete and Masonry” - Part 1 Tensile Loading, Part 2 Shear Loading.

4.0 Approvals, Listings, and Evaluations

Approvals, listings, and applicable GSA Specifications for Powers products are listed below for reference purposes. Current approvals should be reviewed by the design professional responsible for the product installation to determine the approved sizes, installation methods, and compliance with local codes.

Factory Mutual Research Corporation

The following products have been approved based on the FMRC Approval Standard for Pipe Hanger Components for Automatic Sprinkler Systems with sizes as listed in the current Factory Mutual Approval Guide.

Concrete Decks	
Hollow Set Drop-In	Serial No. 15219/1952
Power-Bolt	J.I. 1K8A3.AH
SPIKE (Pipe Version)	J.I. ON5A1.AH

International Conference Of Building Officials (ICBO)

ICBO Evaluation Service Report No. 4514

Power-Bolt, SPIKE, Hollow Set Drop-In, and Powerfast Epoxy Injection Gel.

ICBO Evaluation Service Report No. 4803

Powerfast Epoxy Injection Gel Anchoring System For Use In Unreinforced Masonry Walls.

Underwriter's Laboratories (UL)

File No. EX 1289 (N)

The following products have been tested according to UL Standard 203 and are listed in the UL Fire Protection Equipment Directory.

Hollow Set Drop-In and Power-Bolt.

Warrington Fire Resistance tests

Report No.	F91702 (Socket Anchor)
	F91716 (Safety + Anchor)
	F91703 (Safety + Anchor)
	C91402 (Safety + Anchor)
	F91763 (Power-Bolt)

Work Cover NSW Approval

Power-Bolt Ref: 20243LS1

Workplace Standards Authority

Power-Bolt Ref: G502

Other Evaluations

Contact Powers for evaluations that may not be listed above.

5.0 Conversion Factors

The International System of Units known as the modernized metric system was developed by the General Conference on Weights and Measures. The international abbreviation used for this system is SI (System International) based on the original French name. Use of SI units is described in ASTM Standard E 380.

Conversion from imperial to metric sizes may be done using a “hard" or “soft" method depending upon the accuracy required. In many instances, anchoring and fastening products are converted using the "soft" method. Examples of both methods are shown in the following table.

Imperial System	Hard Metric Conversion	Soft Metric Conversion
1/4"	6.35 mm	6.5 mm
5/16"	7.94 mm	8 mm
3/8"	9.52 mm	10 mm
1/2"	12.70 mm	13 mm
5/8"	15.88 mm	16 mm
3/4"	19.05 mm	20 mm
1"	25.40 mm	26 mm
1-1/4"	31.75 mm	32 mm

The following tables list factors for conversion from both metric to imperial and imperial to metric units. For quick reference, they are grouped by commonly used terms in anchor and fastener design technology.

Imperial Units to Metric Units

To Convert From	To	Multiply By
	Length	
Inch (in)	Millimeter (mm)	25.4
Foot (ft)	Meter (m)	0.3048
Yard (yd)	Meter (m)	0.9144
Mile [statute](mi)	Kilometer (km)	1.6093
	Area	
Square inch (in²)	Square centimeter (cm²)	6.4516
Square foot (ft²)	Square meter (m²)	0.0929
Square yard (yd²)	Square meter (m²	0.8361
	Volume	
Ounce [US] (oz. fl.)	Cubic centimeter (cm³)	29.5729
Cubic inch (in³)	Cubic centimeter (cm³)	16.3871
Gallon [US] (US gal)	Cubic meter (m³)	0.0037
Cubic foot (ft³)	Cubic meter (m³)	0.0283
Cubic yard (yd³)	Cubic meter (m³)	0.7646
	Force	
Pound force (lbf)	Newton (N)	4.4482
Kilo-pound (kip)	Kilonewton (kN)	4.4482
Pound force (lbf)	Kilonewton (kN)	0.0045
	Pressure	
Kilo-pound/square inch (ksi)	MegaPascal (MPa)	6.8947
Pound/square foot (psf)	Pascal (Pa)	47.8803
Pound/square inch (psi)	MegaPascal (MPa)	0.0069
Pound/square inch (psi)	KiloPascal (KPa)	6.8947
Pound/square inch (psi)	Newton/Square millimeter (N/mm²)	0.0069
	Bending Moment or Torque	
Foot-pound (ft-lbs)	Newton meter (Nm)	1.3558
Inch-pound (in-lbs)	Newton meter (Nm)	0.1130

Metric Units to Imperial Units

To Convert From	To	Multiply By
	Length	
Millimeter (mm)	Inch (in)	0.0394
Meter (m)	Foot (ft)	3.2808
Meter (m)	Yard (yd)	1.0936
Kilometer (km)	Mile [statute] (mi)	0.6214
	Area	
Square centimeter (cm²)	Square inch (in²)	0.1550
Square meter (m²)	Square foot (ft²)	10.7639
Square meter (m²)	Square yard (yd²)	1.1960
	Volume	
Cubic centimeter (cm³)	Ounce [US] (oz fl)	0.0338
Cubic centimeter (cm³)	Cubic inch (in³)	0.0610
Cubic meter (m³)	Gallon (US gal)	264.1721
Cubic meter (m³)	Cubic foot (ft³)	35.3144
Cubic meter (m³)	Cubic yard (yd³)	1.3080
	Force	
Newton (N)	Pound force (lbs)	0.2248
Kilonewton (kN)	Kilo-pound (kip)	0.2248
Kilonewton (kN)	Pound force (lb)	224.8
	Pressure	
MegaPascal (MPa)	Kilo-pound/square inch (ksi)	0.1450
MegaPascal (MPa)	Pound/square inch (psi)	145.0
Pascal (Pa)	Newton/square meter (N/m²)	1.0
Pascal (Pa)	Pound/square foot (psf)	0.0208
KiloPascal (kPa)	Pound/square inch (psi)	0.1450
Newton/Square millimeter (N/mm²)	Pound/square inch (psi)	145.0
	Bending Moment or Torque	
Newton meter (Nm)	Foot-pound (ft-lbs)	0.7375
Newton meter (Nm)	Inch-pound (in-lbs)	8.8500

Useful Conversion Factors

Loads

1kN	=	1000N		
1kN	=	224.8lbf	=	102.0kgf
1kgf	=	9.807N	=	2.205lbf
1lbf	=	4.448N	=	0.454kgf
1tonf	=	2240lbf	=	9.964kN
1Pa	=	1N/m²		
1MPa	=	1N/mm²		

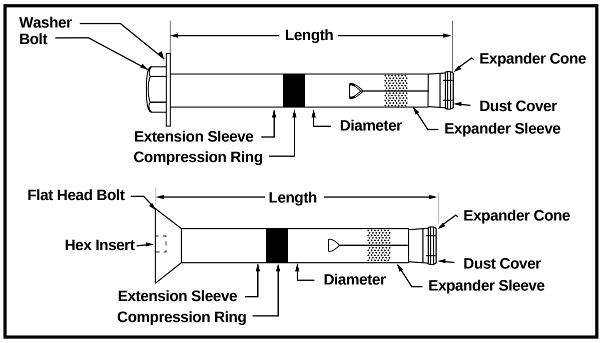
6.0 Power-Bolt

6.1 Introduction

The Power-Bolt Anchor is a heavy duty sleeve style undercut anchor which is vibration resistant and removable. This anchor bolt assembly is available with a finished hex head or flat head with a hex key insert and can be used in concrete, block, brick, or stone.

6.2 Product Description

The nominal diameter of the Power-Bolt anchor is the same as that for the hole, which eliminates layout or hole-spotting. As the anchor is driven into the hole, the slotted, over-sized annular ring on the bottom of the cone is compressed until it mates perfectly with the hole. This action prevents the anchor from spinning as it is being tightened.



For optimum performance, expansion occurs at two levels within the drilled hole. First, the cone is pulled into the large triple-tined expansion sleeve, developing a mid-level, compression force over a large surface area. Further turning causes the threaded bolt to advance into the threads at the compressed end on the cone, forcing the four sections of the annular ring on the cone outward, driving them into the base material. This action undercuts the base material deep in the hole over a the full 360° area, greatly increasing the holding power of the anchor.

As the bolt enters the compressed threaded area of the cone, tremendous lateral forces are created between the concrete and the mating male and female threads. These forces keep the bolt and cone locked together preventing loosening under even the most severe vibratory conditions.

To further increase vibration resistance, the Power-Bolt is designed to draw the fixture into full bearing against the base material through the action of its unique, flexible, compression ring. As the anchor is being tightened, the nylon compression ring will crush if necessary to tightly secure the fixture against the face of the base material.

6.2.1 Material Specifications

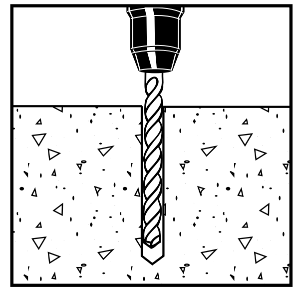
Anchor Component	Component Material		
	Carbon Steel Hex Head	Carbon Steel Flat Head	Stainless Steel Hex Head
Internal Bolt	*Grade 5	*Grade 5	Type 303/4 SS
Washer	AISI 1040	N/A	Type 18-8 SS
Expansion Sleeve	AISI 1010	AISI 1010	Type 304 SS
Extension Sleeve	AISI 1010	AISI 1010	Type 304 SS
Expansion Cone	AISI 12L14	AISI 12L14	Type 303 SS
Compression Ring	Nylon	Nylon	Nylon
Dust Cap	Nylon	Nylon	Nylon
Plating	ASTM B 633, SC1, Type III		N/A

** Grade 5: U.T.S. = 827MPa, Yield Strength = 634MPa*

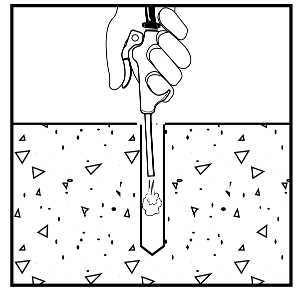
NB: SAE Grade 5 is equivalent to Property Class 8.8 (for bolts & studs)

6.3 Installation Procedures

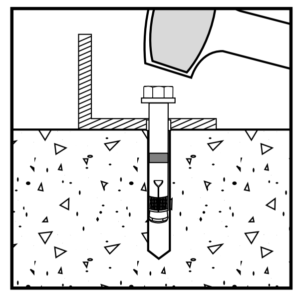
Using the proper diameter bit, drill a hole into the base material to a depth of at least 13mm or one anchor diameter deeper than the embedment required. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035.



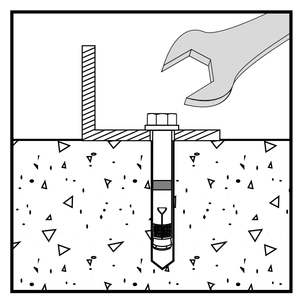
Blow the hole clean of dust and other material. Remove the inspection tag from the anchor and position the fixture. Do not expand the anchor prior to installation.



Drive the anchor through the fixture into the anchor hole until the bolt head is firmly seated against the fixture. Be sure the anchor is driven to the required embedment depth.

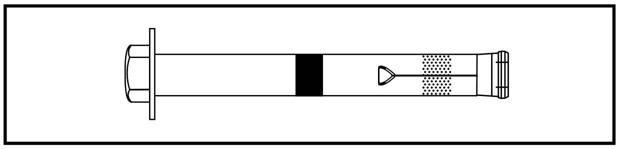


Tighten the anchor by turning the head 3 to 4 turns or by applying the guide installation torque from the finger tight position.



6.4 Anchor Sizes and Styles

The following tables list the sizes and styles of standard Power-Bolt anchors. The anchor length published for the Hex Head Power-Bolt is measured from below the washer. On the Flat Head style, the length is measured end to end. To select the proper length, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth. This will be the minimum anchor length required.

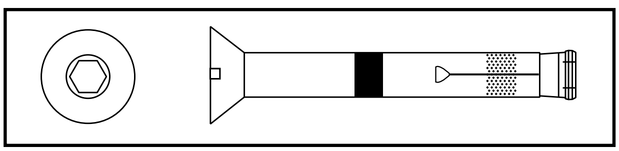


Carbon Steel Hex Head Power-Bolt®

Carbon steel Power-Bolt Anchors are manufactured using a Grade 5 bolt. They are plated with a commercial bright zinc finish and have a supplementary chromate treatment in accordance with ASTM Specification B 633.

Cat. No.	Part No.	Size (mm)	Drill Dia.	Bolt Size	Min. Depth	Fixture Clearance Hole
1268	RBHM1057	10 x 57	10mm	5/16˝	50mm	12mm
1226	RBHM1075	10 x 75	10mm	5/16˝	50mm	12mm
1269	RBHM1089	10 x 89	10mm	5/16˝	50mm	12mm
1227	RBHM10100	10 x 100	10mm	5/16˝	50mm	12mm
1228	RBHM1370	13 x 70	13mm	3/8˝	65mm	15mm
1270	RBHM1395	13 x 95	13mm	3/8˝	65mm	15mm
1271	RBHM13121	13 x 121	13mm	3/8˝	65mm	15mm
1229	RBHM1675	16 x 75	16mm	1/2˝	70mm	18mm
01287	RBHM1685	16 x 85	16mm	1/2˝	70mm	18mm
1225	RBHM16100	16 x 100	16mm	1/2˝	70mm	18mm
1273	RBHM16125	16 x 125	16mm	1/2˝	70mm	18mm
1274	RBHM16150	16 x 150	16mm	1/2˝	70mm	18mm
1276	RBHM2083	20 x 83	20mm	5/8˝	75mm	22mm
1277	RBHM20108	20 x 108	20mm	5/8˝	75mm	22mm
1278	RBHM20133	20 x 133	20mm	5/8˝	75mm	22mm
1279	RBHM20184	20 x 184	20mm	5/8˝	75mm	22mm
1281	RBHM26150	26 x 150	26mm	3/4˝	110mm	30mm
1282	RBHM26175	26 x 175	26mm	3/4˝	110mm	30mm
1283	RBHM32175	32 x 175	32mm	1˝	150mm	35mm
1284	RBHM32225	32 x 225	32mm	1˝	150mm	35mm

The published length is measured from below the washer to the end of the anchor.



Carbon Steel Flat Head Power-Bolt®

The flat head Power-Bolt has a hex key insert formed in the head of the bolt. Each box contains an allen wrench which matches the insert size.

Cat. No.	Part No.	Size (mm)	Drill Dia.	Bolt Size	Min. Depth	Fixture Clearance Hole
1230	RBCSKM1095	10 x 95	10mm	5/16˝	50mm	12mm
1231	RBCSKM10125	10 x 125	10mm	5/16˝	50mm	12mm
1285	RBCSKM10150	10 x 150	10mm	5/16˝	50mm	12mm
1232	RBCSKM13125	13 x 125	13mm	3/8˝	65mm	15mm
1233	RBCSKM16140	16 x 140	16mm	1/2˝	70mm	18mm

The published length is the overall length of the flat head anchor.

6.5 Dynamic Loading

Slip Load capacities for carbon steel Power-Bolt

Anchor Hole Size (mm)	Anchor Bolt Size (inches)	Bolt Proof Load (kN)	Rec. Assembly Torque (Nm)	Final Preload (kN)	*Permissible Slip Load (kN)
10	5/16	19.8	45	7.7	5.0
13	3/8	29.4	80	11.5	7.4
16	1/2	53.8	135	21.0	13.7
20	5/8	85.4	160	33.3	21.6
26	3/4	126.0	270	49.1	31.9
32	1	229.0	510	89.3	58.1

NB: The Working Load Conditions of an anchor should never be exceeded.

* Permissible Slip Load = 65% of Final Preload

6.6 Performance Data

The following load capacities are based on testing conducted according to ASTM Standard E 488.

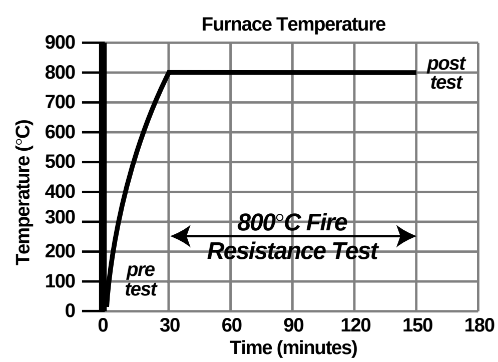
Ultimate Load Capacities for Carbon Steel Power-Bolt®

Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	15 MPa Concrete		30 MPa Concrete		40 MPa Concrete	
			Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)
10	50	45	17.9	29.0	21.5	35.0	23.6	35.0
10	65	45	23.1	32.3	24.9	36.3	27.9	36.8
10	90	45	24.8	39.0	27.4	37.9	33.6	40.3
13	65	80	26.4	42.1	33.0	43.0	33.3	50.7
13	75	80	32.6	45.2	43.5	47.6	46.9	53.4
13	100	80	34.2	51.3	45.9	56.6	48.9	58.8
16	70	135	35.9	66.7	37.5	66.7	41.1	66.7
16	80	135	39.9	88.4	46.6	89.2	53.5	94.9
16	100	135	46.5	89.3	56.4	90.3	69.7	95.8
16	125	135	48.3	90.3	61.7	91.6	75.0	97.0
20	75	160	46.5	89.6	46.6	89.6	49.7	89.6
20	100	160	51.4	102.0	54.9	118.0	62.3	132.5
20	125	160	56.1	112.0	69.8	127.7	80.3	137.5
20	180	160	63.0	132.2	81.0	147.4	107.1	147.5
26	110	270	65.8	133.5	90.7	158.4	113.4	181.5
26	125	270	72.1	156.6	97.0	170.8	119.7	186.8
26	150	270	81.4	164.6	107.7	177.9	127.2	186.8
32	150	510	109.4	236.7	150.4	282.0	194.8	332.7
32	180	510	122.1	257.1	157.9	297.2	202.8	342.5
32	205	510	133.5	266.9	169.0	311.4	214.1	342.5

NOTE: *The load capacities listed above are ultimate or failure loads based on laboratory testing in accordance with ASTM E-488. To calculate the safe or allowable working loads, these capacities should be reduced by a minimum safety factor of four as determined by a design professional.*

6.7 Fire Resistance

The fire resistance of elements in building construction including drilled-in fixings is of significant importance to the overall structural adequacy of a building. Steel drilled-in fixings generally preserve more of their strength than other unprotected elements of a structure under fire. For example: In the event of a large scale fire in a single storey steel framed building consisting of external precast concrete panels, venting available through the roof structure would prevent maximum temperature from reaching both steel connections and drilled-in fixings. As part of a drilled-in fixing is always embedded in concrete, the heat sink effect of both concrete and steel connection ensures that drilled-in fixings are never exposed to the maximum temperature generated in a fire. The Power-Bolt anchor has been fire tested whilst loaded to service limits and achieved the following results.

