STRUT CHANNEL & ACCESSORIES

CHANNEL

Pre-Galvanized
-ASTM A653 Grade 33 SS, Zinc Coated by Hot Dip Process

Plain, Powder Coated, or Hot Dip Galvanized
-ASTM A1011/A1011M Grade 33 SS

Stainless Steel
-ASTM A240, Type 304
-ASTM A240, Type 316

Aluminum
-Aluminum alloy 6005-T5

CHANNEL NUTS

Steel
-ASTM A576, Grade M1015, Case Hardened to RC25 min.

Stainless Steel
-ASTM A240, Type 304
-ASTM A240, Type 316
-Sintered Nuts: MPIF 35 Type 316 (Domestic only)

Aluminum
-Aluminum alloy 5052-H32

PIPE CLAMPS & ACCESSORIES

Pre-Galvanized Steel:
-ASTM A653 Grade 33 SS, Zinc Coated by Hot Dip Process

Carbon Steel: (3 Gauge Thickness and Below)
-ASTM A1011 CS Type A, B, or C

Carbon Steel: (1/4" Thickness and Above)
-ASTM A36, Structural Quality

Stainless Steel:
-ASTM A240, Type 304
-ASTM A240, Type 316

Aluminum
-Aluminum alloy 6005-T5 Structural Grade

Cast Iron:
-Grey Cast Iron, ANSI/ASTM A48, Class #20

Malleable Iron:
-ANSI/ASTM A47, Grade Number 32510

ROOFTOP SUPPORT BASE

Test Name	Value	Test Method
Color	27.29	Spectrophotometer "L" Value
Durometer	87.00 A	ASTM D2240 (15 sec delay)
Specific Gravity	1.131	ASTM D792-91
Tensile Strength	706 psi	ASTM D412
Elongation	346%	ASTM D412
Tear	30.235 kN/m	ASTM D624
Melt Flow Rate	14.836 g/10 min 230C/5.0 Kg	ASTM D624
Percent Moisture	0.064%	Moisture Analyzer

ALUMINUM

The high strength to weight ratio of PHD Manufacturing, Inc. products made of aluminum greatly reduces the overall cost of installation through ease of handling and field cutting.

Aluminum owes its excellent corrosion resistance to its ability to form an aluminum oxide film that immediately reforms when scratched or cut. In most outdoor applications, aluminum has excellent resistance to "weathering". The resistance to chemicals, indoor or outdoor, can best be determined by tests conducted by the user with exposure to the specific conditions for which it is intended.

To determine the approximate load data for strut, multiply the load data found in this catalog by a factor of 0.38.

CARBON STEEL

PHD Manufacturing, Inc. products made from high-quality carbon steel are cold formed to precise dimensions. By cold working the steel mechanical properties are increased, allowing lightweight structures to carry the required load. Corrosion resistance of carbon steel varies widely with coating and alloy. See "Finishes" for more detailed information.

STAINLESS STEEL

Because of its corrosion resistance, stainless steel is recommended for applications where corrosion is a problem. Load data for PHD Manufacturing, Inc. products is the same as the load data in this catalog.

Stainless steel products are available in ASTM A-240, Type 304 or 316 material. Both are low-magnetic and belong to the austenitic stainless steels group, based on alloy content and crystallographic structure. Like carbon steel, stainless steel exhibits increased strength when cold worked.

Several conditions make the use of stainless steel ideal. These include reducing long term maintenance costs, high ambient temperatures, appearance, and stable structural properties such as yield strength, and high creep strength.

Type 304 resists most organic chemicals, dyestuffs and a wide variety of inorganic chemicals at elevated or cryogenic temperatures. Type 316 contains slightly more nickel and adds molybdenum to give it better corrosion resistance in chloride and sulfuric acid environments.

SPECIAL FEATURES

PHD Manufacturing, Inc. Rooftop Support Bases are made from 100% post-consumer American recycled rubber and recycled plastic, thus qualifying for LEED credits. This material will not deteriorate over time and dampens vibration. These bases are UV resistant and suitable for use on most types of roofing materials or other flat surfaces. Consult with the roofing manufacturer or an engineer to ensure safe loading and material compatibility. If necessary, a compatible swatch of roofing material may be placed under the base to limit movement, disperse load, and ensure compatibility. When utilized on a gravel topped roof, it is recommended that the gravel be removed from under the Rooftop Support Base. Water channels designed into the bottom of these bases assist in water drainage and help to prevent damming. Hex recesses present under PHD Manufacturing, Inc. bases accept ½" standard hex nuts or bolt heads, retaining them for ease of installation. Square pockets under these bases accept PHD Manufacturing, Inc. Fig. 5000 series square washers, which can be implemented to reduce hardware or fasteners for use with through holes. Screw fasteners can be utilized to attach pipe straps or strut directly to these bases.
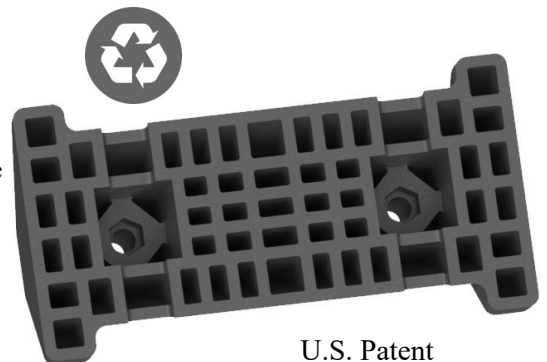
U.S. Patent
No. 9,528,271
No. D749,935
No. D810,010

PLAIN (PL)

Plain finish designation means that the product retains the oiled surface applied to the raw steel during the forming process. The fittings have the original oiled surface of the bar-stock material.

PVC COATING (PVC)

PVC coating helps reduce noise and protect the pipe or tubing from the metal surface of the hanger. Corrosion resistance protection is minimal. PVC coating is not compatible with CPVC pipe.

COPPER COLOR EPOXY FINISH (CCEF)

Designed for use with copper tubing. This coating provides a better level of corrosion resistance than the traditional copper plated finish. It also acts as a protective barrier, avoiding contact between dissimilar metals. The copper color epoxy powder is applied by an electrostatic method, and the coated parts are baked at 180 degrees for 20 minutes.

POWDER COATING (PTD)

PHD Manufacturing, Inc. offers a polyester powder coating that utilizes powder material conforming to ASTM D3451. It is applied by means of an electrostatic spray at ambient temperature.

CHANNEL GREEN: POLYESTER

POWDER PROPERTIES

Test Method	Powder Properties	Tolerances
ASTM D3451 (18.30)	Specific Gravity	1.33 ± 0.03
ASTM D3451 (18.30)	Theoretical Coverage	144.58 ± 4.0 FT²/Lb./Mil.
ASTM D3451 (13)	Volatile Content	Max. 2.5%
ASTM D3451 (13)	Storage Temperature Max	80°F

COATING PROPERTIES
All tests performed on substrate 0.032 CRS Pretreatment Bonderite 1000

Test Method	Coating Properties	Tolerances/Specifications
ASTM D523	Gloss 20°/60°	70-80
ASTM D2454	Over Bake Resistance Time	100%
ASTM D3363	Pencil Hardness	H - 2H
ASTM D2794 (Modified)	Direct Impact (Gardner)	80 in. Lbs.
ASTM D2794 (Modified)	Reverse Impact (Gardner)	80 in. Lbs.
ASTM D3359	Adhesion (Cross Hatch)	Pass No Adhesion Loss
ASTM D522	Flexibility (Mandrel)	1/8 Bend No Fracture
ASTM B117	Salt Spray	1000 Hrs.
ASTM D2247	Humidity	500 Hrs.

APPLICATION

Test Method	Application	Cure Schedule
Electrostatic Spray	Ambient Temperature	15' @ 375°F (190°C) Recommended Minimum Film Thickness 1.5

EPOXY E-COAT

PHD Manufacturing's epoxy E-Coat offers state of the art corrosion resistance without the use of heavy metals such as lead, chrome, and zinc. It is applied to our products by a controlled cathodic electro-deposition process. This process is accomplished by transporting the product through several cleaning, phosphatizing, rinsing, and application stages prior to being baked for 20 minutes at 375°F (190°C).

EPOXY PROPERTIES

Property	Test Method	Performance
Color	---	Various
Film Thickness	---	0.5 - 1.5 Mils
Gloss - 60 Degree	ASTM D523	65 - 85
Pencil Hardness	ASTM D3363	2H Minimum
Direct Impact	ASTM D2794	120 in-lb. Minimum
Reverse Impact	ASTM D2794	100 in-lb. Minimum
Cross-Hatch Adhesion	ASTM D3359	4B - 5B
Humidity	ASTM D1735	1000 Hours Minimum
Water Immersion	ASTM D870	250 Hours Minimum
Gravelometer	GM 9508P	6 Minimum
Throwpower	GM 9535P	12 - 15 Inches

All tests performed on Cold Rolled Steel Lab Panels, Zinc Phosphate Pretreatment, 0.6 Mil Average Film Thickness, Cure 20 Minutes @ 375°F

Property	Substrate / Pretreatment	Salt Spray* 500 hrs.	Salt Spray* 1000 hrs.	20 Cycle** Scab
Corrosion Resistance	CRS/Zinc Phos/Non-Chrome	0 in. (0 mm)	0 - 0.039 in. (0 - 1 mm)	0.039 - 0.079 in. (1 - 2 mm)

(Average Total Scribe Creep), * Salt Spray - ASTM B117
** Cycle Scab - GM9511P, Cold Rolled Steel Lab Panels
Cure 20 Minutes @ 375°F (190°C)

ZINC COATING

PHD offers 3 basic forms of zinc coating on its products:
1) **Electro-Galvanized** (Electro-Plated Zinc)
2) **Pre-Galvanized**
3) **Hot-Dipped Galvanized**

For best results, a zinc rich paint should be applied to field cuts. The zinc rich paint will provide immediate protection for these areas and eliminate the short time period for galvanic action to "heal" the damaged coating.

Note: The corrosion resistance of zinc is based on its thickness, the environment, and the coating process used. The acceptability of galvanized coatings at temperatures above 450°F is at the discretion of the end user.

Zinc offers two types of protection:

• **Barrier:** The zinc coating protects the steel substrate from direct contact with the environment
• **Sacrificial:** The zinc coating will protect scratches, cut edges, etc… through an anodic sacrificial process.

ELECTRO-GALVANIZED "EG" (ASTM B633 SC1 & SC3)

This type of coating is recommended for use indoors in relatively dry areas. The steel is submersed in a bath of zinc salts, through the process of electrolysis, a coating of pure zinc adheres to the steel with a molecular bond. A maximum of 0.5 mils of zinc per side can be applied using this method.

SC1 (Mild) is the standard finish thickness which has a zinc coating of 0.2 mils per side. SC3 (Severe) has a zinc coating of 0.5 mils per side.

PRE-GALVANIZED "PG" (ASTM A653 COATING G90)

This type of coating is suitable for extended exposure in dry or mildly corrosive atmospheres but not generally recommended for use outdoors in industrial environments. Also known as "mill galvanized" or "hot-dipped mill galvanized" pre-galvanized zinc coatings are produced by rolling the steel coils or sheets through molten zinc, at the steel mill, the material is then cut or slit to size. Zinc near the uncoated edges or weld areas becomes a sacrificial anode which protects the bare areas.