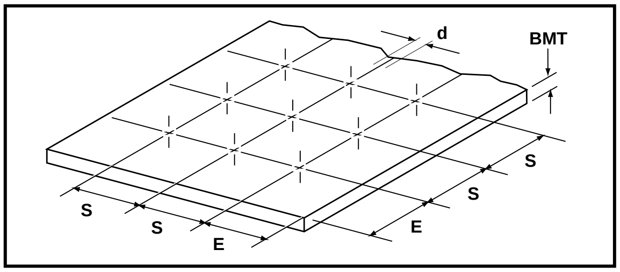


DRILL SIZE (mm)	BOLT SIZE (inches)	EMBED. DEPTH (mm)	SERVICE LOAD (kN)	TEST DURATION (minutes)	FIRE RESISTANCE (minutes)	FURNACE TEMP. °C	MODE OF FAILURE
16	1/2	75	13.4	120	84	800	Bolt head deformation
20	5/8	100	15.6	120	120	800	No failure

NOTE: Anchors were installed in 150mm thick precast concrete panel

Report reference: WFRA No.F91763

6.8 Design Criteria



Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Power-Bolt is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material thickness should be 125mm.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor; Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Hole Size	Anchor Spacing, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
10	100	90	80	70	60	50
13	130	117	104	91	78	65
16	160	144	128	112	96	80
20	200	180	160	140	120	100
26	260	234	208	182	156	130
32	320	288	256	224	192	160
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
10	120	110	100	90	80	70	60	50
13	156	143	130	117	104	91	78	65
16	192	176	160	144	128	112	96	80
20	240	220	200	180	160	140	120	100
26	312	286	260	234	208	182	156	130
32	384	352	320	288	256	224	192	160
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
10	120	110	100	90	80	70	60	50
13	156	143	130	117	104	91	78	65
16	192	176	160	144	128	112	96	80
20	240	220	200	180	160	140	120	100
26	312	286	260	234	208	182	156	130
32	384	352	320	288	256	224	192	160
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

6.9 Approvals and Listings

The following approvals and listings are for reference purposes. They should be reviewed by the design professional responsible for the product installation to verify approved base materials, sizes, and compliance with local codes.

Fire resistance test report No.F91763

Work Cover - NSW (Lift Installations) Ref.20243LS1

Work Place Standards Authority - TAS. (Lift Installation) Ref.G502

ICBO Research Report No. 4514

Factory Mutual J.I. 1K8A3.AH

Underwriter's Laboratories File No. EX 1289 (N)

6.10 Suggested Specification

Carbon Steel Hex Head Power-Bolt

Carbon steel expansion anchors shall be a pre-assembled heavy duty sleeve style undercut anchor with a Grade 5 hex head internal bolt. The anchors shall have a nylon compression ring and an expansion cone with an oversized annular ring which expands to undercut the base material. Carbon steel components shall be plated according to ASTM specification B 633, SC1, Type III. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

Carbon Steel Flat Head Power-Bolt

Carbon steel expansion anchors shall be a pre-assembled heavy duty sleeve style undercut anchor with a Grade 5 flat head internal bolt. The anchors shall have a nylon compression ring and an expansion cone with an oversized annular ring which expands to undercut the base material. Carbon steel components shall be plated according to ASTM specification B 633, SC1, Type III. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

6.11 Limit State Design

Limit State Design Data on the Power-Bolt Anchor is available upon request.

7.0 Safety +

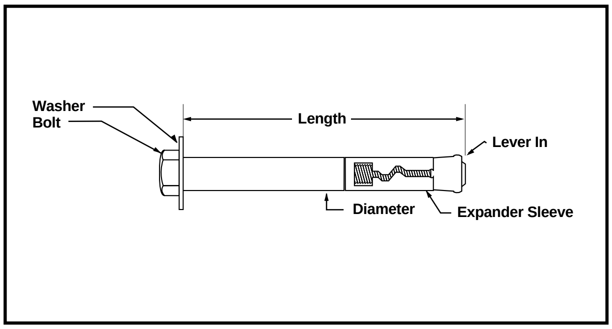
7.1 Introduction

The Safety + Anchor is an all steel heavy duty sleeve style anchor which is vibration resistant and removable. This anchor bolt assembly is available with a finished hex head for use in concrete, block, brick, or stone.

7.2 Product Description

Safety+ is a 'through' fixing, torque controlled, expansion anchor which allows the hole to be drilled through the fixture, eliminating the need for layout or hole spotting.

Integral controlled collapse and anti-rotation features allied to a unique zig-zag interlocking system in the heavy duty expander ensure secure setting even in the tensile zone of reinforced and high strength concrete where cracks may be present. As the anchor is tightened, the case



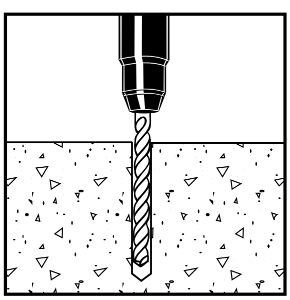
hardened nut is pulled into the interlocking, heavy weight expander sleeve. The expander sleeve has a unique zig-zag design which insures balanced expansion for maximum load bearing in all situations. An integral controlled collapse mechanism insures that fixtures are firmly seated.

7.2.1 Material Specifications

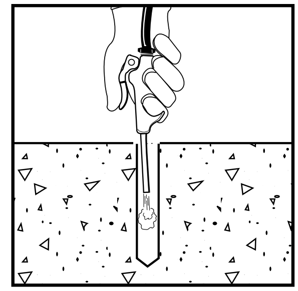
Zinc Plated steel to BS:1706 Class C requirements with a gold Chromate passivation and case hardened taper nut with class 8.8 bolt. Grade 316 S/S also available

7.3 Installation Procedures

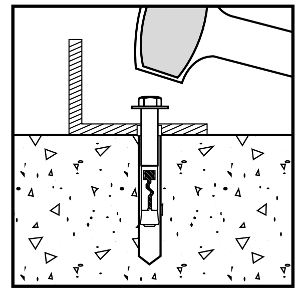
Using the proper diameter bit, drill a hole into the base material to a depth of at least 13mm or one anchor diameter deeper than the embedment required. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035.



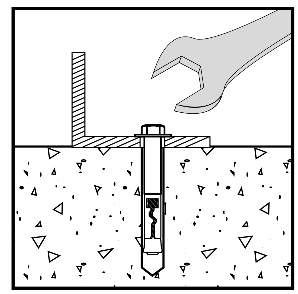
Blow the hole clean of dust and other material. Do not expand the anchor prior to installation.



Drive the anchor through the fixture into the anchor hole until the bolt head is firmly seated against the fixture. Be sure the anchor is driven to the required embedment depth.



Tighten the anchor by turning the head 3 to 4 turns or by applying the guide installation torque from the finger tight position.



7.4 Anchor Sizes and Styles

The following tables list the sizes and styles of standard Safety + Anchors. The anchor length published for the hex head version is measured from below the washer. To select the proper length, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth. This will be the minimum anchor length required.

Carbon Steel Hex Head Safety +

Cat. No.	Part No.	Size (mm)	Drill Dia.	Bolt Size	Min. Depth	Std. Box
50-010	SPM815L	12 x 90	12mm	M8	55mm	50
50-015	SPM840L	12 x 115	12mm	M8	55mm	50
50-020	SPM1020L	15 x 105	15mm	M10	70mm	50
50-025	SPM1040L	15 x 125	15mm	M10	70mm	50
50-035	SPM1225L	18 x 125	18mm	M12	85mm	25
50-040	SPM1250L	18 x 150	18mm	M12	85mm	25
50-050	SPM1625L	24 x 145	24mm	M16	100mm	10
50-055	SPM1650L	24 x 170	24mm	M16	100mm	10
50-065	SPM2030L	28 x 175	28mm	M20	155mm	10
50-070	SPM2060L	28 x 205	28mm	M20	155mm	10
50-075	SPM2080L	28 x 225	28mm	M20	155mm	10

7.5 Performance Data

The following load capacities are based on testing conducted according to the British Board of Agrément (BBA).

Ultimate Load Capacities for Safety +

Anchor (Hole) Size (mm)	Anchor (Bolt) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	30 MPa Concrete	
				Tension (kN)	Shear (kN)
12	M8	55 80	25 25	14.4 23.8	24.4 31.5
15	M10	70 90	50 50	22.8 40.1	38.7 49.3
18	M12	85 105	80 80	31.5 51.8	56.2 68.4
24	M16	100 125	180 180	56.4 80.9	105.0 110.0
28	M20	155	275	115.0	162.0

Allowable Working Load Capacities for Safety +

Anchor (Hole) Size (mm)	Anchor (Bolt) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	30 MPa Concrete	
				Tension (kN)	Shear (kN)
12	M8	55 80	25 25	4.8 7.9	7.0 10.5
15	M10	70 90	50 50	7.6 13.3	11.0 16.4
18	M12	85 105	80 80	10.5 17.3	16.0 22.8
24	M16	100 125	180 180	18.8 26.9	30.0 36.7
28	M20	155	275	38.3	54.0

Dynamic Loading

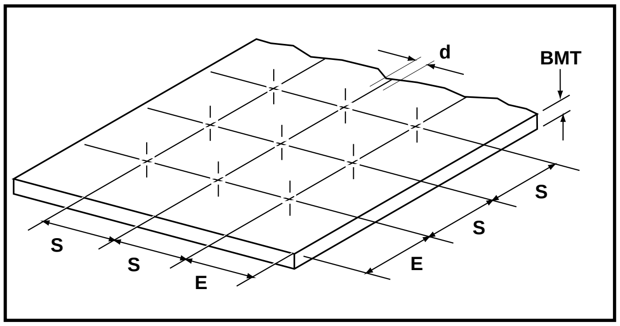
Slip Load Capacities for Safety + (30 MPa Concrete)

Anchor Bolt Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	*Final Preload (kN)	*Permissible Slip Load (kN)	Data Source
M8	55 80	25 25	6.7 11.0	4.4 7.2	CSTB Report Series A1.B
M10	70 90	50 50	8.8 15.5	5.7 10.1	Product 029 Series A1-10
M12	85 105	80 80	15.7 25.6	10.2 16.6	Product 029 Audit 09/5650
M16	100 125	180 180	23.8 33.9	15.5 22.0	Ref. 3-029 Series A1-16
M20	155	275	38.6	25.1	Product 029 Audit 09/5748

Final Preload = Slip Load at 0.1mm displacement

* Permissible Slip Load = 65% of Final Preload

7.6 Design Criteria



Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Safety Bolt is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material thickness should be 125mm. This does not apply to the thickness of the face shell in a hollow block wall.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor; Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Hole Size	Anchor Spacing, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
12	120	108	96	84	72	60
15	150	135	120	105	90	75
18	180	162	144	126	108	90
24	240	216	192	168	144	120
28	280	252	224	196	168	140
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
12	144	132	120	108	96	84	72	60
15	180	165	150	135	120	105	90	75
18	216	198	180	162	144	126	108	90
24	288	264	240	216	192	168	144	120
28	336	308	280	252	224	196	168	140
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
12	144	132	120	108	96	84	72	60
15	180	165	150	135	120	105	90	75
18	216	198	180	162	144	126	108	90
24	288	264	240	216	192	168	144	120
28	336	308	280	252	224	196	168	140
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

7.7 Suggested Specification

Carbon Steel Hex Head Safety+

Carbon steel expansion anchors shall be a pre-assembled heavy duty sleeve style undercut anchor with a Grade 8.8 hex head internal bolt. The anchors shall have a hardened expansion and a zig-zag design expander sleeve with an integral controlled collapse mechanism. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

7.8 Limit State Design

Limit State Design Data on the Safety+ Anchor is Available upon request.

7.9 Approvals

Fire Resistance Test Report

No. F91716

No. F91703

No. C91402

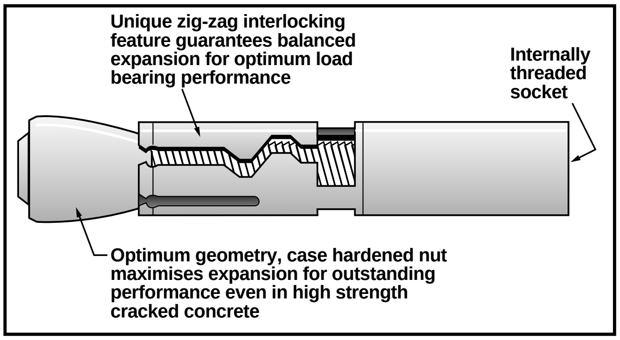
8.0 Socket Anchor

Versatile High Performance Anchor

Powers Socket Anchor is a versatile problem solver for the modern construction industry. It provides a permanent high performance screw socket for a wide variety of studding applications in concrete, rock and other hard substrates.

The Socket Anchor can:

- be set flush to the surface where embedment depth is limited by rebars or substrate thickness.
- be set at depth where high tensile loads are required or where substrates are weak at the surface but have hard strata below.



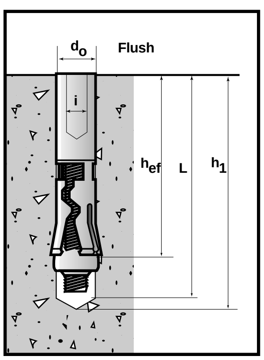
High Performance Anchor

The standard Powers Socket Anchor is made entirely from carbon steel with case hardened taper nuts and a zinc plated, yellow passivated finish.

Used in conjunction with 8.8 grade studs, deep set, the Powers Socket Anchor has been designed to meet the requirements of the european Technical Guidelines for the tensile zone of reinforced high strength concrete, where cracks may occur.

Typical Applications

Ideal for any application where a high tensile load has to be carried. For example starter bar sockets, formwork supports, geological stabilisation (such as in mining and tunnelling projects). An alternative to precast sockets in refurbishment work etc

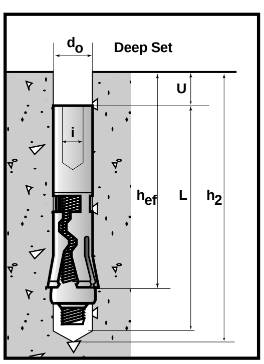


Flush to the substrate surface

4.6 grade studs are recommened where the anchor is installed flush to the substrate surface.

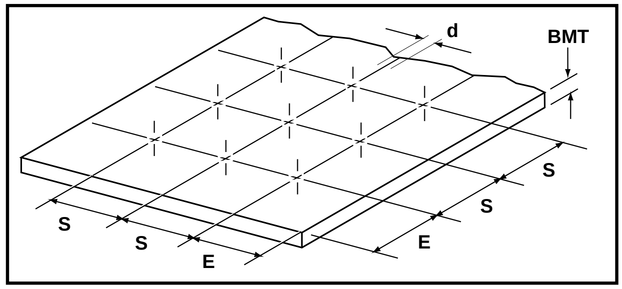
Deep Set Applications below substrate surface

8.8 grade studs are recommended for applications where the anchor is deep set. For deep set applications, the depth of the anchor below the surface (U) should not be less than 15mm for M8 - M12, 20mm for M16 and 30mm for M20.



8.1 Design Criteria

Base Material Thickness



The minimum recommended thickness of base material, BMT, when using the Socket Anchor is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material thickness should be 125mm.

Spacing Between Anchors

To obtain the maximum load in tension, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor; Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Hole Size	Anchor Spacing, S (mm) Tension					
d (mm)	10d	9d	8d	7d	6d	5d
12	120	108	96	84	72	60
15	150	135	120	105	90	75
18	180	162	144	126	108	90
24	240	216	192	168	144	120
28	280	252	224	196	168	140
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
12	144	132	120	108	96	84	72	60
15	180	165	150	135	120	105	90	75
18	216	198	180	162	144	126	108	90
24	288	264	240	216	192	168	144	120
28	336	308	280	252	224	196	168	140
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

8.2 Selection Data

Selection of Socket Anchors can be made using the selection data table. Data is given for set flush to surface and set at depth applications.

Socket Anchors are available in :

- Zinc plated, yellow passivated carbon steel, sizes M8 to M20 as standard.
- Stainless steel and sheradized steel variants, available as specials. Please contact Powers for details.

THREAD SIZE i	ANCHOR LENGTH (MM) L	HOLE DIAMETER (MM) IN SUBSTRATE (MM) d_o	HOLE DIAMETER (MM) MAX IN FIXTURE (MM) d_h	MAXIMUM TIGHTING TORQUE (Nm) 4.6 STUD	MAXIMUM TIGHTING TORQUE (Nm) 8.8 STUD	SET FLUSH TO SURFACE MIN HOLE DEPTH (MM) h_1	SET FLUSH TO SURFACE EFFECTIVE EMBED. DEPTH (MM) h_{ef}	SET AT DEPTH (U) MIN HOLE DEPTH (MM) h_2	SET AT DEPTH (U) EFFECTIVE EMBED. DEPTH (MM) h_{ef}
M8	55	12	10	11	19	65	45	80	60
M10	67	15	12	22	37	75	55	90	70
M12	80	18	14.5	39	65	90	65	105	80
M16	95	24	18.5	96	163	105	80	125	100
M20	115	28	24	187	280	125	95	155	125

8.3 Design Data

The Socket Anchor is designed to carry tensile loads only.

Loads shown are for 30 and 50 MPa concrete. Values shown for flush setting are based on using a grade 4.6 stud, those for deep setting are based on using an 8.8 grade stud.

Tension Loads with anchor set flush to surface

Thread Size i	30 MPa Concrete 4.6 Grade Stud: Allowable working load kN	30 MPa Concrete 4.6 Grade Stud: Ultimate load kN	50 MPa Concrete 4.6 Grade Stud: Allowable working load kN	50 MPa Concrete 4.6 Grade Stud: Ultimate load kN
M8	4.3	15.6	5.9	20.3
M10	5.8	19.9	7.8	25.9
M12	9.2	30.3	12.3	39.4
M16	13.4	42.9	17.7	55.8
M20	17.5	55.0	23.0	71.5

*Tension Loads with anchor set at depth

Thread Size i	30 MPa Concrete 8.8 Grade Stud: Allowable working load kN	30 MPa Concrete 8.8 Grade Stud: Ultimate load kN	50 MPa Concrete 8.8 Grade Stud: Allowable working load kN	50 MPa Concrete 8.8 Grade Stud: Ultimate load kN
M8	7.9	23.8	9.4	30.9
M10	13.3	40.1	16.5	52.1
M12	17.3	51.8	21.6	67.3
M16	26.9	80.9	34.2	105.0
M20	38.3	115.0	49.0	150.0

* Based on the anchor being at a minimum of U mm (see diagram) below the concrete surface i.e., M8 - M12 U = 15mm, M16 U = 20mm and M20 U = 30mm

8.4 Approvals

Fire Resistance Test Report No F91702.

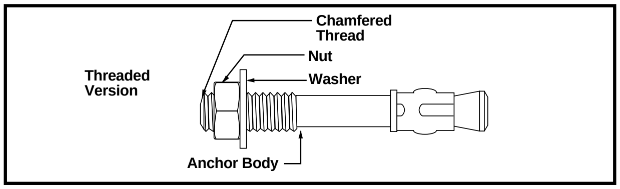
9.0 Through Bolt

9.1 Introduction

The Through Bolt Anchor is a one piece, wedge style anchor available in carbon steel, stainless steel and mechanically galvanized steel.

9.2 Product Description

The Through Bolt anchor diameter is the same as that for the hole size which eliminates the need for hole spotting or layout. It is designed with a chamfer on the threaded end and a tapered expansion section on the working end of the anchor on which a wedge mechanism is mounted.



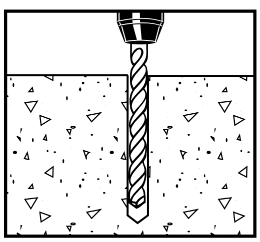
During installation, the chamfer prevents damage to the threads of the anchor. The wedges are held on to the tapered expansion section of the anchor by a band mechanism which grips the anchor body firmly to prevent spinning of the anchor during tightening. As the anchor is tightened, the body is pulled upwards causing the tapered expansion section to compress the wedges circumferentially against the wall of the anchor hole.

9.2.1 Material Specifications

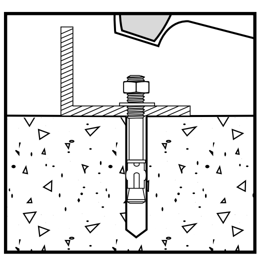
Class 4.6 steel, Zinc plated to BS:1706 Class C requirements with a gold chromate passivation. Also available in stainless steel type 316 and hot dipped galvanized.

9.3 Installation Procedures

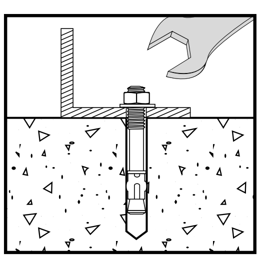
Using the proper diameter bit, drill a hole into the base material to a depth of at least 13mm or one anchor diameter deeper than the embedment required. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035.



Drive the anchor through the fixture into the anchor hole until the nut and washer are firmly seated against the fixture. Be sure the anchor is driven to the required embedment depth.



Tighten the anchor by turning the nut 3 to 4 turns or by applying the guide installation torque from the finger tight position.



9.4 Anchor Sizes and Styles

The following tables list the sizes and styles of standard Through Bolt anchors including zinc plated carbon steel, mechanically galvanized carbon steel, and stainless steel. The anchor length published for the standard threaded Through Bolt is measured end to end. To select the proper length, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth, along with the nut and washer thickness. The nut and washer thickness is equal to the nominal anchor diameter. This will be the minimum anchor length required.

Carbon Steel Through Bolt

Carbon Steel Through Bolt anchors are manufactured from carbon steel which is plated with commercial bright zinc and a supplementary chromate treatment.

Cat. No.	Part No.	Size	Hole Size	Thread Length	Std. Box
56-139	SBA1280	12 x 80mm	12mm	35mm	50
56-140	SBA12100	12 x 100mm	12mm	40mm	25
56-148	SBA12135	12 x 135mm	12mm	40mm	25
56-153	SBA16105	16 x 105mm	16mm	53mm	25
56-152	SBA16140	16 x 140mm	16mm	60mm	25
56-159	SBA20125	20 x 125mm	20mm	65mm	20
56-164	SBA20160	20 x 160mm	20mm	65mm	20

Hot Dipped Galvanized Through Bolt

Hot Dipped Galvanized Through Bolt anchors are manufactured from steel which has a hot dipped galvanized coating.

Cat. No.	Part No.	Size	Hole Size	Thread Length	Std. Box
56-839	SBA1280G	12 x 80mm	12mm	35mm	50
56-840	SBA12100G	12 x 100mm	12mm	40mm	25
56-848	SBA12135G	12 x 135mm	12mm	40mm	25
56-853	SBA16105G	16 x 105mm	16mm	53mm	25
56-852	SBA16140G	16 x 140mm	16mm	60mm	25
56-859	SBA20125G	20 x 125mm	20mm	65mm	20
56-860	SBA20160G	20 x 160mm	20mm	65mm	20

Type 316 Stainless Steel Through Bolt

This version of the Through Bolt is manufactured 100% from Type 316 Stainless Steel for marine and other highly corrosive environments.

Cat. No.	Part No.	Size	Hole Size	Thread Length	Std. Box
56-639	SBA1280SS	12 x 80mm	12mm	35mm	50
56-640	SBA12100SS	12 x 100mm	12mm	40mm	25
56-648	SBA12135SS	12 x 135mm	12mm	40mm	25
56-653	SBA16105SS	16 x 105mm	16mm	53mm	25
56-652	SBA16140SS	16 x 140mm	16mm	60mm	25
56-659	SBA20125SS	20 x 125mm	20mm	65mm	20
56-660	SBA20160SS	20 x 160mm	20mm	65mm	20

9.5 Performance Data

The following load capacities are based on testing conducted according to the British Board of Agrément (BBA).

Ultimate Load Capacities for Throughbolt

Anchor (Hole) Size (mm)	Anchor (Bolt) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	30 MPa Concrete	
				Tension (kN)	Shear (kN)
12	M12	60 80	45 45	19.6 30.5	29.2 32.2
16	M16	80 100	110 110	30.0 47.6	57.8 61.4
20	M20	100 120	180 180	49.7 59.0	85.2 90.0

Allowable working load capacities for the Throughbolt

Anchor (Hole) Size (mm)	Anchor (Bolt) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	30 MPa Concrete	
				Tension (kN)	Shear (kN)
12	M12	60 80	45 45	5.2 9.0	6.5 10.5
16	M16	80 100	110 110	7.1 14.2	12.8 16.3
20	M20	100 120	180 180	13.4 17.5	20.5 24.0

9.6 Design Criteria

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Through Bolt is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material thickness should be 125mm.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor. Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Hole Size	Anchor Spacing , S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
12	120	108	96	84	72	60
16	160	144	128	112	96	80
20	200	180	160	140	120	100
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
12	144	132	120	108	96	84	72	60
16	192	176	160	144	128	112	96	80
20	240	220	200	180	160	140	120	100
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum shear load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size	Edge Distance, E (mm) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
12	144	132	120	108	96	84	72	60
16	192	176	160	144	128	112	96	80
20	240	220	200	180	160	140	120	100
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

9.7 Suggested Specification

Carbon Steel Through Bolt

Carbon steel expansion anchors shall have a one piece anchor body and an expansion mechanism which consists of a band device. Carbon steel components shall be plated according to ASTM specification B 633, SC1, Type III. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

Hot Dipped Galvanized Through Bolt

Carbon steel expansion anchors shall have a one piece anchor body and an expansion mechanism which consists of a band device. Carbon steel components shall be hot dipped Galvanized. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

316 Stainless Steel Through Bolt Anchor

Stainless steel expansion anchors shall have a one piece anchor body manufactured from Type 316 stainless steel. The expansion mechanism shall consist of a band type device. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

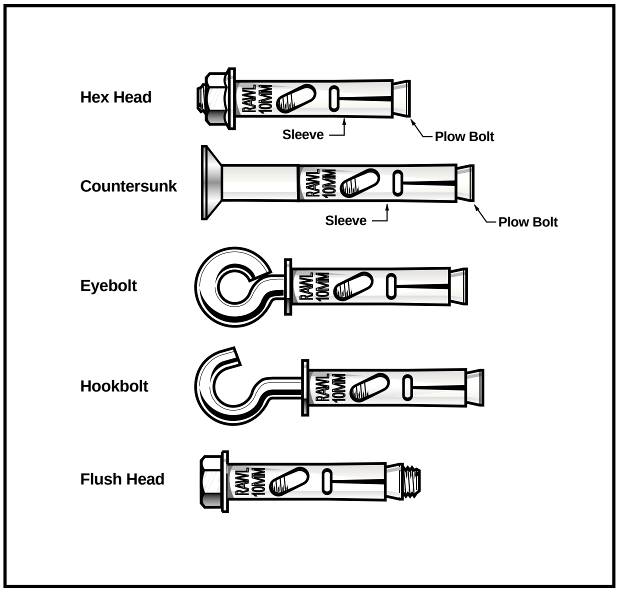
10.0 Sleeve Anchors

10.1 Introduction

The Sleeve Anchors is a pre-assembled single unit sleeve anchor available in carbon steel, stainless steel and hot dipped galvanized which can be used in concrete, block, brick, and stone.

10.2 Product Description

The Sleeve Anchors anchor diameter is the same as that for the hole which eliminates layout or hole spotting. The anchor consists of a threaded plow bolt which has a cone shaped end. Precision stamped tubular expansion sleeves are assembled over the plow bolt and butted



against the cone. Five head styles are available: hex nut/washer, countersunk, eye bolt, hook bolt, and flush head.

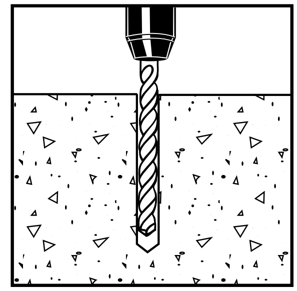
As the anchor is being tightened, the specially tapered plow bolt is drawn into the expansion sleeve to develop a locking action against the walls of the hole.

10.2.1 Material Specification:

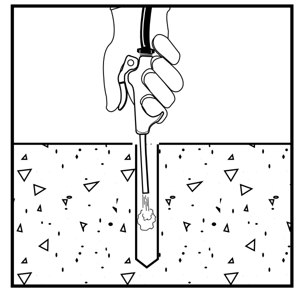
Class 4.6 steel, zinc plated to BS:1706 Class C requirements with gold chromate passivation. Some styles available in stainless steel type 316 and Hot Dipped Galvanized

10.3 Installation Procedures

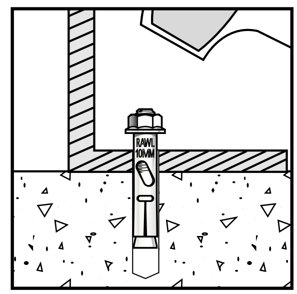
Using the proper diameter bit, drill a hole into the base material to a depth of at least 13mm or one anchor diameter deeper than the embedment required. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035.



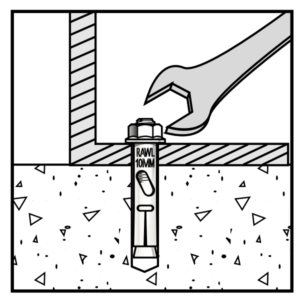
Blow the hole clean of dust and other material. Do not expand the anchor prior to installation.



Drive the anchor through the fixture into the anchor hole until the head is firmly seated against the fixture. Be sure the anchor is driven to the required embedment depth.



Tighten the anchor by turning the nut or head 3 to 4 turns or by applying the guide installation torque from the finger tight position.



10.4 Anchor Sizes and Styles

The following tables list the sizes and styles of Sleeve Anchors. To select the proper length for the hex nut and countersunk, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth along with the nut mechanism. This will be the minimum anchor length required. The eyebolt and hook bolt anchor styles are installed directly into the base material to the minimum required embedment.

Hex Nut mild steel

Cat. No.	Part No.	Size	Hole Size	Min. Embed.	Std. Box
N/A	HS6520	6.5 x 20mm	6.5mm	15mm	100
N/A	HS6525	6.5 x 25mm	6.5mm	15mm	100
N/A	HS6535	6.5 x 35mm	6.5mm	30mm	100
N/A	HS6555	6.5 x 55mm	6.5mm	30mm	100
N/A	HS6575	6.5 x 75mm	6.5mm	30mm	100
69-508	HS0840	8 x 40mm	8mm	35mm	100
69-510	HS0865	8 x 65mm	8mm	35mm	50
69-512	HS0885	8 x 85mm	8mm	35mm	50
N/A	HS1040	10 x 40mm	10mm	35mm	50
69-514	HS1050	10 x 50mm	10mm	40mm	50
N/A	HS1060	10 x 60mm	10mm	40mm	50
69-516	HS1075	10 x 75mm	10mm	40mm	50
69-518	HS1095	10 x 95mm	10mm	40mm	50
69-520	HS1260	12 x 60mm	12mm	50mm	50
69-522	HS1275	12 x 75mm	12mm	50mm	25
69-524	HS12100	12 x 100mm	12mm	50mm	25
69-525	HS12130	12 x 130mm	12mm	50mm	25
69-526	HS1665	16 x 65mm	16mm	55mm	25
69-528	HS16110	16 x 110mm	16mm	55mm	10
69-530	HS16145	16 x 145mm	16mm	55mm	10
69-533	HS2075	20 x 75mm	20mm	60mm	10
69-534	HS20105	20 x 105mm	20mm	60mm	10
69-536	HS20150	20 x 150mm	20mm	60mm	10

The published length is measured from below the washer to the end of the anchor.

Hex Nut All 316 Grade Stainless Steel

Cat. No.	Part No.	Size	Hole Size	Min. Embed.	Std. Box
69-308	HS0840SS	8 x 40mm	8mm	35mm	100
69-314	HS1050SS	10 x 50mm	10mm	40mm	50
N/A	HS1075SS	10 x 75mm	10mm	40mm	50
N/A	HS1095SS	10 x 95mm	10mm	40mm	50
N/A	HS1260SS	12 x 60mm	12mm	50mm	50
69-322	HS1275SS	12 x 75mm	12mm	50mm	25
N/A	HS12100SS	12 x 100mm	12mm	50mm	25

Hex Nut All Galvanized Finish

Cat. No.	Part No.	Size	Hole Size	Min. Embed.	Std. Box
N/A	HS0840G	8 x 40mm	8mm	35mm	100
N/A	HS0865G	8 x 65mm	8mm	35mm	50
N/A	HS0885G	8 x 85mm	8mm	35mm	50
N/A	HS1040G	10 x 40mm	10mm	35mm	50
N/A	HS1050G	10 x 50mm	10mm	40mm	50
N/A	HS1060G	10 x 60mm	10mm	40mm	50
N/A	HS1075G	10 x 75mm	10mm	40mm	50
N/A	HS1095G	10 x 95mm	10mm	40mm	50
N/A	HS1260G	12 x 60mm	12mm	50mm	50
N/A	HS1275G	12 x 75mm	12mm	50mm	25
N/A	HS12100G	12 x 100mm	12mm	50mm	25
N/A	HS12130G	12 x 130mm	12mm	50mm	25
N/A	HS1665G	16 x 65mm	16mm	50mm	25

Countersunk - Mild Steel

Cat. No.	Part No.	Size	Hole Size	Min. Embed.	Std. Box
N/A	FS6536	6.5 x 36mm	6.5mm	30mm	100
N/A	FS6555	6.5 x 55mm	6.5mm	30mm	100
N/A	FS6575	6.5 x 75mm	6.5mm	30mm	100
N/A	FS65100	6.5 x 100mm	6.5mm	30mm	100
N/A	FS0860	8 x 60mm	8mm	35mm	50
N/A	FS0885	8 x 85mm	8mm	35mm	50
N/A	FS1075	10 x 75mm	10mm	40mm	50
N/A	FS10100	10 x 100mm	10mm	40mm	50

For Suspension Applications (mild steel)

Cat. No.	Part No.	Description	Hole Size	Min. Embed.	Std. Box
N/A	EB8045	8 x 45mm Eye Bolt	8mm	45	100
N/A	HB8045	8 x 45mm Hook Bolt	8mm	45	100

NB: Safe working Load of the EB8045 and HB8045 is 50kg.

Flush Head Sleeve Anchor

For details refer to the Powers Buyers Guide

10.5 Performance Data

The following load capacities are based on testing conducted according to the British Board of Agrément (BBA).

Ultimate load capacities for the Sleeve Anchor

Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	30 MPa Concrete	
			Tension (kN)	Shear (kN)
6.5	30	2.5	6.1	4.6
8	35	6.0	9.5	7.3
10	40	11.0	11.2	12.4
12	50	22.0	15.4	19.6
16	55	38.0	18.7	28.5
20	60	95.0	21.1	53.0

Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	20.5 MPa Brickwork	
			Tension (kN)	Shear (kN)
6.5	30	2.5	3.0	6.6
8	35	6.0	4.3	7.1
10	40	11.0	5.9	7.8
12	50	22.0	7.6	8.5
16	55	38.0	9.1	9.2

Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	14 MPa Block Work	
			Tension (kN)	Shear (kN)
6.5	30	1.5	1.7	6.0
8	35	3.0	5.4	7.5
10	40	6.0	6.8	12.8
12	50	11.0	8.7	14.0
16	55	25.0	8.8	18.0

Brick and Blockwork

Note: When fixing into brickwork or blockwork, position the anchor a minimum of 300mm from the vertical edge of the wall and four courses down from the top of an unrestrained wall. Embedment should be limited to within 30mm of the remote face.

Allowable working loads for the Sleeve Anchor

Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	30 MPa Concrete	
			Tension (kN)	Shear (kN)
6.5	30	2.5	1.6	2.0
8	35	6.0	2..3	3.3
10	40	11.0	3.4	5.2
12	50	22.0	4.4	7.5
16	55	38.0	5.3	9.5
20	60	95.0	7.0	16.0

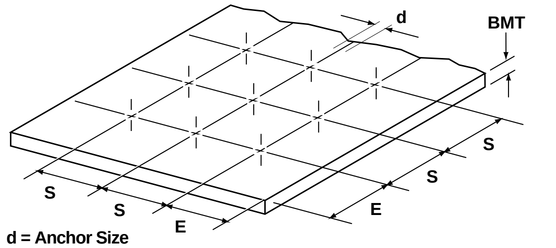
Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	20.5 MPa Brickwork	
			Tension (kN)	Shear (kN)
6.5	30	2.5	0.6	1.4
8	35	6.0	0.9	1.5
10	40	11.0	1.2	1.6
12	50	22.0	1.6	1.7
16	55	38.0	1.9	1.9

Anchor (Hole) Size (mm)	Embed. Depth (mm)	Guide Torque (Nm)	14 MPa Block Work	
			Tension (kN)	Shear (kN)
6.5	30	1.5	0.6	2.0
8	35	3.0	1.6	2.8
10	40	6.0	2.3	3.7
12	50	11.0	3.0	4.5
16	55	25.0	3.0	5.8

10.6 Design Criteria

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Sleeve Anchors is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material thickness should be 125mm. This does not apply to the thickness of the face shell in a hollow block wall.



Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor. Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacings, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
6.5	65	59	52	46	39	33
8	80	72	64	56	48	40
10	100	90	80	70	60	50
12	120	108	96	84	72	60
16	160	144	128	112	96	80
20	200	180	160	140	120	100
Re	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
6.5	78	72	65	59	52	46	39	33
8	96	88	80	72	64	56	48	40
10	120	110	100	90	80	70	60	50
12	144	132	120	108	96	84	72	60
16	192	176	160	144	128	112	96	80
20	240	220	200	180	160	140	120	100
Rs	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum shear load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
6.5	78	72	65	59	52	46	39	33
8	96	88	80	72	64	56	48	40
10	120	110	100	90	80	70	60	50
12	144	132	120	108	96	84	72	60
16	192	176	160	144	128	112	96	80
20	240	220	200	180	160	140	120	100
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

10.7 Suggested Specification

Carbon Steel Sleeve Anchor

Carbon steel expansion anchors shall be a pre-assembled sleeve style anchor with a ________ head. Carbon steel components shall be zinc plated. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

Stainless Steel Sleeve Anchor

Stainless steel expansion anchors shall be a pre-assembled sleeve style anchor with a _________ head. All anchor components should be manufactured from Type 316 stainless steel. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

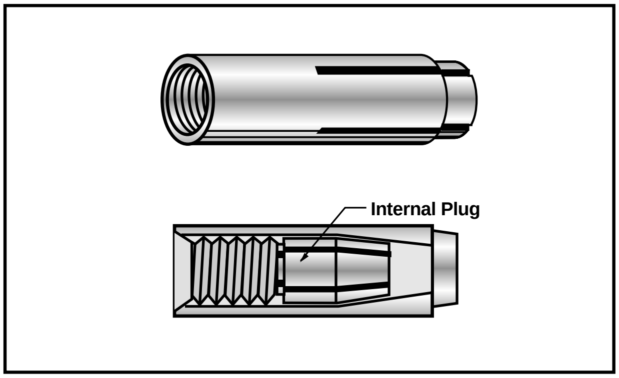
11.0 Wedge Anchor / Drop-In

11.1 Introduction

The Steel Drop-In is an all-steel, machine bolt anchor available in carbon steel and stainless steel. It can be used in solid concrete, hard stone, and solid block.