The pre-galvanized material conforms to ASTM A653 with a G90 zinc coating. The zinc thickness per side is nominally 0.75 mils thick or 0.45 oz /sq. ft.
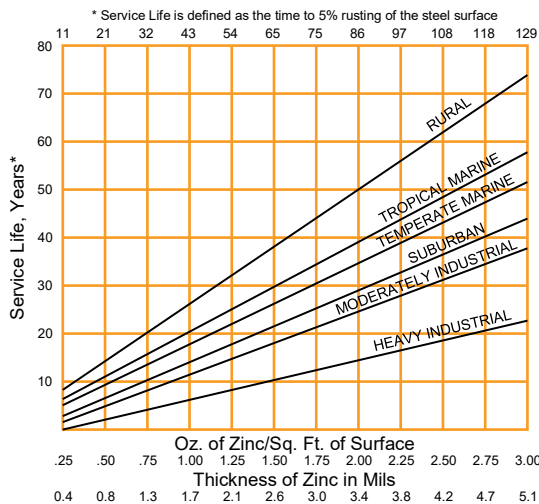
HOT-DIP GALVANIZED "HDG" (ASTM 123)

Recommended for prolonged outdoor exposure and will usually protect steel in most atmospheric environments. After fabrication the part is immersed in a bath of molten zinc. A metallurgical bond is formed resulting in a zinc coating that coats all surfaces including edges. Please note that some items cannot be hot-dipped galvanized due to design, tolerances, or threaded components. Check with the PHD factory or your local representative when questionable. Threaded components on hot dipped galvanized products will be electro-galvanized.

The hot-dip galvanized coating is typically 2.6 mils or 1.5 oz /sq. ft per side.

As shown in the graph, when the zinc coating is double, the service life is double under most conditions.

Life of Protection vs. Thickness of Zinc And Type of Atmosphere

* Service Life is defined as the time to 5% rusting of the steel surface

Top axis: 11 21 32 43 54 65 75 86 97 108 118 129

Y-axis (Service Life, Years*): 80, 70, 60, 50, 40, 30, 20, 10

Curves (top to bottom): RURAL, TROPICAL MARINE, TEMPERATE MARINE, SUBURBAN, MODERATELY INDUSTRIAL, HEAVY INDUSTRIAL

Oz. of Zinc/Sq. Ft. of Surface
.25   .50   .75   1.00   1.25   1.50   1.75   2.00   2.25   2.50   2.75   3.00

Thickness of Zinc in Mils
0.4   0.8   1.3   1.7   2.1   2.6   3.0   3.4   3.8   4.2   4.7   5.1

Comparison of Zinc Finishing	
Finish	**Zinc Thickness (mils)**
Hot-Dip Galvanized	2.6
Pre-Galvanized	0.75
Electro-Galvanized (SC1)	0.2
Electro-Galvanized (SC3)	0.5

CORROSION

All metal surfaces are affected by corrosion. Depending on the physical properties of the metal and the environment to which it is exposed, chemical or electromechanical corrosion may occur.

Atmospheric Corrosion

Atmospheric corrosion occurs when metal is exposed to airborne liquids, solids or gases. Some sources of atmospheric corrosion are moisture, salt, dirt and sulphuric acid. This form of corrosion is typically more severe outdoors, especially near marine environments.

Chemical Corrosion

Chemical corrosion takes place when metal comes in direct contact with a corrosive solution. Some factors which affect the severity of chemical corrosion include: chemical concentration level, duration of contact, frequency of washing, and operating temperature.

Galvanic Corrosion

Galvanic corrosion occurs when two or more dissimilar metals are in contact in the presence of an electrolyte (i.e. moisture). An electrolytic cell is created and the metals form an anode or a cathode depending on their relative position on the Galvanic Series Table. The anodic material will be the one to corrode. Anodic or cathodic characteristics of two dissimilar metals will depend on the type of each material. For example: If zinc and steel are in contact, the zinc acts as the anode and will corrode; the steel acts as the cathode, and will be protected. If steel and copper are in contact, the steel is now the anode and will corrode. The rate at which galvanic corrosion occurs depends on several factors:

1. The relative position on the Galvanic Series Table - the further apart materials are in the Galvanic Series Table, the greater the potential for corrosion of the anodic material.

2. The amount and concentration of electrolyte present - an indoor, dry environment will have little or no galvanic corrosion compared to a wet atmosphere.

3. The relative size of the materials – a small amount of anodic material in contact with a large cathodic material will result in greater corrosion. Likewise, a large anode in contact with a small cathode will decrease the rate of attack.

Storage Corrosion

Wet storage stain (white rust) is caused by the entrapment of moisture between surfaces of closely packed and poorly ventilated material for an extended period. Wet storage stain is usually superficial, having no affect on the properties of the metal.

Light staining normally disappears with weathering. Medium to heavy buildup should be removed in order to allow the formation of normal protective film. Proper handling and storage will help to assure stain-free material. If product arrives wet, it should be unpacked and dried before storage. Dry material should be stored in a well ventilated "low moisture" environment to avoid condensation formation. Outdoor storage is undesirable, and should be avoided whenever possible.

GALVANIC SERIES IN SEA WATER

More Anodic →

Anodic End
- Magnesium
- Magnesium Alloys
- Zinc (Galvanized Coating)
- Beryllium
- Aluminum - Zinc Alloys
- Aluminum - Magnesium Alloys
- Aluminum
- Aluminum - Magnesium Alloys
- Aluminum - Magnesium - Silicon Alloys
- Cadmium
- Aluminum - Copper Alloys
- Low Carbon Steel, Cast Iron, Wrought Iron
- Austenitic Nickel Cast Iron
- Type 410 Stainless Steel (active)
- Type 316 Stainless Steel (active)
- Type 304 Stainless Steel (active)
- Naval Brass, Yellow Brass, Red Brass
- Tin
- Copper
- Lead-Tin Solders
- Admiralty Brass, Aluminum Brass
- Manganese Bronze
- Silicon Bronze
- Tin Bronze
- Type 410 Stainless Steel (passive)
- Nickel - Silver
- Copper Nickel Alloys
- Lead
- Nickel - Aluminum Bronze
- Silver Solder
- Nickel 200
- Silver
- Type 316 Stainless Steel (passive)
- Type 304 Stainless Steel (passive)
- Incoloy 825
- Hastelloy B
- Titanium
- Hastelloy C
- Platinum
- Graphite

Cathodic End

Metals in descending order of activity in the presence of an electrolyte.

CORROSION

The corrosion data given in this table is for general comparison only.

The presence of contaminates and the effect of temperature in chemical environments can greatly affect the corrosion of any material.

PHD Manufacturing, Inc. strongly suggests that field service tests or simulated laboratory tests using actual environmental conditions are conducted in order to determine the proper materials and finishes to be selected.

R = Recommended

F = May be used under some conditions

NR = Not Recommended

– = Information not available

Chemical	Aluminum	Channel Green	Type 304 Stainless	Type 316 Stainless	Zinc Coated Steel
Acetic Acid 10%	R	NR	R	R	NR
Acetic Acid 2%	R	F	R	R	NR
Acetone	R	R	R	R	R
Ammonium Hydroxide-Conc,	R	R	R	R	-
Ammonium Hydroxide 10%	F	R	R	R	-
Ammonium Hydroxide 2%	R	R	R	R	-
Benzene	R	R	R	R	-
Bromine Water	NR	R	NR	NR	-
Butanol (Butyl Alcohol)	R	R	R	R	R
Carbon Disulfide	R	R	R	R	-
Carbon Tetrachloride	F	R	R	R	-
Chlorine Water	R	R	NR	F	R
Cutting Oil	-	R	-	-	-
Diethanolamine	R	R	-	-	NR
Ethanol	R	R	R	R	R
Ethyl Acetate	R	R	-	-	R
Ethylene Dichloride	F	R	-	-	R
Formaldehyde 20%	R	R	R	R	R
Gasoline	R	R	R	R	R
Glycerine	R	R	R	R	R
Household Detergent 10%	F	R	R	R	-
Hydrochloric Acid 40%	NR	NR	NR	NR	NR
Hydrochloric Acid 10%	NR	F	NR	NR	NR
Hydrochloric Acid 2%	NR	F	NR	NR	NR
Hydrogen Peroxide 30%	R	NR	R	R	-
Hydrogen Peroxide 3%	R	R	R	R	-
Hydrogen Sulfide (Gas)	R	R	F	R	-
JP-4 Jet Fuel	R	R	R	R	-
Lactic Acid 85%	F	R	NR	-	-
Latex	R	R	R	R	NR
Linseed Oil Fatty Acid	R	F	R	R	-
Methanol	R	R	R	R	R
Methyl Ethyl Ketone	R	R	-	-	R
Methyl Isobutyl Ketone	R	R	-	-	R
Mineral Spirits	R	R	-	-	-
Motor Oil - 10W	R	R	R	R	R
Naphtha, VM&P	R	R	R	R	R
Nitric Acid 2%	F	NR	R	R	-
Perchloroethylene	R	R	-	-	NR
Petroleum Ether	-	R	R	R	R
Phenol 10%	R	R	R	R	R
Phosphoric Acid 2%	F	NR	R	R	NR
Potassium Hydroxide 50%	NR	R	R	R	-
Potassium Hydroxide 10%	NR	R	R	R	-
Potassium Hydroxide 2%	NR	R	R	R	-
Sodium Chloride 25%	F	R	R	R	F
Sodium Hydroxide 50%	NR	R	R	R	NR
Sodium Hydroxide 10%	NR	R	R	R	F
Sodium Hydroxide 2%	NR	R	-	-	-
Sodium Hypochlorite-C1. 10%	F	R	-	-	-
Sodium Hypochlorite-C1. 6%	F	R	NR	R	-
Sulfuric Acid 50%	F	NR	NR	R	NR
Tall Oil Fatty Acid 50%	R	R	-	-	-
Tannic Acid 50%	F	R	R	R	-
Water-Deionized	R	R	R	R	F
Water-Sea	F	F	R	R	F
Water-Tap	R	R	F	F	R
Xyol	R	R	-	-	-

DESIGN OF STRUT SYSTEMS

PHD Manufacturing, Inc. follows the guidelines of the Metal Framing Manufacturers Association (MFMA) in the manufacture and recommended use of strut systems. In all design applications using strut systems and accessories, proper engineering design practices should be applied and load limits observed. The following pages include helpful information to assist the user in the proper design of strut systems.

Appropriate beam and column loading information is provided with the dimensional tables accompanying each channel. In addition, the following discussion and tables are designed to assist in the proper selection and use of PHD strut products. Basic engineering information is provided to define the concepts needed to design a safe and economical strut installation.

PHD channel strut is often installed to serve either as beams or columns in structural applications. A brief discussion of these types of structural elements and their safe design follows:

BEAMS

Structural members installed in a horizontal attitude and subject to vertical and/or horizontal loads are known as beams. The method by which a beam is mounted affects its load-carrying capability. Common mounting methods include:

Simple Beam –
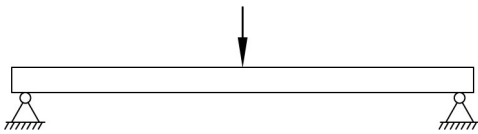
A simple beam is one that is supported at both ends without being restricted from bending or flexing. Most beams are analyzed as simply supported beams, even though they are often rigidly fixed at their supports. PHD beam load data is based upon simple beam configurations unless otherwise noted.

Fixed End Beam –
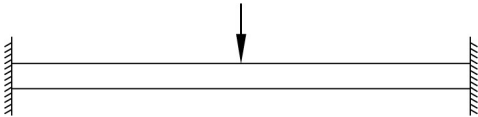
A fixed end beam is supported at both ends in such a way that motion or bending of the beam is restricted. An example of a fixed end beam is a strut welded at both ends to a very rigid structure. The result is a beam capable of carrying greater loads, but subject to large bending moments at the supports.