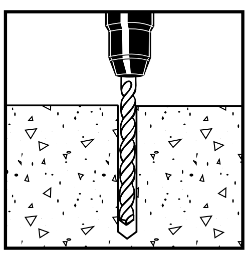
11.2 Product Description

The Steel Drop-In is an internally threaded expansion anchor complete with a pre-assembled integral expander plug. The anchor is expanded with a matching setting tool designed to protect internal threads while driving the pre-fitted plug to the end of the anchor. The tapered plug is precisely matched to the

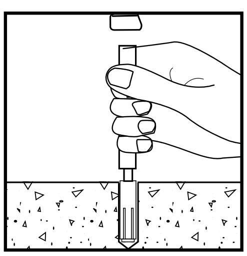


internal configuration of the anchor body to develop maximum expansion against the walls of the hole. Each steel anchor body has 4 slots on the leading end which allows it to expand. During installation, as the plug is driven into the bottom of the anchor, the steel shell is forced outward in four directions compressing against the walls of the anchor hole.

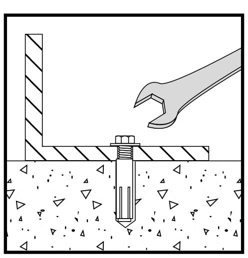
11.3 Installation Procedures



Drill a hole into the base material to the depth of embedment required. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035. Do not over drill the hole unless the application calls for a sub set anchor.



Blow the hole clean of dust and other material. Insert the anchor into the hole and tap flush with the surface. Using a Powers setting tool, set the anchor by driving the tool into the anchor until the shoulder of the tool is seated against the anchor.



If using a fixture, position it, insert bolt or threaded rod and tighten. Minimum thread engagement should be at least 2/3 of the anchor thread length.

11.4 Anchor Sizes and Styles

The following tables list the sizes of Steel Drop-In anchors including both zinc plated carbon steel and stainless steel.

Carbon Steel - Drop-In

Cat. No.	Size	Drill Dia. mm	Min. Depth mm	Thread Depth mm	Std. Box	Std. Ctn.
77-108	M6	8	27	11	100	1000
77-120	M8	10	32	13	100	1000
77-132	M10	12	42	15	50	500
77-141	M12	15	52	20	50	500
77-150	M16	20	67	25	25	250
77-162	M20	25	82	35	25	100

Type 316 Stainless Steel Drop-In

77-608	M6	8	27	11	100	1000
77-620	M8	10	32	13	100	1000
77-632	M10	12	42	15	50	500
77-641	M12	15	52	20	50	500
77-650	M16	20	67	25	25	250

Setting Tools for Internal Plug Drop-In

Cat. No.	Size	Pin Length (mm)
77-208	ST-6	15.5
77-220	ST-8	18.5
77-232	ST-10	24.5
77-241	ST-12	30.5
77-250	ST-16	36.0
77-262	ST-20	50.5

11.5 Installation Specifications

Anchor Size	M6	M8	M10	M12	M16	M20
Drill Bit Size (mm)	8	10	12	15	20	25
Max Torque (Nm.)	4.5	11.0	22.0	38.0	95.0	185.0

11.6 Material Specifications

Anchor Component	Carbon Steel	Type 316 SS Steel
Anchor Body	AISI 12L14	Type 316 SS
Plug	AISI 1018	Type 316 SS
Plating	ASTM B633, SC1, Type III	N/A

11.7 Performance Data

Anchor Size	30 MPa Concrete		
	Safe Working Loads		Ultimate Load
	Tension (kN)	Shear (kN)	Tension (kN)
M6	2.2	1.7	7.2
M8	4.1	3.1	14.1
* M10	3.7	3.5	13.4
M10	5.3	4.0	18.8
M12	6.4	4.8	25.4
M16	9.3	7.0	32.0
M20	12.1	9.1	47.2

* Lipped Drop-In (M10 x 30mm) to be installed using special setting tool.

11.8 Design Criteria

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Steel Drop-In is 125% of the embedment to be used. For example, when installing an anchor to a depth of 42mm, the base material should be at least 53mm thick.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 8 anchor diameters (8d) at which point the load should be reduced by 50%. The following table lists the load reduction factor. Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Hole Size (mm)	Anchor Spacing, S (mm) Tension And Shear					
d	10d	9d	8d	7d	6d	5d
8	80	72	64	56	48	40
10	100	90	80	70	60	50
12	120	108	96	84	72	60
15	150	135	120	105	90	75
20	200	180	160	140	120	100
25	250	225	200	175	150	125
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 8 anchor diameters (8d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size (mm)	Edge Distance, E (mm) Tension Only				
d	12d	11d	10d	9d	8d
8	96	88	80	72	64
10	120	110	100	90	80
12	144	132	120	108	96
15	180	165	150	135	120
20	240	220	200	180	160
25	300	275	250	225	200
Re	**1.00**	**0.95**	**0.90**	**0.85**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 8 anchor diameters (8d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Hole Size (mm)	Edge Distance, E (mm) Shear Only				
d	12d	11d	10d	9d	8d
8	96	88	80	72	64
10	120	110	100	90	80
12	144	132	120	108	96
15	180	165	150	135	120
20	240	220	200	180	160
25	300	275	250	225	200
Re	**1.00**	**0.88**	**0.75**	**0.63**	**0.50**

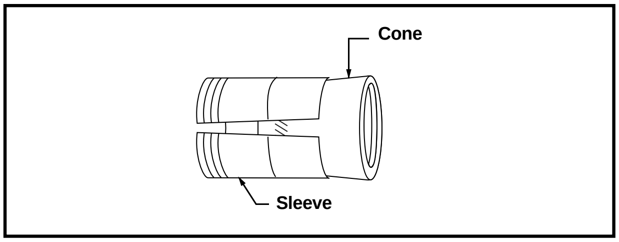
12.0 Hollow Set Drop-In

12.1 Introduction

The Hollow Set Drop-In anchor is designed for anchoring in hollow base materials such as hollow concrete block, brick with weep holes, and hollow core pre-cast concrete plank. It can also be used in solid base materials.

12.2 Product Description

The Hollow Set Drop-In is designed with a slotted, tapered expansion sleeve and a serrated expansion cone. Hollow



masonry materials often have a maximum outer wall thickness of 35mm. During the drilling process, spalling on the back side of the wall as the bit penetrates into the hollow portion of the base material often decreases the wall thickness available for anchoring to 25mm or less. This creates a problem for most conventional style anchors which will not function properly in materials of this thickness.

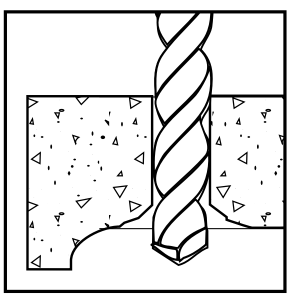
The design of the Hollow Set Drop-In overcomes this problem because the expansion sleeve length is sized to be compatible with outer wall thickness of most hollow base materials. The expansion sleeve has a large radial bearing area which reduces the amount of compression force applied to the base material during the expansion process.

Material Specifications:

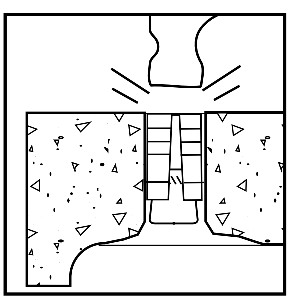
Anchor Body: Zamac 7 Alloy
Cone: AISI 12L14 or 304S/S
Plating (cone): ASTM B 633, SC1 Type III (Zn / Fe)

12.3 Installation Procedures

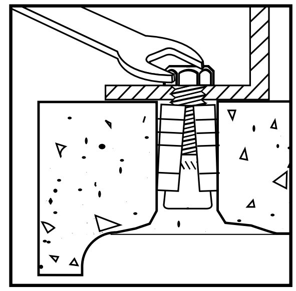
Drill a hole into the base material to the required depth. In hollow base materials, drill through into the cell or void. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035



Blow the hole clean of dust and other material. Do not expand the anchor prior to installation. Insert cone end and tap flush to surface.



Position fixture, insert bolt and tighten. The bolt should engage a minimum of 2/3 of the anchor threads. The anchor can also be expanded using a setting tool.



12.4 Anchor Sizes

The following tables list the sizes of Hollow Set Drop-In anchors. To select the proper length bolt, determine the thickness of the fixture including any spacers or shims. Add this to the depth required to engage at least 2/3 of the threads in the cone.

Part No.	Cat. No.	Anchor Size Inches	Hole Size mm	Overall Length mm	Sleeve Length mm	Std. Box	Std. Ctn.	Wt./ 100
HSDI14	9320	1/4"	10	22	16	100	1000	0.8
HSDI516	9330	5/16"	16	33	24	100	500	2.5
HSDI38	9340	3/8"	16	33	24	100	500	2.5
HSDIM10	N/A	10mm	16	33	24	100	500	2.5
HSDI12	9350	1/2"	20	45	32	100	100	4.3
HSDI58	9360	5/8"	26	50	38	100	100	9.6

Setting Tools

Anchor	1/4”	5/16”	3/8”	1/2”	5/8”
Hollow Tool	9323	9333	9343	9353	9363
Solid Tool	9322	9332	9342	9352	9362

12.5 Performance Data

The following ultimate load capacities are based on testing conducted according to ASTM Standard E 488.

		15 MPa Concrete		30 MPa Concrete		40 MPa Concrete	
Anchor Size	Embed. Depth	Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)
1/4”	22	4.9	6.5	7.4	8.1	9.2	14.0
5/16”	38	12.1	10.2	16.4	11.8	21.7	12.6
3/8” (10mm)	38	13.5	14.1	20.5	18.9	22.8	26.7
1/2”	38	15.3	18.0	26.6	30.6	43.5	49.3
5/8”	56	25.7	39.0	43.3	56.8	57.1	64.1

Ultimate Load Capacities for C-90 Block and Solid Brick

		C-90 Hollow Block	
Anchor Size	Embed. Depth	Tension (kN)	Shear (kN)
1/4”	*22	5.9	7.1
5/16”	*38	13.8	8.1
3/8” (10mm)	*38	15.5	11.1
1/2”	*38	16.0	16.4
5/8”	*38	16.0	16.8

		Solid Red Brick	
Anchor Size	Embed. Depth	Tension (kN)	Shear (kN)
1/4”	22	3.9	7.4
5/16”	38	6.5	10.0
3/8” (10mm)	38	8.3	13.4
1/2”	38	14.5	18.9
5/8”	56	20.9	28.8

*Anchors were installed with sleeve flush to face shell surface.

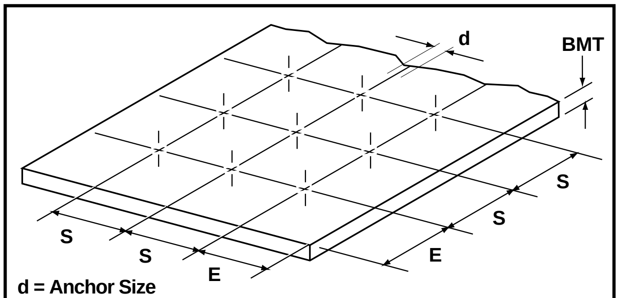
Ultimate Load Capacities for Hollow Core Concrete

Anchor Size	Embed. Depth	30 MPa Hollow Core Concrete	
		Tension (kN)	Shear (kN)
1/4"	*22	10.0	8.1
5/16"	*38	14.7	11.8
3/8" (10mm)	*38	16.2	18.9
1/2"	*38	20.9	30.6
5/8"	*38	43.3	56.8

*Anchors were installed with sleeve flush to surface of the plank.

NOTE: *The values listed above are ultimate load capacities in Kilonewtons for Powers Hollow Set Drop-In anchors. These capacities should be reduced by minimum safety factor of 4 or greater to determine the allowable working load. Refer to the section on Product Selection Guidelines for details. Since the consistency of hollow block and brick varies greatly, these load capacities listed should be used as guidelines only. Job site tests should be conducted to determine the actual load capacities.*

12.6 Design Criteria



d = Anchor Size
S = Spacing
E = Edge Distance
BMT = Base Material Thickness

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Hollow Set Drop-In is 125% of the embedment to be used for solid materials. For hollow materials, a minimum wall thickness of of 35mm is suggested. Job site tests should be performed on installations in hollow base materials.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor. Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacing, S (mm) Tension And Shear					
d	10d	9d	8d	7d	6d	5d
1/4"	65	59	52	46	39	33
5/16"	80	72	64	56	48	40
3/8 (10mm)	100	90	80	70	60	50
1/2"	120	108	96	84	72	60
5/8	160	144	128	112	96	80
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 8 anchor diameters (8d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only				
(mm)	12d	11d	10d	9d	8d
1/4"	78	72	65	59	52
5/16"	96	88	80	72	64
3/8 (10mm)	120	110	100	90	80
1/2"	144	132	120	108	96
5/8	192	176	160	144	128
Re	**1.00**	**0.95**	**0.90**	**0.85**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 8 anchor diameters (8d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Shear Only				
(mm)	12d	11d	10d	9d	8d
1/4"	78	72	65	59	52
5/16"	96	88	80	72	64
3/8 (10mm)	120	110	100	90	80
1/2"	144	132	120	108	96
5/8	192	176	160	144	128
Re	**1.00**	**0.88**	**0.75**	**0.63**	**0.50**

12.7 Approvals and Listings

The following approvals and listings are for reference purposes. They should be reviewed by the design professional responsible for the product installation to verify approved base materials, sizes, and compliance with local codes.

ICBO Research Report No. 4514

Factory Mutual Serial No. 15219 / 1952

Underwriter's Laboratories File EX 1289 (N)

12.8 Suggested Specification

Expansion anchors shall be pre-assembled and shall consist of a tapered, slotted expansion sleeve formed from Zamac 7 alloy in which a threaded steel expansion cone is inserted. The cone shall be zinc plated. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

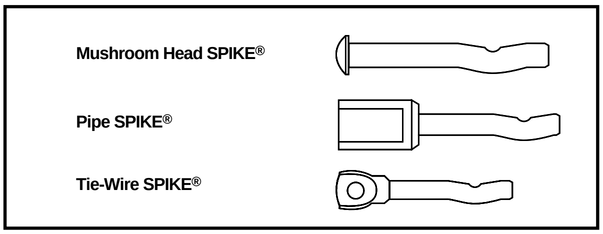
13.0 SPIKE®

13.1 Introduction

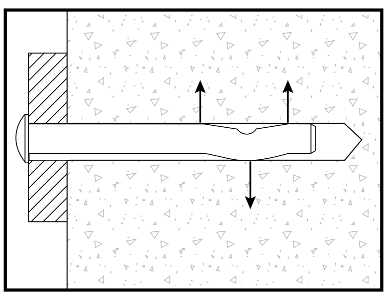
The Powers SPIKE is a patented, one-piece, vibration resistant anchor for use in concrete, block, brick, or stone. Several head styles and anchor materials are available.

13.2 Product Description

Using a special manufacturing process, the SPIKE anchor is formed with an "s" shaped configuration at the working end of the anchor to create an expansion mechanism. The pre-expanded mechanism is activated as the anchor is driven into the drilled hole and creates a spring type compression force against the walls of the hole. To develop the spring action of the expansion mechanism, manufacturing processes such as heat treatment, cold working, die-casting, or injection molding are used depending upon the SPIKE style.



The basic working principle is the same for all versions. As the anchor is driven into the hole, the expansion mechanism is compressed and flexes to accommodate the size of the hole. Once seated at the required embedment, residual spring force developed in the expansion mechanism provides three compression forces at three different levels, at the bottom of the anchor hole. The first level is near the bottom of the anchor hole, with the second and third levels of compression force spaced equidistant above it. When a vibratory load is applied to some anchors, the area of the base material around the expansion mechanism may experience localized pulverization at the point of contact. The Powers SPIKE has been designed to overcome this problem. When subjected to vibratory loads, the SPIKE will expand due to the residual spring action of the expansion mechanism if localized pulverization occurs.



Use of the SPIKE anchor reduces installation time. Since the anchor is pre-expanded, there is no secondary tightening operation required which greatly reduces the overall cost of an anchor installation. The simple installation procedure helps to insure a quality application each time the SPIKE anchor is used.

13.2.1 Material Specifications

Mushroom Head, Carbon Steel SPIKE®
Pipe and Tie-Wire SPIKE®

Anchor Component	Component Materia
Anchor Body	Grade 8.2 Carbon Steel
Zinc Plating	ASTM B 633, SCI, Type III (Fe / Zn)

Threaded Carbon Steel SPIKE®

Anchor Component	Component Materia
Anchor Body	Grade 8.2 Carbon Steel
Nut	Carbon Steel, ASTM A563, Grade A
Washer	Carbon Steel
Zinc Plating	ASTM B 633, SCI, Type III (Fe / Zn)

Mushroom Head Stainless Steel SPIKE®

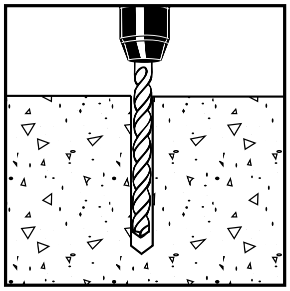
Anchor Component	Component Materia
Anchor Body	Type 316 Stainless Steel

Threaded Stainless Steel SPIKE®

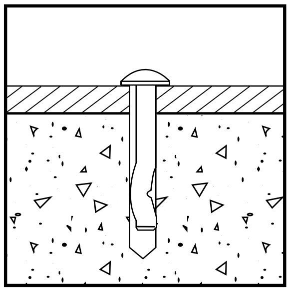
Anchor Component	Component Materia
Anchor Body	Type 316 Stainless Steel
Nut	Type 316 Stainless Steel
Washer	Type 316 Stainless Steel

13.3 Installation Procedures

Drill a hole into the base material to a depth of at least 13mm deeper than the embedment required. The tolerances of the drill bit used should meet the requirements of ISO/DIN Standard 8035. Blow the hole clean of dust and other material.



Where a fixture is used, drive the anchor through the fixture into the anchor hole until the head is firmly seated against the fixture. Be sure the anchor is driven to the required embedment depth. The Tie-Wire and Pipe SPIKE versions should be driven in until the head is seated against the surface of the base material.



13.4 Anchor Sizes and Styles

The following tables list the many sizes and styles of SPIKE anchors. To select the proper length, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth. This will be the minimum anchor length required. On the Tie-Wire and Pipe Spike versions, no fixture is used. These anchors should be driven in until the head is seated against the surface of the base material.

Mushroom Head Carbon Steel SPIKE®

Cat. No.	Part No.	Anchor Size (mm)	Drill Dia.	Min. Embed.	Std. Box	Std. Ctn.	Wt./100 (kg)
1013	**MH53MM**	5 x 25	5mm	22mm	100	1000	0.6
1016	**MH510MM**	5 x 32	5mm	22mm	100	1000	0.7
1017	**MH56MM**	5 x 38	5mm	32mm	100	1000	0.8
1018	**MH519MM**	5 x 50	5mm	32mm	100	1000	0.9
1019	**MH653MM**	6.5 x 25	6.5mm	22mm	100	1000	0.7
1197	**MH657MM**	6.5 x 32	6.5mm	25mm	100	1000	1
1021	**MH656MM**	6.5 x 38	6.5mm	32mm	100	1000	1.1
1023	**MH6519MM**	6.5 x 50	6.5mm	32mm	100	1000	1.4
1006	**MH6532MM**	6.5 x 64	6.5mm	32mm	100	1000	1.8
1024	**MH6544MM**	6.5 x 75	6.5mm	32mm	100	1000	2
1145	**MH6556MM**	6.5 x 89	6.5mm	32mm	100	1000	2.3
1026	**MH6568MM**	6.5 x 100	6.5mm	32mm	100	500	2.7
1236	**SMH1050MM**	10 x 50	10mm	40mm	25	250	3.6
1237	**SMH1075MM**	10 x 75	10mm	40mm	25	250	4.5
1238	**SMH1095MM**	10 x 100	10mm	40mm	25	250	5
1239	**SMH1260MM**	12 x 60	13mm	50mm	50	200	7
1240	**SMH1275MM**	12 x 75	13mm	50mm	50	200	9.5
1241	**SMH12100MM**	12 x 100	13mm	50mm	25	150	12

The published length is measured from below the head to the end of the anchor.