Cantilever Beam –
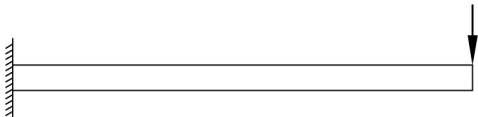
A cantilevered beam is one that is fixed at one end and completely unsupported at the other end.

Continuous Beam –
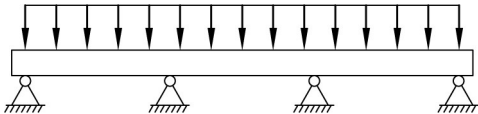
A continuous beam is supported at three or more points along its length. Continuous beams act similarly to simple beams, particularly at the end spans. However, the counter-balancing effect of adjacent spans restricts movement at the support, much like a fixed beam.

TYPES OF BEAM LOADING

Concentrated Load –
Also known as a point load, this type of load is applied at one point along the span of the beam. See Figure 1. A beam may have multiple concentrated loads along its span.

Uniform Load –
This is a load spread evenly over a length of the beam's span. See Figure 2. It may cover the entire span or only a portion.

Combined Load –
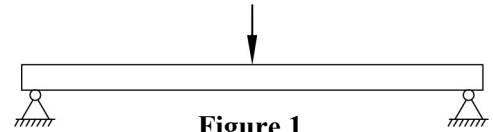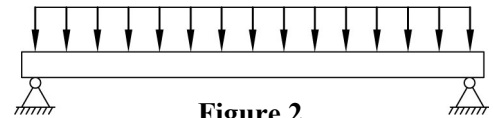Concentrated loads and uniform loads may be carried simultaneously by a beam, arranged in any combination.

Figure 1

Figure 2

BEAM DEFLECTION

Deflection is the amount of displacement, or sag, experienced by a load-carrying beam. All loaded beams will deflect to a greater or lesser degree, depending upon:

♦ The size and placement of loads   ♦ The manner of supporting the beam
♦ The beam material   ♦ The stiffness of the beam
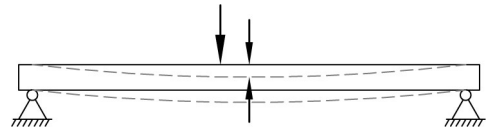
PHD provides deflection values for beams of various spans in the tables accompanying each channel shape. When determining the deflection of a strut, the rule of thumb observed by the industry is that a deflection of $\frac{1}{240}$ of the beam's span is acceptable.

The following table of beam formulas contains factors to be applied when analyzing a strut/beam in various configurations. These factors account for the difference in deflection that will be experienced by beams mounted in various configurations and subject to various types of loads.

Also included in the tables of channel information are values for the Moment of Inertia (I) and Section Modulus (S) of the channel. These values are given for both the X-X and Y-Y axis of the channel. They are measures of the stiffness of the beam's cross-sectional shape, and are used to calculate deflection. Deflection decreases as I and S increase. The Modulus of Elasticity (E), listed below I and S, is a measure of the beam material's resistance to bending. Again, as E increases, deflection decreases.

SAFETY FACTOR

The design loads given for strut beam loads are based on a simple beam condition using allowable stress of 25,000 psi. This allowable stress results in a safety factor of 1.68. This is based upon a virgin steel minimum yield strength of 33,000 psi cold worked during rolling to an average yield stress of 42,000 psi.

Aluminum typically has an elastic modulus which is $\frac{1}{3}$ that of steel even though they may have identical strength. As a result, the deflection of aluminum channel will be three times that of steel channel under equal loading. In areas where structures will be subject to general viewing, deflection can produce a displeasing effect. To the untrained eye, a sagging channel may appear to be a result of poor design or excessive loading. This is not usually the case. Many properly designed channel installations will show a noticeable deflection at their designed loads. In areas where cosmetics are not important, deflection should not be a factor. Designing an entire installation based on minimal deflection could result in an over designed structure. This translates into increased material and installation cost. Where cosmetics are important, it may be necessary to limit the deflection to an aesthetically pleasing amount. This "acceptable deflection" amount is typically given as a fraction of the span. $\frac{1}{240}$ span deflection is typically the limit where the amount of deflection appears negligible. For example, a beam span of 240" would be allowed 1" ($\frac{240}{240}$) of deflection at the mid point. A 120" span would only be allowed $\frac{1}{2}$" ($\frac{120}{240}$) of deflection. The maximum load for the channel must be limited in order to remain under these deflection requirements. The allowable load resulting in $\frac{1}{240}$ span deflection is posted in the beam load chart for each channel length.

TWISTING & LATERAL BRACING

For long spans and when loads are apt to cause torsion on the beam, it is a good practice to brace the beam to prevent twisting or lateral bending. PHD offers various types of braces for this purpose.

Loading of strut on long spans can cause torsional stress, resulting in the tendency of the strut to twist or bend laterally. This phenomenon reduces the allowable beam loads as shown in the beam loading charts. It is recommended that long spans be supported in a manner to prevent twisting (fixed ends), and that the channel have adequate lateral bracing. Many typical strut applications provide this support and bracing inherently. Piping, tubing, cable trays, or conduits mounted to the strut with straps and clamps prevent twisting or lateral movement.

BENDING MOMENT & STRESSES

When loads are placed on a beam, the effect is to flex the beam across its unsupported span. The measure of this effect is called the bending moment. Formulas for bending moments created by various load and beam support combinations are given in the beam diagrams & common formulas section.

When the bending moment of a loaded beam is divided by the Section Modulus of the beam, the resulting value is called bending stress. It is this bending stress that is most commonly evaluated to determine whether a beam is strong enough for the loads it must support.

The maximum bending stress prescribed by structural codes is 25,000 psi (172.37 mPa), and this is the stress upon which PHD load figures are based.

Again, the method of supporting a beam affects the maximum bending moment of the beam. The following table gives modifying factors based upon types of beam supports. Users of PHD struts should take care to apply the proper load factor for the specific beam support configuration in order to determine the proper maximum load that the strut will safely support.

WELDING

SPOT WELD

6"
(152.4)

1"
(25.4)

MIG WELD
³⁄₁₆" (4.76) FILLET
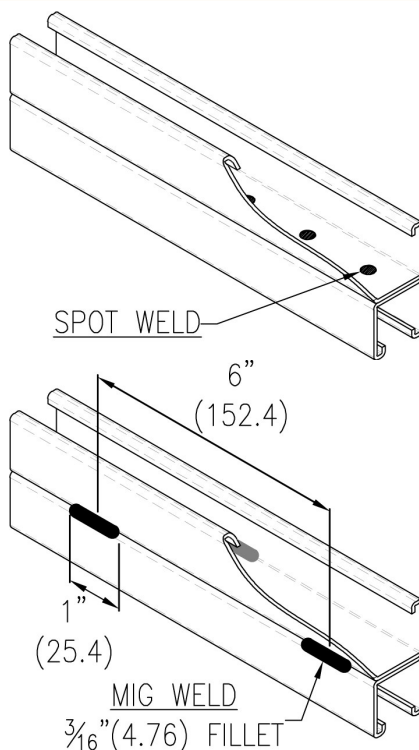
Spot Welding –

Resistance welding of back to back strut channel is accomplished by way of an AC powered press type spot welder. This equipment produces a series of spot welds from 2" (50.8) to 4" (101.6) apart continuously down the length of the channel. Consistency is maintained by the use of a highly sophisticated constant current weld control. This processor is capable of maintaining weld sequence, duration and current control along with other variables. Any deviations in the programmed parameters will issue forth an alarm or shut down fault, which is then investigated. Weld quality is tested every 300-350 welds through the use of a destructive test method.

Through the use of modern technology, destructive and non-destructive testing, the quality of strut can be maintained. Spot weld strut is fabricated in accordance with the R.W.M.A. guidelines for resistance welding.

MIG Welding –

MIG welded, more properly called gas metal arc welded (GMAW) combination channels and fittings, are produced when physical dimensions or certain combinations require a weld process other than automatic spot welding. The same quality control requirements are imposed on MIG welded and spot-welded products.

COLUMNS

Structural members installed in a vertical attitude and subject to vertical loads are known as columns. The loads on a column have the effect of compressing the column and attempting to deflect the column laterally. As with beams, the method by which a column is mounted affects the load-carrying capability of the column. The effect of each method is quantified by the value "K", given for each support condition shown below.

Loads on a column may be concentric (directly in line with the column's vertical axis) or eccentric (offset horizontally from the vertical axis). PHD provides allowable column loads for concentric loading conditions. In addition, the tables accompanying the channels contain a value called the "radius of gyration". This value can be used by a qualified structural engineer to analyze the effect of eccentric loads on strut columns.

Common mounting methods for columns include:

Fixed Top, Fixed Bottom –
Both the top and bottom of the column are rigidly mounted in such a way that rotation and displacement are prevented. The value of "K" for this configuration is .65. *See Figure 1.*

Pinned Top, Pinned Bottom –
Both the top and bottom of the column are mounted in such a way that rotation is permitted but displacement is prevented. The value of "K" for this configuration is 1.0. *See Figure 2.*

Pinned Top, Fixed Bottom –
The top of the column is pinned to allow rotation, and the bottom of the column is rigidly mounted in such a way that rotation and displacement are prevented. This is a common method. And is the "standard" for which PHD allowable column loads are listed. The value of "K" for this configuration is .80. *See Figure 3.*

Free Top, Fixed Bottom –
The bottom of the column is rigidly mounted. The top of the column is free to move laterally, but is restrained to prevent rotation. The value of "K" for this configuration is 1.2. *See Figure 4.*

As stated above, allowable column loads published in this catalog are based on the "Pinned Top, Fixed Bottom" mounting configuration, which has a "K" factor of .80. For any of the other mounting configurations, a qualified design professional can use the "K" values given to calculate the allowable column load.

Fig. 1   Fig. 2

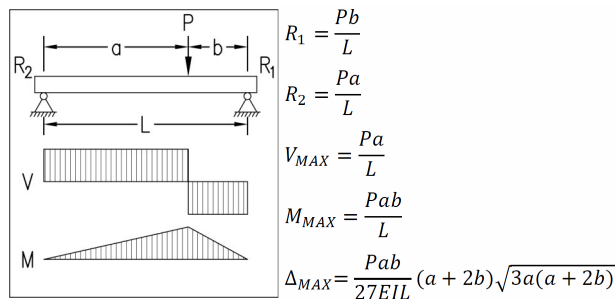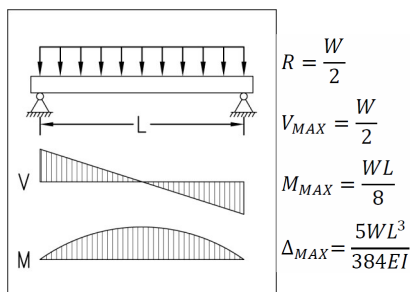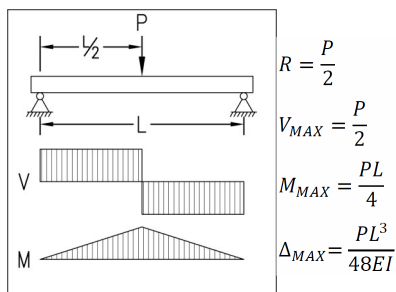Fig. 3   Fig. 4
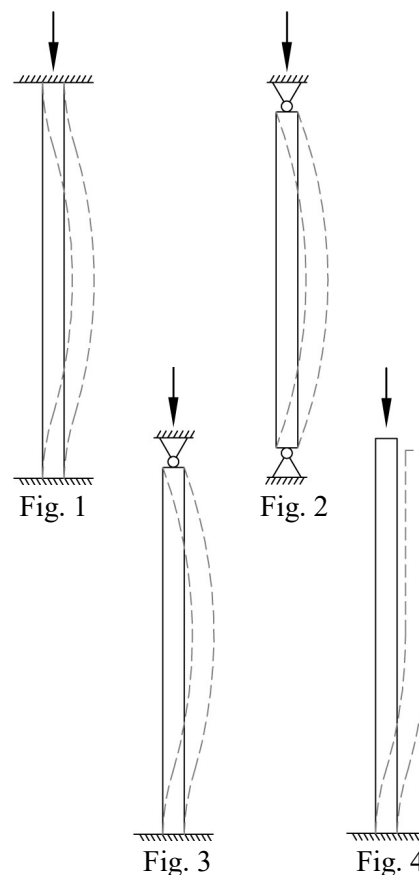
BOLT TORQUE