Mushroom Head Type 316 Stainless Steel SPIKE®

Cat. No.	Part No.	Anchor Size (mm)	Drill Dia.	Min. Embed.	Std. Box	Std. Ctn.	Wt./100 (kg)
1027	**MH53MMSS**	5 x 25	5mm	22mm	100	1000	0.6
1038	**MH510MMSS**	5 x 32	5mm	22mm	100	1000	0.7
1028	**MH56MMSS**	5 x 38	5mm	32mm	100	1000	0.8
1144	**MH519MMSS**	5 x 50	5mm	32mm	100	1000	0.9
1171	**MH653MMSS**	6.5 x 25	6.5mm	22mm	100	1000	0.7
1175	**MH657MMSS**	6.5 x 32	6.5mm	26mm	100	1000	1
1029	**MH656MMSS**	6.5 x 38	6.5mm	32mm	100	1000	1.1
1037	**MH6519MMSS**	6.5 x 50	6.5mm	32mm	100	1000	1.4
1176	**MH6532MMSS**	6.5 x 64	6.5mm	32mm	100	1000	1.8

The published length is measured from below the head to the end of the anchor.

Special Application SPIKE® Anchors

Rod Hanging

Pipe SPIKE®

Cat. No.	Part No.	Thread Size	Shank Dia.	Min. Embed.	Std. Box	Std. Ctn.	Wt./100 (kg)
1036	**PS514**	1/4"	5mm	32mm	100	1000	1.8
1293	**PS656MM**	6mm	5mm	32mm	100	1000	1.8
1215	**PS658MM**	8mm	6.5mm	44mm	50	500	1.8
1139	**PS6538**	3/8"	6.5mm	44mm	50	500	2.7
1074	**PS6510MM**	10mm	6.5mm	44mm	50	500	2.7

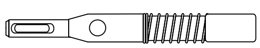
Suspended Ceilings

Tie-Wire SPIKE®

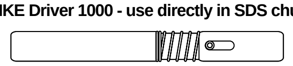
Cat. No.	Part No.	Drill Size	Min. Dia.	Tie-Wire Embed.	Eyelet Hole Size	Std. Box	Std. Ctn.	Wt./100 (kg)
1290	**TW3700**	5mm	5mm	32mm	5.5mm	100	500	0.9
1033	**TW3759**	6.5mm	6.5mm	32mm	7mm	100	500	1.1

SPIKE® Installation Tools

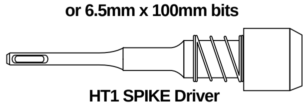
While the SPIKE anchor can easily be installed using a hammer, a specially designed series of drivers and manual tools provide a fast, easy to use method for installing SPIKE anchors into concrete and masonry materials. The tools allow the SPIKE anchor to be installed in confined areas and prevent damage to the fixture from stray hammer blows. Some drivers have a nylon tip to further protect the fixture.



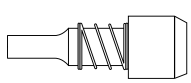
SPIKE Driver 1000 - use directly in SDS chuck



SPIKE Driver 2000 - use with 5mm x 100mm or 6.5mm x 100mm bits



HT1 SPIKE Driver



HT1 SPIKE Driver MK2

Cat. No.	Description	Guide I.D.	Std. Box	Wt./ Each
3790	SPIKE Driver 1000	13mm	1	0.1
3791	SPIKE Driver 2000	13mm	1	0.1
N/A	HT1 SPIKE Driver	25mm	1	0.2
N/A	HT1 SPIKE Driver MK2	25mm	1	0.3

13.5 Performance Data

The Following load capacities are based on testing conducted according to ASTM Standard E 488.

Load Capacities for Carbon Steel SPIKE®

Anchor Size (mm)	Drill Dia. (mm)	Embed. Depth (mm)	20 MPa Concrete Tension (kN)	20 MPa Concrete Shear (kN)	28 MPa Concrete Tension (kN)	28 MPa Concrete Shear (kN)	35 MPa Concrete Tension (kN)	35 MPa Concrete Shear (kN)
5 5 5	5 5 5	22 25 32	3.4 3.6 4.3	5.6 7.7 10.0	3.8 4.4 5.2	5.8 8.3 10.8	4.0 4.4 6.4	6.0 8.3 11.6
6.5 6.5 6.5	6.5 6.5 6.5	22 25 32	3.6 4.3 4.9	9.1 10.3 11.1	4.2 5.0 6.9	9.9 10.9 12.2	4.5 5.3 7.6	10.5 11.7 14.2
10 (3/8)	10	45	11.1	28.0	12.9	31.1	15.6	32.0
12 (1/2)	13	65	15.1	40.0	21.3	48.9	24.0	53.4

Load Capacities in Block - Carbon Steel SPIKE®

Anchor Size (mm)	Drill Dia. (mm)	Embed. Depth (mm)	C-90 Hollow Block Tension (kN)	C-90 Hollow Block Shear (kN)
5 5 5	5 5 5	22 25 32	1.2 1.8 3.3	2.4 2.6 9.3
6.5 6.5 6.5	6.5 6.5 6.5	22 25 32	2.0 3.0 3.6	7.3 8.2 9.3

Load Capacities for Stainless Steel SPIKE®

Anchor Size (mm)	Drill Dia. (mm)	Embed. Depth (mm)	20 MPa Concrete Tension (kN)	20 MPa Concrete Shear (kN)	28 MPa Concrete Tension (kN)	28 MPa Concrete Shear (kN)	35 MPa Concrete Tension (kN)	35 MPa Concrete Shear (kN)
5 5 5	5 5 5	22 25 32	3.2 3.6 4.3	5.1 7.3 9.5	3.8 4.3 5.2	5.5 7.9 10.4	3.9 4.7 6.3	5.7 8.1 10.9
6.5 6.5 6.5	6.5 6.5 6.5	22 25 32	3.5 4.3 4.8	8.8 10.2 10.8	3.9 4.6 6.5	9.5 10.4 11.6	4.4 5.0 7.4	10.1 11.2 12.6
10 (3/8)	10	45	9.0	25.2	10.9	28.1	11.6	29.3
12 (1/2)	13	65	21.9	34.8	24.6	35.5	25.3	36.9

Load Capacities in Block - Stainless Steel SPIKE®

Anchor Size (mm)	Drill Dia. (mm)	Embed. Depth (mm)	C-90 Hollow Block Tension (kN)	C-90 Hollow Block Shear (kN)
5 5 5	5 5 5	22 25 32	1.2 1.4 3.2	2.4 2.6 8.8
6.5 6.5 6.5	6.5 6.5 6.5	22 25 32	1.9 2.9 3.4	6.0 7.2 8.4

NOTE: The load capacities listed above for the Carbon and Stainless Steel SPIKE are ultimate or failure loads which should be reduced by a minimum safety factor of four to determine the allowable working loads.

Load Capacities for Pipe SPIKE®

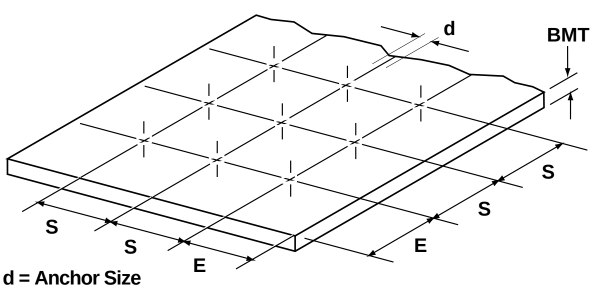
Anchor Size (mm)	Drill Dia. (mm)	Embed. Depth (mm)	20 MPa Concrete Tension (kN)	20 MPa Concrete Shear (kN)	28 MPa Concrete Tension (kN)	28 MPa Concrete Shear (kN)	35 MPa Concrete Tension (kN)	35 MPa Concrete Shear (kN)
1/4" 6mm	5 5	32 32	5.4 5.4	4.2 4.2	6.3 6.3	4.2 4.2	7.0 7.0	4.2 4.2
8mm 3/8" 10mm	6.5 6.5 6.5	44 44 44	8.2 8.2 8.2	9.7 9.7 9.7	9.7 9.7 9.7	9.7 9.7 9.7	11.2 11.2 11.2	9.7 9.7 9.7
8mm 3/8" 10mm	7 7 7	44 44 44	6.9 6.9 6.9	9.7 9.7 9.7	8.5 8.5 8.5	9.7 9.7 9.7	10.1 10.1 10.1	9.7 9.7 9.7

NOTE: The values listed above are ultimate load capacities which should be reduced by minimum safety factor of 4 or greater to determine the allowable working load. For installations in hard aggregate concrete, a special application 7mm SDS drill bit (Cat. No. 0390) is available for the 8mm, 3/8", and 10mm Pipe SPIKE. The tension load capacities listed for installations made with a 7mm drill bit should be used as a guide. Job site tests are required when using this bit.

Load Capacities for Tie-Wire SPIKE®

Anchor Size (mm)	Drill Dia. (mm)	Embed. Depth (mm)	20 MPa Concrete Tension (kN)	20 MPa Concrete Shear (kN)	28 MPa Concrete Tension (kN)	28 MPa Concrete Shear (kN)	35 MPa Concrete Tension (kN)	35 MPa Concrete Shear (kN)
5	5	32	4.3	4.2	4.7	4.2	5.0	4.2
6.5	6.5	32	4.8	5.8	5.1	5.8	5.5	5.8

NOTE: The values listed above are ultimate load capacities which should be reduced by minimum safety factor of 4 or greater to determine the allowable working load. Refer to the section on Product Selection Guidelines for details.



d = Anchor Size
S = Spacing
E = Edge Distance
BMT = Base Material Thickness

13.6 Design Criteria

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the SPIKE anchor is 125% of the embedment to be used. For example, when installing an anchor to a depth of 100mm, the base material thickness should be 125mm.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor; Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacing, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
5	50	45	40	35	30	25
6.5	65	59	52	46	39	33
10	100	90	80	70	60	50
12	120	108	96	84	72	60
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance -Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
5	60	55	50	45	40	35	30	25
6.5	78	72	65	59	52	46	39	33
10	120	110	100	90	80	70	60	50
12	144	132	120	108	96	84	72	60
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
5	60	55	50	45	40	35	30	25
6.5	78	72	65	59	52	46	39	33
10	120	110	100	90	80	70	60	50
12	144	132	120	108	96	84	72	60
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

13.7 Approvals and Listings

The following approvals and listings are for reference purposes. They should be reviewed by the design professional responsible for the product installation to verify approved sizes, base materials, and compliance with local codes.

ICBO Research Report No. 4514

Factory Mutual
Pipe SPIKE J.I. ON5A1.AH

BHP Fire Rating Report
REF: BHPR/SM/S/002

13.8 Suggested Specification

Carbon Steel SPIKE

Expansion anchors shall be a one piece unit with a mushroom style head. The expansion mechanism shall be pre-expanded and shall develop three compression forces at three different levels in the bottom of the anchor hole. The anchors shall be formed from heat treated carbon steel equivalent to Grade 8.2 and shall be plated zinc. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

Stainless Steel SPIKE

Expansion anchors shall be a one piece unit with a ________ style head. The expansion mechanism shall be pre-expanded and shall develop three compression forces at three different levels in the bottom of the anchor hole. The anchors shall be formed from Type 316 stainless steel. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

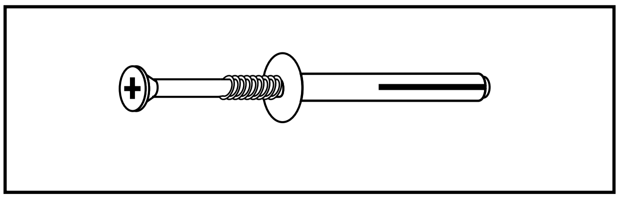
14.0 Zamac HAMMER SCREW®

14.1 Introduction

The Zamac HAMMER-SCREW® is a unique, one-step drive anchor featuring a No. 2 Phillips type head and a screw thread for use in concrete, block, brick or stone. With a body formed from corrosion resistant Zamac 7 alloy and a carbon steel drive screw, this anchor has been developed by Powers as an improvement over standard nailin anchors. Traditionally, Zamac Nailin® anchors have been used for light duty, non-engineered applications and have not been recommended for use overhead. In order to overcome these problems, the new Zamac HAMMER-SCREW® has been designed to provide a removable anchor with 40% higher tension load capacities when installed in concrete.

14.2 Product Description

On the working end of the anchor, two longitudinal slots are formed which allow slot to expand as the pre-assembled drive screw is driven into the anchor body. As the screw is driven into the anchor body, each half of the expansion mechanism is compressed against the walls of the drilled



hole. Once set, the anchor can also be removed.

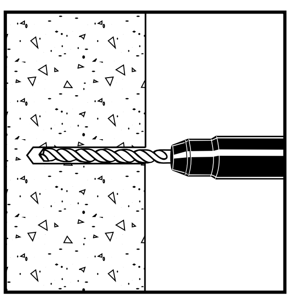
While the standard Zamac Nailin® has not been recommended for use overhead, the Zamac HAMMER-SCREW® can be used overhead provided it is part of an engineered system designed by an engineer who will take the proper design considerations and safety factors into account.

Material Specifications:

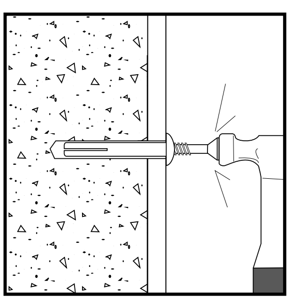
Drive nail: AISI 1018
Anchor Body: Zamac 7 Alloy
Nail Plating : ASTM B 633, SC1 Type III (Zn / Fe)

14.3 Installation Procedures

Using the proper diameter bit, drill a hole into the base material to a depth of at least 6.5mm deeper than the required embedment. Blow the hole clean of dust and other material.

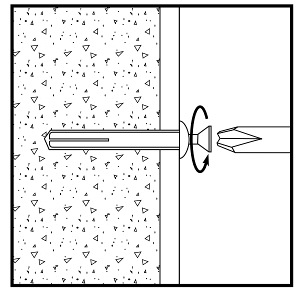


Insert the anchor through the fixture. Drive the screw into the anchor body to expand it. Be sure the head is seated firmly against the fixture and that the anchor is at the proper embedment.



To Remove

Press the No. 2 screw driver firmly into the screw head and turn counter-clockwise. Pry the screw from the anchor body, then pry out the fixture and anchor body.



14.4 Anchor Sizes and Styles

The following tables list the sizes and styles of Powers Zamac HAMMER-SCREW® anchors. For mushroom head anchors, the anchor length is measured from below the head to the end of the anchor. To select the proper length, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth. This will be the minimum anchor length required.

Zamac Hammer-Screw® Anchor-Mushroom Head

Cat. No.	Part No.	Anchor Size	Drill Dia.	Std. Box	Std. Ctn.	Wt./ 100
1107	**ZHSA6525**	6.5mm x 25mm	6.5mm	100	500	0.8
1108	**ZHSA6532**	6.5mm x 32mm	6.5mm	100	500	1
1109	**ZHSA6538**	6.5mm x 38mm	6.5mm	100	500	1.1
1110	**ZHSA6550**	6.5mm x 50mm	6.5mm	100	500	1.4
1219	**ZHSA6557**	6.5mm x 57mm	6.5mm	100	500	1.6
1113	**ZHSA6575**	6.5mm x 75mm	6.5mm	100	500	1.9

14.5 Performance Data

The following load capacities are based on testing conducted according to ASTM Standard E 488.

Anchor Size	Embed. Depth	15 MPa Concrete		30 MPa Concrete		40 MPa Concrete	
		Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)
6.5mm	16mm	3.00	6.32	3.78	8.01	3.96	8.01
6.5mm	22mm	4.72	7.12	5.29	8.01	5.56	8.01
6.5mm	29mm	5.43	7.12	6.01	8.01	6.45	8.01
6.5mm	35mm	6.05	7.12	6.85	8.01	7.38	8.01
6.5mm	48mm	6.58	7.12	7.12	8.01	7.92	8.01

NOTE: *The load capacities listed above are ultimate or failure loads based on laboratory testing in accordance with ASTM E-488. To calculate the design or allowable working loads, these capacities should be reduced by a minimum safety factor of four. Refer to the section on Product Selection Guidelines for details.*

Load Capacities in C-90 Hollow Block and Solid Red Brick

Anchor Size	Embed. Depth	C-90 Hollow Block		Solid Red Brick	
		Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)
6.5mm	20mm	2.40	5.34	4.14	7.12
6.5mm	25mm	2.89	6.23	4.40	7.12
6.5mm	35mm	3.74	6.23	5.12	7.12
6.5mm	38mm	4.40	6.23	5.60	7.12

NOTE: *The values listed above are ultimate load capacities in kilonewtons which should be reduced by a minimum safety factor of four or greater to determine the allowable working load. Refer to the section on Product Selection Guidelines for details. The consistency of hollow block and brick varies greatly. The load capacities listed should be used as guidelines only. Job sit tests should be conducted to determine actual load capacities.*

14.6 Design Criteria

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Zamac HAMMER-SCREW is 125% of the embedment to be used. For example, when installing an anchor to a depth of 20mm, the base material thickness should be 25mm. This does not apply to the thickness of the face shell in a hollow block wall.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor; Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacing, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
6.5	65	59	52	46	39	33
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
6.5	78	72	65	59	52	46	39	33
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (Inches) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
6.5	78	72	65	59	52	46	39	33
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

14.7 Suggested Specification

Zamac HAMMER-SCREW® with Carbon Steel Nail

Expansion anchors shall be pre-assembled nail drive anchor with a mushroom style head and a body formed from Zamac 7 alloy. The anchor shall have a hardened drive screw formed with a No. 2 Phillips Head which is zinc plated. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

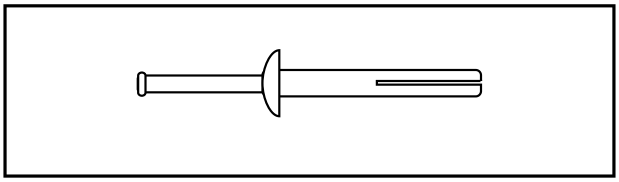
15.0 Metal Pin Anchor

15.1 Introduction

The Metal Pin Anchor is a nail drive anchor which has a body formed from Zamac alloy and a carbon or stainless steel nail. The anchor can be used in concrete, block, brick, or stone.

15.2 Product Description

The diameter of the Metal Pin Anchor anchor is the same as that for the hole which eliminates layout or hole spotting. A corrosion resistant alloy, Zamac 7, is used to form the anchor body with either a mushroom or flat head. On the working end of anchor, two longitudinal slots are formed to allow each half of the body to expand. The anchor is pre-assembled with a carbon steel nail. As the nail is driven into the anchor body, each half of the expansion mechanism is compressed against the walls of the drilled hole. Once set, the anchor is not removable and therefore vandalproof. This anchor is not recommended for applications overhead.