Bolt torque values are given to ensure the proper connection between PHD Metal Framing components. It is important to understand that there is a direct, but not necessarily consistent, relationship between bolt torque and tension in the bolt. Too much tension in the bolt can cause it to break or crush the component parts. Too little tension in the bolt can prevent the connection from developing its full load capacity. The torque values given have been developed over many years of experience and testing.

These are based on using a properly calibrated torque wrench with a clean dry (non-lubricated) PHD fitting, bolt and nut. A lubricated bolt or nut can cause extremely high tension in the connection and may lead to bolt failure. It must be noted that the accuracy of commercial torque wrenches varies widely and it is the responsibility of the installer to ensure that proper bolt torque has been achieved.
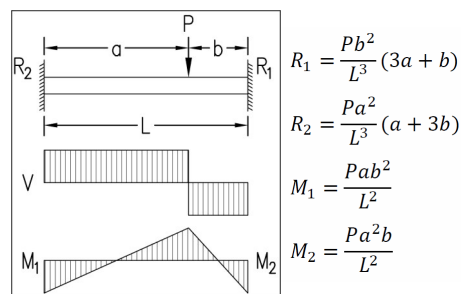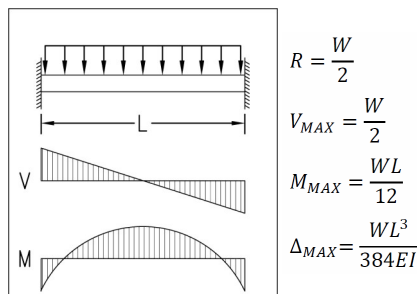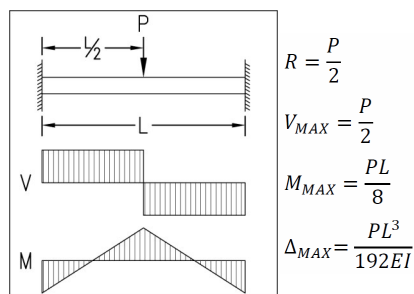
Recommended Bolt Torque						
Bolt Size	1/4"-20	5/16"-18	3/8"-16	1/2"-13	5/8"-11	3/4"-10
ft-lbs	6	11	19	50	100	125
N-m	(8)	(15)	(26)	(68)	(136)	(170)

BEAM DIAGRAMS AND COMMON FORMULAS

Simply Supported Beams

$$R = \frac{P}{2}$$
$$V_{MAX} = \frac{P}{2}$$
$$M_{MAX} = \frac{PL}{4}$$
$$\Delta_{MAX} = \frac{PL^3}{48EI}$$

$$R = \frac{W}{2}$$
$$V_{MAX} = \frac{W}{2}$$
$$M_{MAX} = \frac{WL}{8}$$
$$\Delta_{MAX} = \frac{5WL^3}{384EI}$$

$$R_1 = \frac{Pb}{L}$$
$$R_2 = \frac{Pa}{L}$$
$$V_{MAX} = \frac{Pa}{L}$$
$$M_{MAX} = \frac{Pab}{L}$$
$$\Delta_{MAX} = \frac{Pab}{27EIL}(a+2b)\sqrt{3a(a+2b)}$$

Fixed End Beams

$$R = \frac{P}{2}$$
$$V_{MAX} = \frac{P}{2}$$
$$M_{MAX} = \frac{PL}{8}$$
$$\Delta_{MAX} = \frac{PL^3}{192EI}$$

$$R = \frac{W}{2}$$
$$V_{MAX} = \frac{W}{2}$$
$$M_{MAX} = \frac{WL}{12}$$
$$\Delta_{MAX} = \frac{WL^3}{384EI}$$

$$R_1 = \frac{Pb^2}{L^3}(3a+b)$$
$$R_2 = \frac{Pa^2}{L^3}(a+3b)$$
$$M_1 = \frac{Pab^2}{L^2}$$
$$M_2 = \frac{Pa^2b}{L^2}$$