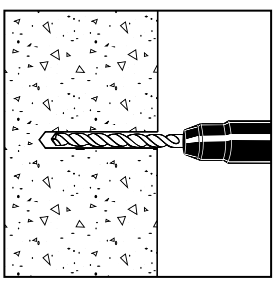


Material Specifications:

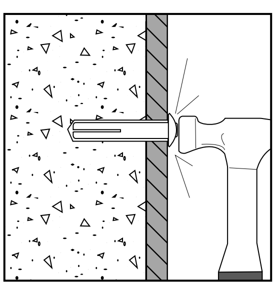
Drive Nail: AISI 1018
Anchor Body: Zamac 7 Alloy
Nail Plating : ASTM B 633, SC1 Type III (Zn / Fe)

15.3 Installation Procedures

Using the proper diameter bit, drill a hole into the base material to a depth of at least 6.5mm deeper than the required embedment. Blow the hole clean of dust and other material.



Insert the anchor through the fixture. Drive the nail into the anchor body to expand it. Be sure the head is seated firmly against the fixture and that the anchor is at the proper embedment. This anchor is not recommended for use overhead.



15.4 Anchor Sizes and Styles

Mushroom Head Zamac Nailin® - Carbon Steel Nail

Cat. No.	Part No.	Anchor Size	Drill Dia.	Std. Box	Std. Ctn.	Wt./ 100
1008	**MPa0522**	5mm x 22mm	5.0mm	100	500	0.2
1039	**MPa6520**	6.5mm x 20mm	6.5mm	100	500	0.5
1011	**MPa6525**	6.5mm x 25mm	6.5mm	100	500	0.8
1010	**MPa6532**	6.5mm x 32mm	6.5mm	100	500	1.0
1119	**MPa6538**	6.5mm x 38mm	6.5mm	100	500	1.1
1120	**MPa6550**	6.5mm x 50mm	6.5mm	100	500	1.4

15.5 Performance Data

The following load capacities are based on testing conducted according to ASTM Standard E 488.

Anchor Size	Embed. Depth	15 MPa Concrete		30 MPa Concrete		40 MPa Concrete	
		Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)
5mm	19mm	2.05	4.09	2.22	4.45	2.58	4.45
6.5mm	16mm	2.14	5.47	2.67	6.67	2.85	6.67
6.5mm	22mm	3.43	6.01	3.65	6.67	3.96	6.67
6.5mm	29mm	3.96	6.23	4.27	6.67	4.72	6.67
6.5mm	35mm	4.36	6.23	5.12	6.67	5.47	6.67
6.5mm	48mm	5.12	6.23	5.78	6.67	6.07	6.67

NOTE: *The values listed above are ultimate load capacities which should be reduced by minimum safety factor of four or greater to determine the allowable working load. Refer to the section on Product Selection Guidelines for details.*

Load Capacities in C-90 Block and Solid Brick

Anchor Size	Embed. Depth	C-90 Hollow Block		Solid Red Brick	
		Tension (kN)	Shear (kN)	Tension (kN)	Shear (kN)
5mm	19mm	1.20	3.83	2.05	4.09
6.5mm	20mm	2.14	5.16	3.51	6.23
6.5mm	25mm	2.62	5.87	3.65	6.23
6.5mm	35mm	3.56	5.87	4.23	6.23
6.5mm	38mm	4.29	5.87	4.52	6.23

NOTE: *The values listed above are ultimate load capacities which should be reduced by minimum safety factor of four or greater to determine the allowable working load. Refer to the section on Product Selection Guidelines for details. The consistency of hollow block and brick varies greatly. The load capacities listed should be used as guidelines only. Job site tests should be conducted to determine actual load capacities*

15.6 Design Criteria

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the Safety Bolt is 125% of the embedment to be used. For example, when installing an anchor to a depth of 20mm, the base material thickness should be 25mm. This does not apply to the thickness of the face shell in a hollow block wall.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor; Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacing, S (mm) Tension and Shear					
d (mm)	10d	9d	8d	7d	6d	5d
5	50	45	40	35	30	25
6.5	65	59	52	46	39	33
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
5	60	55	50	45	40	35	30	25
6.5	78	72	65	59	52	46	39	33
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (Inches) Shear Only							
d (mm)	12d	11d	10d	9d	8d	7d	6d	5d
6.5	78	72	65	59	52	46	39	33
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

15.7 Suggested Specification

Zamac Nailin® with Carbon Steel Nail

Expansion anchors shall be pre-assembled nail drive anchor with a mushroom style head and a body formed from Zamac 7 alloy. The carbon steel nail shall be plated zinc. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

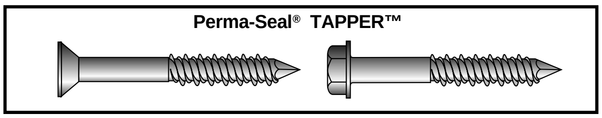
16.0 TAPPER™

16.1 Introduction

The TAPPER Anchoring System is a family of screw anchors, specially designed drill bits, and installation tools designed to meet the needs of most light to medium duty applications in concrete, block, and brick.

16.2 Product Description

The TAPPER concrete screw anchor is produced in either hex washer head or Phillips head styles from Perma-Seal® coated carbon steel. The Perma-Seal® version is available in various lengths in both 3/16" (5mm) and 1/4" (6.5mm) diameters. The anchor is fast and easy to install providing a neat, finished appearance. Suitable base materials for the TAPPER include poured concrete, brick, and concrete block for applications in new construction, remodeling, and maintenance. It is removable and re-usable in the same anchor hole.

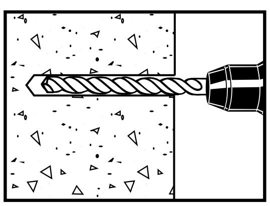


The components of the TAPPER Anchoring System include either a hex washer head or Phillips head screw anchor, a series of specially designed drill bits, and installation tools to provide a matched tolerance anchoring system.

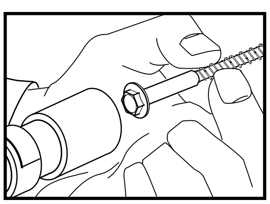
During installation, the specially designed nail point guides the anchor into a pre-drilled hole. As the anchor is driven into the hole using a TAPPER installation tool, the threads cut into the walls of the the hole to provide a tight friction fit. Unlike other systems, the full size thread design at the working end of the anchor insures a positive grip, even in soft or thin walled materials.

16.3 Installation Procedures

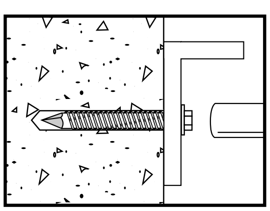
Using the proper diameter bit, drill a hole into the base material to a depth of at least 12mm deeper than the embedment required. A TAPPER drill bit must be used. Blow the hole clean of dust and other material.



Select the TAPPER installation tool and drive socket to be used. Insert the head of TAPPER into the hex head socket or Phillips head driver. For softer concrete or masonry, set the drill motor to the "rotation only" mode.



Place the point of TAPPER through the fixture into the pre-drilled hole and drive the anchor in until it is fully seated at the proper embedment. The drive will automatically disengage from the head of the TAPPER.



16.4 Anchor Sizes and Styles

The following tables list the sizes and styles of standard TAPPER anchors. Hex head TAPPER anchors are measured from below the washer while flat head TAPPER anchors are measured end to end. To select the proper length, determine the embedment depth required to obtain the desired load capacity. Then add the thickness of the fixture, including any spacers or shims, to the embedment depth. This will be the minimum anchor length required. ***Do not select a length that will result in an embedment into the base material which is greater than 45mm to 50mm. Most concrete screw anchors cannot be properly driven to a depth of more than 50mm, especially in denser base materials.***

Installation Tools for 3/16" (5mm) and 1/4" (6.5mm) TAPPER™

Cat. No.	Description	Max Screw Length	Max. Bit Length	Std. Box	Wt./ Each
2791	TAPPER™ 1000 Tool	100mm	140mm	1	0.34
2792	CONDRIVE® 2000	70mm	115mm	1	0.34
2795	1000 SDS Exten (200mm)	150mm	190mm	1	0.23

CONDRIVE® is a Registered Trademark of Illinois Tool Works. This tool cannot be used with SDS Drill Bits or PFH screws.

Blue Perma-Seal® TAPPER™

Standard Packaging-100 screws and 1 drill per box

Cat. No.			Std.	Std.	Wt./	Drill References	
HEX	PFH	Size	Box	Ctn.	100	Straight	SDS Hex
2700	**2740**	3/16" x 1-1/4" (5x32mm)	100	500	0.35	**2781**	**2793**
2702	**2742**	3/16" x 1-3/4" (5x45mm)	100	500	0.45	**2781**	**2793**
2704	**2744**	3/16" x 2-1/4" (5x58mm)	100	500	0.56	**2782**	**2793**
2706	**2746**	3/16" x 2-3/4" (5x70mm)	100	500	0.68	**2782**	**2793**
2708	**2748**	3/16" x 3-1/4" (5x83mm)	100	500	0.80	**2783**	**2794**
2710	**2750**	3/16" x 3-3/4" (5x95mm)	100	500	1.00	**2783**	**2794**
2712	**2752**	3/16" x 4" (5x100mm)	100	500	1.10	**2783**	**2794**
2720	**2760**	1/4" x 1-1/4" (6.5x32mm)	100	500	0.68	**2785**	**2796**
2722	**2762**	1/4" x 1-3/4" (6.5x45mm)	100	500	0.80	**2785**	**2796**
2724	**2764**	1/4" x 2-1/4" (6.5x58mm)	100	500	0.90	**2786**	**2796**
2726	**2766**	1/4" x 2-3/4" (6.5x70mm)	100	500	1.25	**2786**	**2796**
2728	**2768**	1/4" x 3-1/4" (6.5x83mm)	100	500	1.50	**2787**	**2797**
2730	**2770**	1/4" x 3-3/4" (6.5x95mm)	100	500	1.70	**2787**	**2797**
2732	**2772**	1/4" x 4" (6.5x100mm)	100	500	2.00	**2787**	**2797**
-	**2774**	1/4" x 5" (6.5x125mm)	100	100	2.15	**2788**	–
-	**2776**	1/4" x 6" (6.5x150mm)	100	100	2.50	**2789**	–

NOTE: For very hard brickwork and concrete above 30 to 32 MPa, Powers recommend that **only** the 1/4" (6.5mm) Tapper Concrete Screw Anchor with a 5.5mm Tapper masonry drill bit be used.

TAPPER Drill Bits in the diameters listed are nominal size. 3/16" and 1/4" Perma-Seal TAPPER anchors must be installed with special tolerance TAPPER drill bits.

Carbide Drill Bits for Perma-Seal® TAPPER™

Tolerance Range = 0.168" to 0.175" for the 5/32" and 0.202" to 0.204" for the 3/16" bits.

Straight Shank

Cat. No.	Size	Usable Length	Std. Tube
2781	5/32" x 3-1/2"	2"	10
2782	5/32" x 4-1/2"	3"	10
2783	5/32" x 5-1/2"	4"	10
2785	3/16" x 3-1/2"	2"	10
2786	3/16" x 4-1/2"	3"	10
2787	3/16" x 5-1/2"	4"	10
2788	3/16" x 6-1/2"	5"	10
2789	3/16" x 7-1/2"	6"	10

SDS Hex

2793	5/32" x 5"	3"	1
2794	5/32" x 7"	5"	1
2796	3/16" x 5"	3"	1
2797	3/16" x 7"	5"	1
2798	5.5mm x 125mm	75mm	1
2799	5.5mm x 175mm	125mm	1

NOTE: For very hard brickwork and concrete above 30 to 32 MPa, Powers recommend that **only** the 1/4" (6.5mm) Tapper Concrete Screw Anchor with a 5.5mm Tapper masonry drill bit be used.

16.5 Installation Specifications

Perma-Seal® Carbon Steel Hex Head TAPPER™

Anchor Size	3/16"(5mm)	1/4"(6.5mm)
TAPPER Drill Bit Size	5/32"	3/16"
Fixture Clearance Hole	1/4"	5/16"
Thread Size	11-16	1/4-15
Head Height	7/64"	9/64"
Head Width	1/4"	5/16"
Washer O.D.	11/32"	13/32"
Washer Thickness	1/32"	1/32"
Coating	Perma-Seal® Fluoropolymer	

Perma-Seal® Carbon Steel Flat Head TAPPER™

Anchor Size	3/16"(5mm)	1/4"(6.5mm)
TAPPER Drill Bit Size	5/32"	3/16"
Fixture Clearance Hole	1/4"	5/16"
Thread Size	11-16	1/4-15
Phillips Head O.D.	3/8"	1/2"
Phillips Head Height	9/64"	3/16"
Phillips Bit Size	2	3
Coating	Perma-Seal® Fluoropolymer	

16.6 Material Specifications

Perma-Seal® TAPPER™

Anchor Component	Component Material
Anchor Body	Case Hardened AISI 1022
Coating	Perma-Seal® Fluoropolymer

16.7 Performance Data

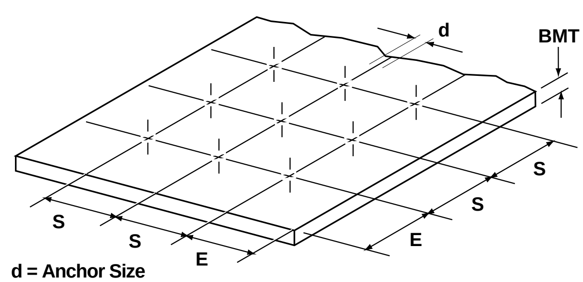
The following load capacities are based on testing conducted according to ASTM Standard E 488.

Ultimate Load Capacities - Perma-Seal® TAPPER™

	Anchor Size (inches)	Emb. Depth (mm)	15MPa Concrete	30MPa Concrete	Concrete Block	Red Brick
Tension Load (kN)	3/16" (5mm)	25	2.9	3.3	2.8	2.8
		32	3.9	4.7	3.4	4.8
		38	4.6	5.4	4.4	5.5
		45	5.9	6.8	5.4	5.9
	1/4" (6.5mm)	25	3.4	4.2	3.2	4.2
		32	4.9	6.9	3.9	5.2
		38	6.8	8.3	4.9	5.9
		45	8.7	10.4	5.8	6.4
Shear Load (kN)	3/16" (5mm)	25	4.4	4.9	4.1	4.4
		32	4.9	5.6	4.6	4.9
		38	5.3	5.7	5.1	5.5
		45	5.8	6.0	5.6	6.0
	1/4" (6.5mm)	25	5.8	7.3	5.2	7.7
		32	7.3	9.6	5.7	8.2
		38	8.9	10.2	6.5	8.6
		45	10.1	10.7	7.8	9.5

NOTE: The values listed in the table above are ultimate load capacities in Kilonewtons which should be reduced by a minimum safety factor of four or greater to determine the allowable working load. The consistency of hollow block and brick varies greatly. The load capacities listed should be used as guidelines only. Job site tests should be conducted to determine actual load capacities in block and brick.

16.8 Design Criteria



d = Anchor Size
S = Spacing
E = Edge Distance
BMT = Base Material Thickness

Base Material Thickness

The minimum recommended thickness of base material, BMT, when using the TAPPER is 125% of the embedment to be used. For example, when installing an anchor to a depth of 40mm, the base material thickness should be 50mm. This does not apply to the face shell of a block wall.

Spacing Between Anchors

To obtain the maximum load in tension or shear, a spacing, S, of 10 anchor diameters (10d) should be used. The minimum recommended anchor spacing, S, is 5 anchor diameters (5d) at which point the load should be reduced by 50%. The following table lists the load reduction factor. Rs, for each anchor diameter, d, based on the center to center anchor spacing.

Anchor Size	Anchor Spacing, S (mm) Tension And Shear					
d	10d	9d	8d	7d	6d	5d
3/16(5mm)	50	45	40	35	30	25
1/4(6.5mm)	65	58	52	45	39	32
Rs	**1.00**	**0.90**	**0.80**	**0.70**	**0.60**	**0.50**

Edge Distance - Tension

An edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum tension load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the tension load should be reduced by 20%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Tension Only							
d	12d	11d	10d	9d	8d	7d	6d	5d
3/16(5mm)	60	55	50	45	40	35	30	25
1/4(6.5mm)	78	71	65	58	52	45	39	32
Re	**1.00**	**0.97**	**0.94**	**0.91**	**0.89**	**0.86**	**0.83**	**0.80**

Edge Distance - Shear

For shear loads, an edge distance, E, of 12 anchor diameters (12d) should be used to obtain the maximum load. The minimum recommended edge distance, E, is 5 anchor diameters (5d) at which point the shear load should be reduced by 50%. The following table lists the load reduction factor, Re, for each anchor diameter, d, based on the anchor center to edge distance.

Anchor Size	Edge Distance, E (mm) Shear Only							
d	12d	11d	10d	9d	8d	7d	6d	5d
3/16(5mm)	60	55	50	45	40	35	30	25
1/4(6.5mm)	78	71	65	58	52	45	39	32
Re	**1.00**	**0.93**	**0.86**	**0.79**	**0.71**	**0.64**	**0.57**	**0.50**

16.9 Approvals and Listings

The following approvals and listings are for reference purposes. They should be reviewed by the design professional responsible for the product installation to verify approved base materials, sizes, and compliance with local codes.

ICBO ES Research Report Applied For

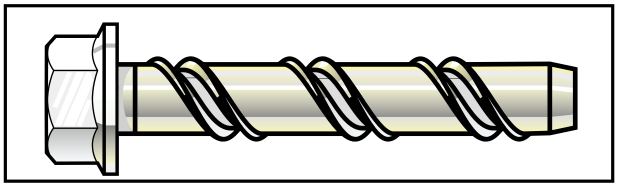
Metro-Dade Acceptance No. 43-1102.08

16.10 Suggested Specification

Perma-Seal TAPPER™

Concrete screw anchors shall be a one piece unit with a ________ style head. The anchors shall be formed from heat treated carbon steel with a hi-lo thread design and shall be coated with a fluoropolymer barrier coating. TAPPER anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

17.0 Excalibur Screwbolt



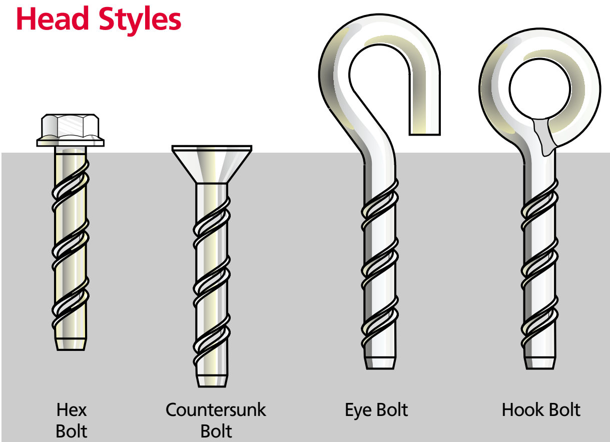
Unique Features

- One fixing for all substrates.
- Available in a wide range of head styles, lengths and diameters.
- Thread gives secure grip over full embedment.
- 30 degree helix angle for fast insertion with power or hand tools (eg. 3 turns=40mm embedment on 8mm).
- Wide pitch producing high strength grip without distressing surrounding substrate.
- Deep thread engagement results in high performance.
- No expansion provides close to the edge fixing ability.
- Self tapping of thread into substrate allows for removal and replacement.

Diameter Range and Ultimate Strength

Diameter	$30\ N/mm^2$ Concrete		
	Embedment Depth	Tensile Stength (kN)	Shear Strength (kN)
6mm	45mm	11.5	14.5
8mm	60mm	21.0	25.5
10mm	75mm	33.4	46.0
12mm	90mm	43.0	59.8
16mm	120mm	73.0	70.0

Head Styles



Screwbolt offers a unique combination of benefits which remain unmatched by any other single masonry fastener:

Screwbolt

- high strength
- shallow embedment ability
- replaces all common sleeve and resin anchors
- does not turn in the hole
- fixes instantly
- full range of head styles
- can be removed and refitted
- close to edge fixing
- single fixing for all substrates
- high speed installation
- cuts its own thread
- neat appearance

High strength :

Screwbolt's high shear and tensile strength exceeds the performance of conventional anchors. In many situations, Screwbolt will enable the sleeve-anchor user to reduce fastener diameter and embedment depth whilst retaining designed joint strength.

Shallow embedment ability :

Screwbolt provides higher strength at lower embedment depth than conventional anchors. This means shallower holes, hence less drill wear, less chance of striking reinforcing steel, and faster drilling.

Replaces all common sleeve and resin anchors :

Screwbolt is stronger than a sleeve anchor and just as quick to install. Screwbolt has the close to edge performance of a resin anchor without the time and cost disadvantages.

Neat appearance :

Screwbolt has a bolt head, rather than a nut with bolt sticking through. This not only looks better, but is much safer as well. It completely eliminates the need to grind off the excess stud length from a conventional anchor.

No turning in the hole :

Screwbolt is not a friction device, therefore you never have the old sleeve anchor problem of the fastener turning rather than expanding.

Instant fix :

Screwbolt delivers immediate strength. There is no waiting time, unlike resin anchors.

Full range of head styles :

Screwbolt has a head style for every situation, including tamper-resistant security applications.

Can be removed and refitted :

Screwbolt can be unscrewed and removed, leaving nothing but the hole. If necessary, the Screwbolt can then be re-inserted into the same hole with no loss of strength.

Close to edge fixing :

Screwbolt is not an expanding anchor, therefore it can be placed close to edges and corners in brick and concrete without damaging the substrate.

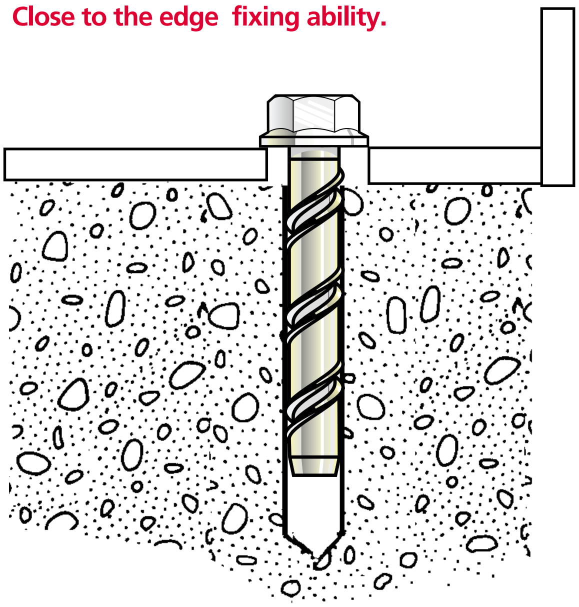
Single fixing for all substrates :

Screwbolt will function in virtually all masonry substrates, as well as wood. This eliminates the need for designers and installers to change fasteners in different areas of the same job, making it easier during the construction phase and ensuring consistency of appearance for ever.

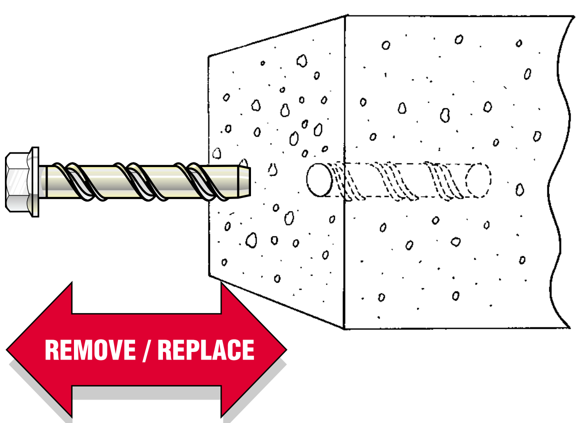
High speed installation :

Screwbolt's 30 degree helix angle means very fast insertion whether hand or power tools are used.

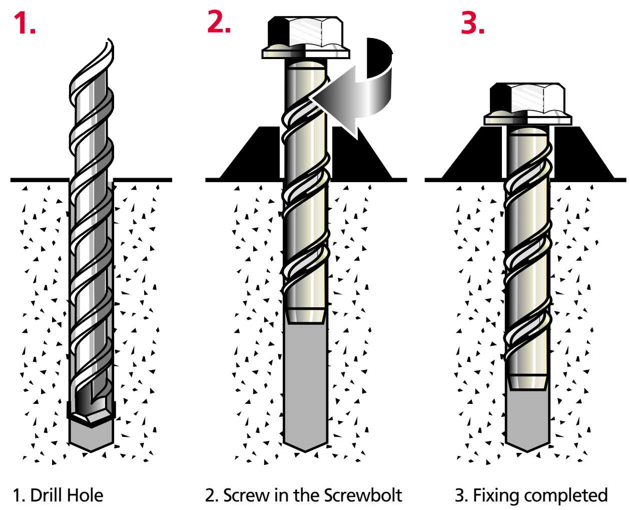
Close to the edge fixing ability.

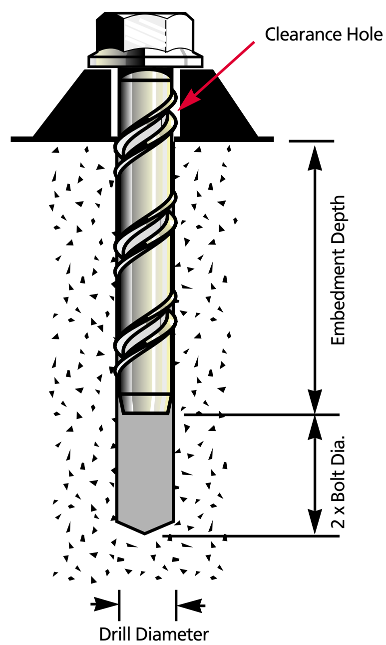


Remove and replace in the same hole.



17.1 Simple and Effective





Hole Preparation

Use the right drill.

Check that the drill bit diameter is correct for the Screwbolt size and substrate (refer to the relevant catalogue page for specific details).

Screwbolt is designed to function correctly within DIN standards. Drill bits must not be worn below normal tolerance levels.

Drill deep enough.

The hole depth must be at least the embedment depth of the Screwbolt plus twice the diameter of the Screwbolt (see diagram). Clean out excess dust.

Screwbolt Installation.

Use a good socket.

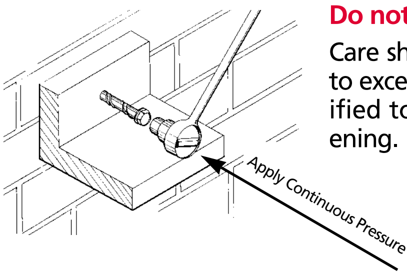
For HSB and HSA heads, we recommend the use of a quality full hexagon socket or hexagon male drive with a ratchet spanner. Alternatively, where the substrate allows, a torque controlled impact wrench can be used.

Apply pressure to start.

Ensure that continual pressure is applied (see diagram), particularly when engaging the first thread.

Back-off if tight.

During installation, debris or dust created by the thread cutting action may cause some resistance to be experienced. This is easily overcome by unscrewing the Screwbolt for one turn or more, and then continuing to fix to full embedment.



Do not over tighten.

Care should be taken not to exceed maximum specified torque when tightening.

Specification Data

Material	Boron steel BS3111/9/2.1.A
Finish	Zinc and yellow passivated.
Tensile strength	800MPa (minimum)
Treatment	Case hardened.
Other finishes	Other platings and finishes are available to special order subject to quantity.
Other materials	Stainless steel.
Other sizes	Other lengths of all diameters are available to special order subject to quantity.
Embedment concrete and brick	Minimum recommended is 4.5 x bolt diameter.
Soft block	Minimum recommended is 75mm.
Edge distance	Minimum 5 x bolt diameter. Apply reduction factor (see bolt diameter page).
Edge distance	Not affected by reduction factor. 10 x bolt diameter.

Additional technical data available on request.

- Cyclic loading test data.
- Shock loading test data.
- Centre spacing test data.
- Shear loading in brick and block.
- Independent test house reports.

17.2 Excalibur Screwbolt 6mm BZP

Hexagon - Countersunk - Hook - Eye

Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSB06-030-BZP	Hex.	30	3	25
HSB06-050-BZP	Hex.	50	20	25
HSB06-075-BZP	Hex.	75	35	25
HSB06-100-BZP	Hex.	100	50	25
CSB06-030-BZP	C/sunk*	30	3	25
CSB06-050-BZP	C/sunk*	50	20	25
CSB06-075-BZP	C/sunk*	75	35	25
CSB06-100-BZP	C/sunk*	100	50	25
EYB06-050-BZP	Eye	50	-	25
HYB06-050-BZP	Hook	50	-	25

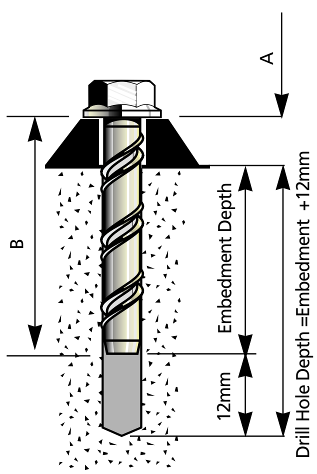
* Posi Drive

Tamperproof - Hex. Drive Countersunk

Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSA06-050-BZP	C/sunk	50	20	25
HSA06-075-BZP	C/Sunk	75	35	25
PL-06-BZP	For converting HSA & DSA Screwbolts into Tamperproof Anchors			25

CSB, HSA & HSB Ultimate & Safe load characteristics

Material	Embedment Depth	Tensile load kN		Shear load kN		Maximum Torque Nm	Edge distance (reduction factor)	
		Ultimate	Safe	Ultimate	Safe		30mm	50mm
Concrete 60 N/mm²	30mm	7.0	1.7	11.6	2.9	32	0.8	0.9
	45mm	13.0	4.2	14.5	3.6	32	0.8	0.9
Concrete 30 N/mm²	30mm	5.2	1.3	11.6	2.9	20	0.8	0.9
	45mm	11.5	2.8	14.5	3.6	20	0.8	0.9
Engr. Brick 100 N/mm²	45mm	14.3	3.6			12		
Semi. Engr.70 N/mm ²	45mm	11.2	2.8			12		
Fletton 20 N/mm ²	45mm	7.1	1.8			12		
Butterley 20 N/mm ²	45mm	3.5	0.8			8		
Hemelite 3.5 N/mm ²	75mm	6.1	1.5			5		
Lignacite 3.5 N/mm ²	75mm	4.0	1.0			5		
Topcrete 7.0 N/mm²	75mm	9.0	2.2			12		



Drill Bit Diameter

Concrete and Brick 6.5mm

Soft materials 6mm

Clearance Drill Diameter 8mm

Screwbolt Head Dimensions

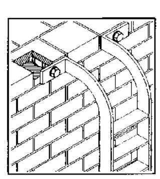
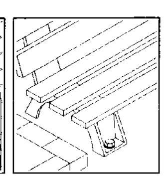
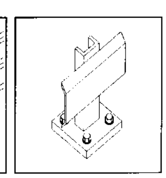
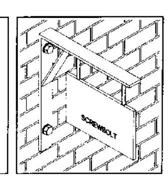
HSB 10mm A/F (Flange 13mm dia.)

CSK 12.5mm dia. No.3 point drive

HSA 16mm dia 5mm A/F drive

HYB 12mm internal dia.

EYB 12mm internal dia.

17.3 Excalibur Screwbolt 8mm BZP

Hexagon - Countersunk - Hook - Eye

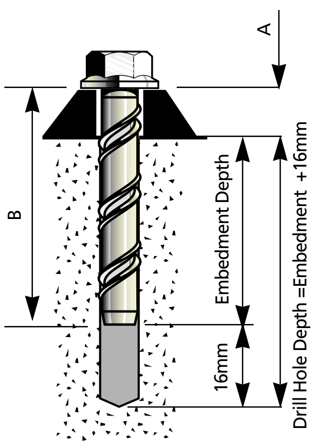
Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSB08-050-BZP	Hex.	50	14	25
HSB08-075-BZP	Hex.	75	39	25
HSB08-100-BZP	Hex.	100	50	25
EYB08-055-BZP	Eye	55	-	25
HYB08-055-BZP	Hook	55	-	25

Tamperproof - Hex. Drive Countersunk

Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSA08-050-BZP	C/sunk	50	14	25
HSA08-075-BZP	C/Sunk	75	39	25
HSA08-100-BZP	C/Sunk	100	50	25
PL-08-BZP	For converting HSA & DSA Screwbolts into Tamperproof Anchors			25

CSB, HSA & HSB Ultimate & Safe load characteristics

Material	Embedment Depth	Tensile load kN Ultimate	Tensile load kN Safe	Shear load kN Ultimate	Shear load kN Safe	Max. Torque Nm	Edge distance (reduction factor) 40mm	Edge distance (reduction factor) 60mm
Concrete 60 N/mm²	40mm	20.5	5.1	22.4	5.6	55	0.6	0.8
	60mm	28.5	7.1	25.5	6.3	70	0.6	0.8
Concrete 30 N/mm²	40mm	14.6	3.6	22.4	5.6	45	0.6	0.8
	60mm	21.0	5.2	25.5	6.3	55	0.6	0.8
Engr. Brick 100 N/mm²	45mm	17.2	4.3			15		
Semi. Engr.70 N/mm²	45mm	12.6	3.1			15		
Fletton 20 N/mm²	45mm	8.2	2.0			15		
Butterley 20 N/mm²	45mm	3.5	0.9			10		
Hemelite 3.5 N/mm²	75mm	6.3	1.6			10		
Lignacite 3.5 N/mm²	75mm	5.0	1.2			10		
Topcrete 7.0 N/mm²	75mm	11.2	2.8			15		

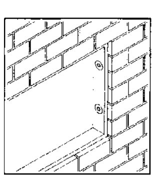
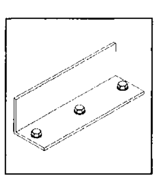
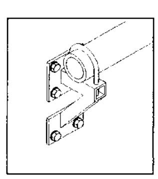
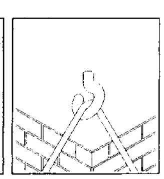


Drill Bit Diameter

Concrete and Brick 8mm
Soft materials 7mm
Clearance Drill Diameter 10mm

Screwbolt Head Dimensions

HSB 13mm A/F
(Flange16.5mm dia.)
HSA 21mm dia. 6mm A/F drive
HYB 15mm internal dia.
EYB 15mm internal dia.

17.4 Excalibur Screwbolt 10mm BZP

Hexagon - Countersunk - Hook - Eye

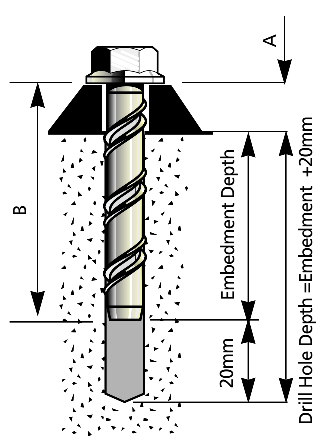
Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSB10-060-BZP	Hex.	60	15	25
HSB10-075-BZP	Hex.	75	30	25
HSB10-100-BZP	Hex.	100	50	25
HSB10-120-BZP	Hex.	120	70	25
EYB10-065-BZP	Eye	65	-	25
HYB10-065-BZP	Hook	65	-	25

Tamperproof - Hex. Drive Countersunk

Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSA10-060-BZP	C/sunk	60	15	25
HSA10-075-BZP	C/Sunk	75	30	25
HSA10-100-BZP	C/Sunk	100	50	25
PL-10-BZP	For converting HSA & DSA Screwbolts into Tamperproof Anchors			25

CSB, HSA & HSB Ultimate & Safe load characteristics

Material	Embedment Depth	Tensile load kN Ultimate	Tensile load kN Safe	Shear load kN Ultimate	Shear load kN Safe	Max. Torque Nm	Edge distance (reduction factor) 50mm	Edge distance (reduction factor) 75mm
Concrete 60 N/mm²	50mm	29.0	7.2	40.5	10.1	55	0.4	0.7
	75mm	48.0	12.0	46.0	11.5	80	0.4	0.7
Concrete 30 N/mm²	50mm	18.8	4.7	40.5	10.1	55	0.4	0.7
	75mm	33.4	8.3	46.0	11.5	80	0.4	0.7
Engr. Brick 100 N/mm²	45mm	20.0	5.0			20		
Semi. Engr.70 N/mm²	45mm	14.2	3.6			20		
Fletton 20 N/mm²	45mm	11.6	2.9			20		
Butterley 20 N/mm²	45mm	3.9	1.0			10		
Hemelite 3.5 N/mm²	75mm	10.6	2.6			15		
Lignacite 3.5 N/mm²	75mm	9.0	2.2			15		
Topcrete 7.0 N/mm²	75mm	14.0	3.6			15		

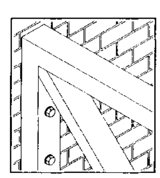
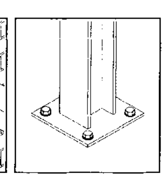
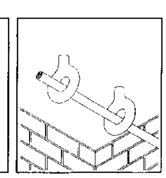
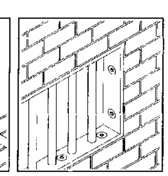


Drill Bit Diameter

Concrete and Brick 10mm
Soft materials 9mm
Clearance Drill Diameter 12mm

Screwbolt Head Dimensions

HSB 17mm A/F
(Flange 22mm dia.)
HSA 25mm dia. 8mm A/F drive
HYB 18mm internal dia.
EYB 18mm internal dia.

17.5 Excalibur Screwbolt 12mm BZP

Hexagon - Countersunk - Hook -Eye

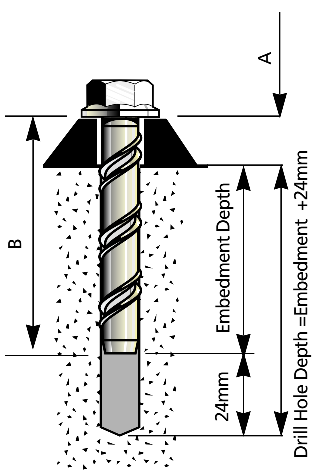
Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSB12-075-BZP	Hex.	75	20	25
HSB12-100-BZP	Hex.	100	46	25
HSB12-150-BZP	Hex.	150	96	25
EYB12-075-BZP	Eye	75	-	25
HYB12-075-BZP	Hook	75	-	25

Tamperproof - Hex. Drive Countersunk

Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSA12-075-BZP	C/sunk	75	20	25
HSA12-100-BZP	C/Sunk	100	46	25
HSA12-150-BZP	C/Sunk	150	96	25
PL-12-BZP	For converting HSA & DSA Screwbolts into Tamperproof Anchors			25

CSB, HSA & HSB Ultimate & Safe load characteristics

Material	Embedment Depth	Tensile load kN		Shear load kN		Max. Torque Nm	Edge distance (reduction factor)	
		Ultimate	Safe	Ultimate	Safe		60mm	90mm
Concrete 60 N/mm²	60mm	38.7	9.7	51.0	12.8	80	0.4	0.6
	90mm	69.0	17.2	59.8	14.9	80	0.4	0.6
Concrete 30 N/mm²	60mm	26.5	6.6	51.0	12.8	80	0.4	0.6
	90mm	43.0	10.7	59.8	14.9	80	0.4	0.6
Engr. Brick 100 N/mm²	45mm	20.0	5.0			20		
Semi. Engr.70 N/mm²	45mm	15.0	3.7			20		
Fletton 20 N/mm²	45mm	15.8	3.9			20		
Butterley 20 N/mm²	45mm	5.1	1.2			10		
Hemelite 3.5 N/mm²	75mm	12.1	3.0			15		
Topcrete 7.0 N/mm²	75mm	18.9	4.7			15		

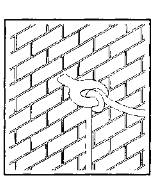
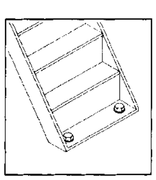
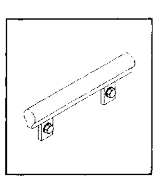
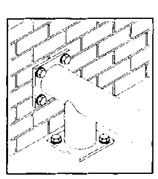


Drill Bit Diameter

Concrete and Brick 12mm
Soft materials 11mm
Clearance Drill Diameter 14mm

Screwbolt Head Dimensions

HSB 19mm A/F
(Flange 25mm dia.)
HSA 28mm dia. 10mm A/F drive
HYB 22mm internal dia.
EYB 22mm internal dia.

17.6 Excalibur Screwbolt 16mm BZP

Hexagon

Type No.	Head Style	Length B(mm)	Max. Fixing Thickness A(mm)	Box Quantity
HSB16-100-BZP	Hex.	100	28	15
HSB16-150-BZP	Hex.	150	58	15
HSB16-200-BZP	Hex.	200	108	15

Note: Working length C(mm)

Length shown above is overall bolt length
Working length = overal length less 20mm
(this note applies to 16mm dia. bolts only).

CSB, HSA & HSB Ultimate & Safe load characteristics

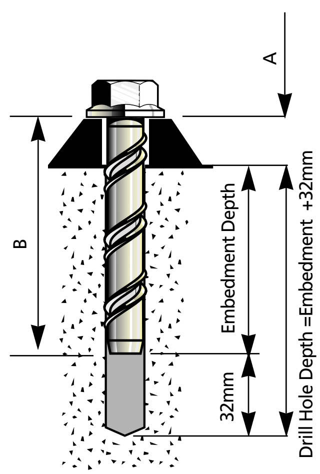
Material	Embedment Depth	Tensile load kN		Shear load kN		Max. Torque Nm	Edge distance (reduction factor)	
		Ultimate	Safe	Ultimate	Safe		80mm	120mm
Concrete 30 N/mm²	80mm	44.7	11.2	63.0	15.8	100	0.4	0.6
	120mm	73.0	18.2	70.0	17.5	100	0.4	0.6

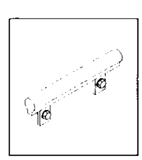
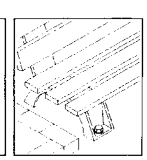
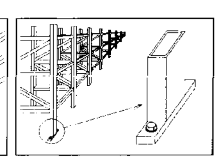
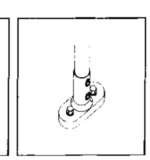
Drill Bit Diameter

Concrete and Brick 16mm
Soft materials 15mm
Clearance Drill Diameter 18mm

Screwbolt Head Dimensions

HSB 24mm A/F



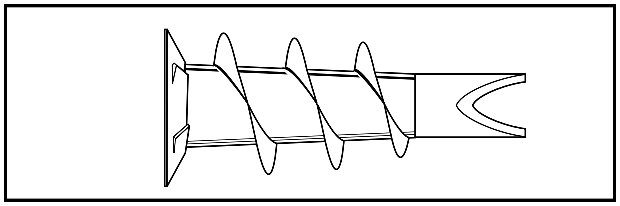
18.0 *Zip-It*®

18.1 Introduction

The *ZiP-It* anchor is a one piece self drilling anchor designed for use in hollow gypsum wallboard for light duty loads. It is available in both engineered nylon and Zamac 7 alloy for use with No. 8 screws in 10mm to 25mm wallboard. The *ZiP-It* is formed with a drill tip on the working end, a specially designed threaded section, and a large, low profile collar on the other end.

18.2 Product Description

The core bit design insures fast and true cutting during installation. A unique thread design with thin, knife like threads have an oversize outer diameter that cuts deeply and cleanly into the wallboard to spread the load over a large bearing area while the tapered root of the threaded section compacts the wall material around the anchor to further increase the load capacity. Anti-rotation ratchet teeth under the collar secure the anchor when removing the screw. Once fully seated, the collar of the *ZiP-It* sets flush to the surface of the wallboard. The *ZiP-It* is ideal for applications such as mounting electrical fixtures, fastening drapery supports, installing phone systems and accessories, and other similar fixtures. The *ZiP-It* fastener is one of the fastest and easiest hollow wall anchors you can use in wallboard.

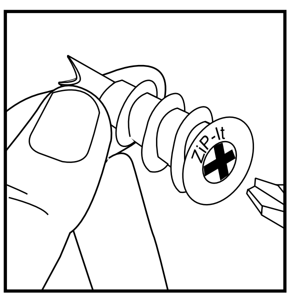


Material Specifications:

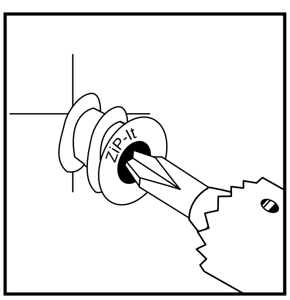
Nylon Anchor Body: Engineered Plastic
Zinc Anchor Body: Zamac 7 Alloy

18.3 Installation Procedures

Insert either # 2 or # 3 Phillips driver bit into the recess of the ZiP-It anchor head. Use a manual screwdriver or electric screw gun.

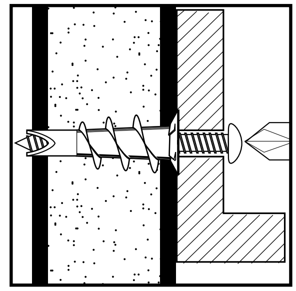


Push ZiP-It anchor into the surface of the wallboard until the two cutting blades penetrate the surface. Using gentle forward pressure, rotate the ZiP-It until the collar sets flush to the surface of the wall.



Put fixture in place, insert screw and tighten until it feels secure.

Note: When using an electric screw gun for application, set clutch and use slow speed (approximately. 300-400 rpm.).



18.4 Anchor Sizes and Styles

Australasian Nylon *ZiP-It*®

Cat. No.	Description	Wall Thickness	Screw Size
2391	Zip-It Nylon	10mm to 25mm	#6,8

Australasian Zinc *ZiP-It*®

Cat. No.	Description	Wall Thickness	Screw Size
2392	Zip-It Metal	10mm to 25mm	#6,8

18.5 Performance Data

The following load capacities are based on testing conducted according to ASTM Standard E 488.

Load Capacities for *ZiP-It*® Anchor

Wallboard Thickness	10mm	13mm	16mm	20mm
Tension Load (kN)	0.22	0.29	0.36	0.38
Shear Load (kN)	0.27	0.31	0.44	0.44

NOTE: *The values listed above are ultimate load capacities for both the Nylon and Zinc Zip-It anchors which should be reduced by minimum safety factor of 4 or greater to determine the allowable working load. Refer to the section on Product Selection Guidelines for details.*

18.6 Suggested Specification

Nylon *ZiP-It*®

Anchors for gypsum wallboard shall be a single unit self drilling style with a low profile collar on one end and a tip on the working end. The core type drill shall have a threaded section with a tapered root and shall be formed from an engineered plastic. No. 8 sheet metal screws shall be used to attach the fixture to the anchors. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

Zinc *ZiP-It*®

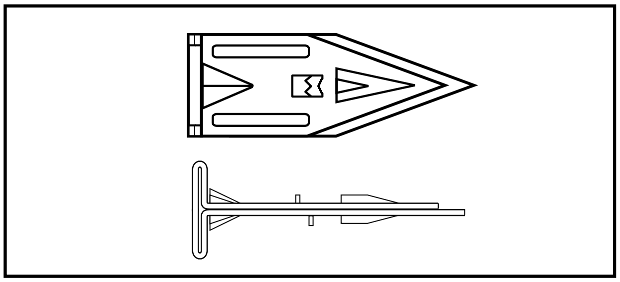
Anchors for gypsum wallboard shall be a single unit self drilling style with a low profile collar on one end and a core type drill tip on the working end. The anchors shall have a threaded section with a tapered root and shall be formed from Zamac 7 alloy. No. 8 sheet metal screws shall be used to attach the fixture to the anchors. Anchors shall be as dimensioned and supplied by Powers Fasteners Australasia.

19.0 Legs®

19.1 Introduction

The Legs anchor is a fast, easy to use expansion anchor designed for use in wallboard.

19.2 Product Description



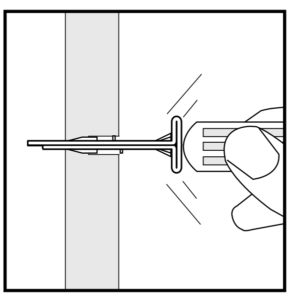
Using a progressive stamping die, the anchor has a pierce point formed on its working end and a square head on the other end. Installation is fast and simple. Press the point of the anchor into the wallboard, then drive it in using the back of a screw driver or a hammer until the square head is seated flush against the wallboard surface. Position the fixture, then thread in a No. 6 or No. 8, screw into the anchor to expand it. It's that simple. As the screw enters the anchor, it engages the pre-formed tabs in each leg causing them to expand outward into the base material. Removal on the anchor, if required, is easy. Once removed, the anchor leaves a small slit in the wallboard versus the gaping holes left with other types of hollow wall anchors.

Material Specifications:

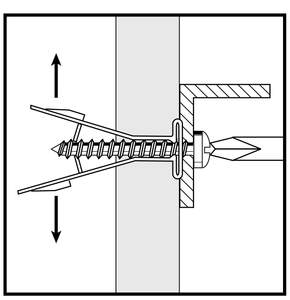
Anchor Body: Stamped from spring steel SAE 1050 which is spherodized and annealed

19.3 Installation Procedures

Place tip of anchor against face of wallboard and tap in with hammer or back of screw-driver until the flange is seated flush against the wallboard.

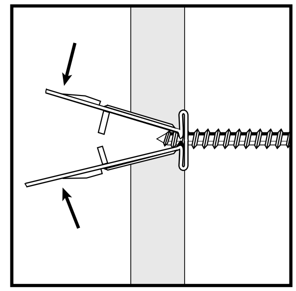


Locate the fixture and insert a #6 or #8 sheet metal screw through the fixture hole into the installed anchor. Tighten the screw until the fixture is securely seated against the base material and the anchor is fully expanded.

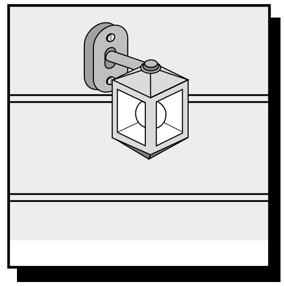


To Remove

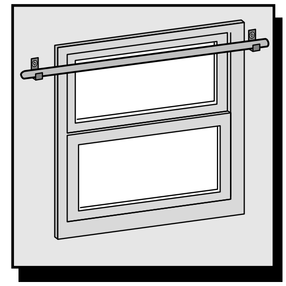
Remove the screw and take down the fixture, then insert the screw into the anchor one turn. Pull on the screw to slide the anchor out of the slit in face of the wallboard.



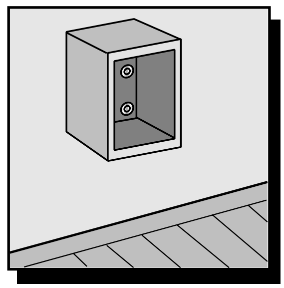
(Minimum screw length is 20mm plus the fixture thickness.)



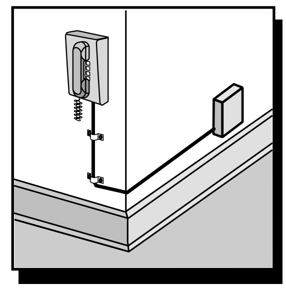
Anchor lightweight electrical fixtures to wallboard without drilling.



Quickly fasten drapery supports to wallboard without pre-drilling.



Lightweight fixtures are easily anchored to wallboard.



Phone and related accessories are easily mounted without special tools.

19.4 Anchor Sizes

Legs® Drywall Anchor

Cat. No.	Part No.	Description	Std. Box	Std. Ctn.	Wt. 100
1104	**Legs 2336**	Legs Wallboard Anchor	100	1000	0.3

15.5 Performance Data

The following load capacities are based on testing conducted according to ASTM Standard E 488.

Load Capacities for Legs™ Anchor

Wallboard Thickness	10mm	13mm	16mm	20mm
Tension Load (kN)	0.27	0.31	0.42	0.44
Shear Load(kN)	0.38	0.51	0.73	0.76

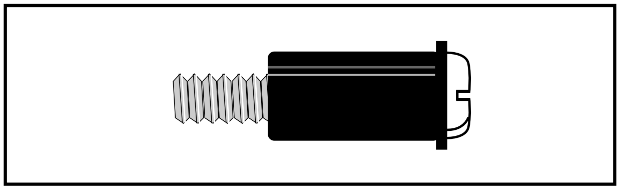
NOTE: *The values listed above are ultimate load capacities for Legs anchors which should be reduced by minimum safety factor of 4 or greater to determine the allowable working load. Shear values are based on applying the load perpendicular to the wide portion of the anchor legs. Refer to the Section on Product Selection Guidelines for details.*

20.0 Rubber-Nut

20.1 Introduction

The Rubber-Nut is a multi-purpose anchor for use in a variety of base materials ranging from plaster board, hollow doors, and hollow building blocks. They can also be used in solid masonry.

20.2 Product Description

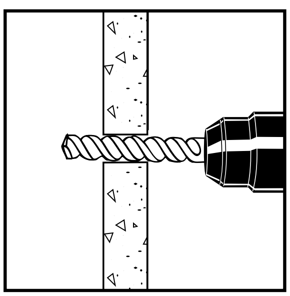


The Rubber-nut anchor consisting of a tough natural rubber sleeve with a specially ribbed non ferrous nut bonded in one end, and a moulded external flange at the other. When the screw is tightened, the sleeve compresses into a strong, demountable "rivet" fixing on the reverse side of the wall. Only one side of the fixing material need be accessible, and the Multi-Purpose Fixing is ideal when the nature of the base material is not known. It is equally at home fixing into solids, hollow materials or partial voids, and can therefore be used in virtually every construction material. Larger sizes have been specified for fixings into road surfaces, as the Multi-Purpose Fixing works well in both concrete and tarmac.

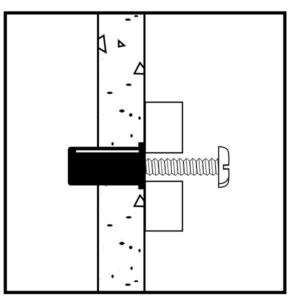
Material Specifications:

Anchor Body: Natural Rubber
Threaded Insert: Brass

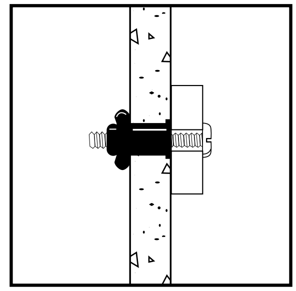
Drill a hole to the required diameter. If using in sheet metal, deburr the hole to avoid damaging the Rubber-Nut .



Insert the Rubber-Nut up to its flange. Pass the screw through the fixture and into the Rubber-Nut. Tighten the screw to compress the Rubber-Nut sleeve and form a rigid fixture. It should not be over tightened.



If the screw is removed, the Rubber-Nut can be taken out and re-used.



20.3 Anchor Sizes

Cat. No.	Part No.	Description	Hole Size	Wall Thcks.	Std. Box	Wt./ 100
09-040	**WS3240**	M3 x 24 w/screw	8mm	14	50	
09-093	**WOS4115**	M4 x 11.5 w/o screw	8mm	2	50	
09-100	**WS4115**	M4 x 11.5 w/screw	8mm	2	50	
09-123	**WOS4240**	M4 x 24 w/o screw	8mm	14	50	
09-130	**WS4240**	M4 x 24 w/screw	8mm	14	50	
09-184	**WOS5140**	M5 x 14 w/o screw	10mm	2	50	
09-195	**WS5140**	M5 x 14 w/screw	10mm	2	50	
09-224	**WOS5250**	M5 x 25 w/o screw	10mm	14	50	
09-235	**WS5250**	M5 x 25 w/screw	10mm	14	50	
09-310	**WOS5380**	M5 x 38 w/o screw	10mm	26	50	
09-341	**WOS5450**	M5 x 45 w/o screw	10mm	30	50	
09-317	**WS5380**	M5 x 38 w/screw	10mm	26	50	
09-355	**WOS6150**	M6 x 15 w/o screw	13mm	2	50	
09-385	**WOS6250**	M6 x 25 w/o screw	13mm	13	50	
09-415	**WOS6350**	M6 x 35 w/o screw	13mm	23	50	
09-473	**WOS8300**	M8 x 30 w/o screw	18mm	15	50	
09-533	**WOS8500**	M8 x 50 w/o screw	18mm	35	50	
09-594	**WOS1055**	M10 x 55 w/o screw	20mm	35	25	
09-654	**WOS1275**	M12 x 75 w/o screw	24mm	45	20	

20.4 Performance Data

Size Ref.	Material	Average failure load (kN)	Type of failure
1275	**Hardwood 100mm thick**	15.37	Fixing failed
5250	**10mm & 13mm Gyprock/ Gib board**	.43	Board failed
	3mm medium grade hardboard	.68	Board failed
	3mm hard grade	.82	Board failed
	4.5mm plywood	.54	Panel failed
	3mm fibreglass panel	.59	Panel failed
	Hollow clay blocks	3.00	Fixing failed
	Hollow concrete beams	1.40	Fixing failed
5250	**Siporex (with 25mm spacers)**	1.08	Block failed
6150	**3mm thick aluminum**	2.63	Metal failed

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Disclaimer - This manual has been designed as a reference guide for use in selecting anchors and fasteners. It provides the user with information based on the most common applications. Since it is not possible to include information on all applications or data for all materials, it is the responsibility of the user to verify the accuracy of the data contained in this manual as it pertains to each unique application. Powers Fasteners Australasia Pty Ltd shall not be liable for any claim, damage, demand, expense, injury, or loss, direct, incidental, or consequential, based on the use of the data contained in this manual. As always, the selection of a product and the determination of its suitability for use must be performed by a qualified design professional responsible for the specific product application. Data contained in this manual is subject to change without notice.

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