Cantilever Beams

$$V_{MAX} = P$$
$$M_{MAX} = PL$$
$$\Delta_{MAX} = \frac{PL^3}{3EI}$$

$$V_{MAX} = W$$
$$M_{MAX} = \frac{WL}{2}$$
$$\Delta_{MAX} = \frac{WL^3}{8EI}$$

$$V_{MAX} = P$$
$$M_{MAX} = Pb$$
$$\Delta_{MAX} = \frac{Pb^2(3L-b)}{6EI}$$
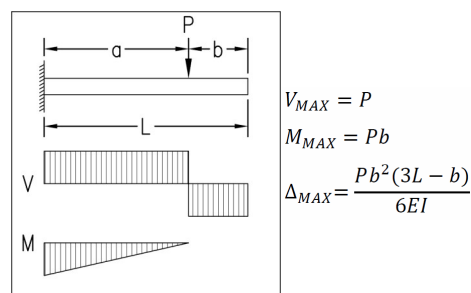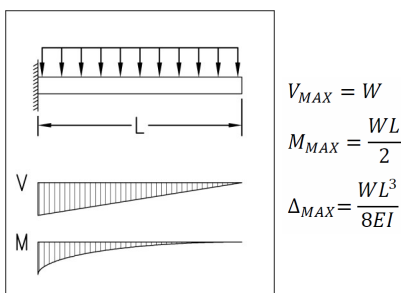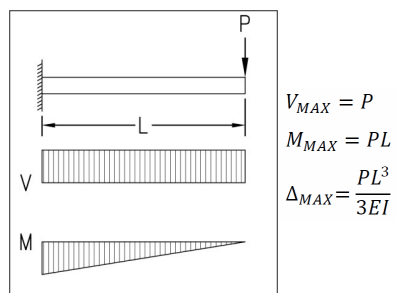
Beams with one end Fixed and one end Simply Supported

$$R_1 = \frac{5P}{16}$$
$$V_{MAX} = \frac{11P}{16}$$
$$M_{MAX} = \frac{3PL}{16}$$
$$\Delta_{MAX(at\ P)} = 0.447L$$

$$R_1 = \frac{3W}{8}$$
$$V_{MAX} = \frac{5W}{8}$$
$$M_{MAX} = \frac{WL}{8}$$
$$\Delta_{MAX} = \frac{WL^3}{185EI}$$

$$R_1 = \frac{Pb^2}{2L^3}(a+2L)$$
$$R_2 = \frac{Pa}{2L^3}(3L^2+a^2)$$
$$M_{(at\ P)} = R_1 a$$
$$M_{(at\ R_1)} = \frac{Pab}{2L^3}(a+L)$$
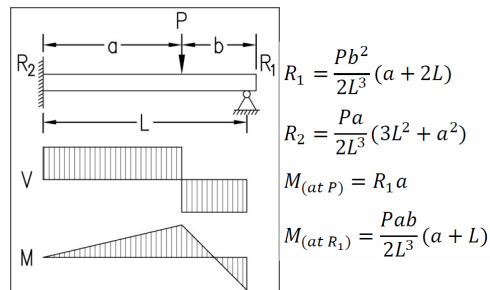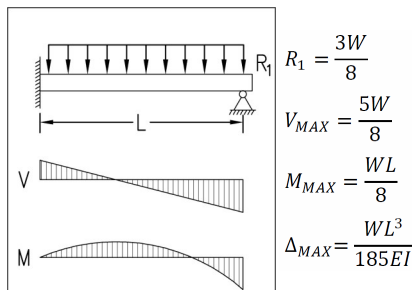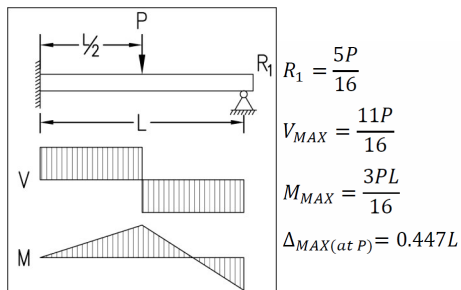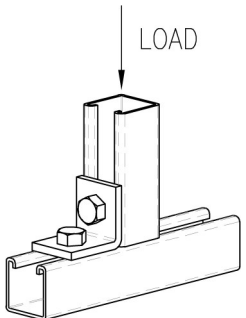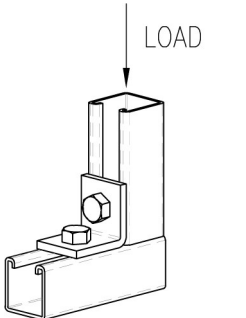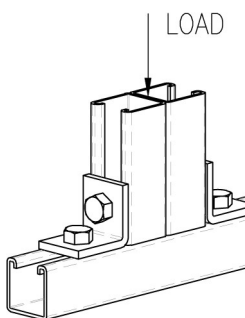
LATERAL BRACING LOAD REDUCTION FACTORS

Beam Span or Unbraced Length		Single Channel Series									Welded Double Channel Series								
		1000	1100	1200	1300	1400	1500	1600	1700	1800	1000	1100	1200	1300	1400	1500	1600	1700	1800
24	(609.6)	1.00	1.00	1.00	1.00	1.00	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
36	(914.4)	0.94	0.89	1.00	0.98	1.00	0.85	0.89	0.96	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
48	(1219.2)	0.88	0.78	1.00	0.94	0.98	0.70	0.77	0.91	0.88	1.00	0.98	1.00	1.00	1.00	0.97	0.98	1.00	0.98
60	(1524.0)	0.82	0.68	1.00	0.91	0.96	0.55	0.67	0.88	0.83	0.97	0.93	1.00	0.96	1.00	0.90	0.93	0.98	0.93
72	(1828.8)	0.78	0.59	0.98	0.89	0.94	0.44	0.58	0.84	0.79	0.93	0.87	0.97	0.92	0.97	0.83	0.87	0.95	0.88
84	(2133.6)	0.75	0.52	0.97	0.86	0.92	0.38	0.51	0.82	0.75	0.89	0.82	0.95	0.89	0.95	0.76	0.81	0.92	0.83
96	(2438.4)	0.71	0.47	0.96	0.84	0.91	0.33	0.46	0.79	0.72	0.85	0.76	0.92	0.85	0.92	0.68	0.76	0.88	0.79
108	(2743.2)	0.69	0.43	0.95	0.82	0.89	0.30	0.42	0.77	0.69	0.81	0.70	0.90	0.81	0.90	0.61	0.70	0.85	0.74
120	(3048.0)	0.66	0.40	0.94	0.80	0.87	0.28	0.40	0.75	0.66	0.78	0.65	0.87	0.78	0.87	0.54	0.64	0.82	0.69
144	(3657.6)	0.61	0.36	0.91	0.76	0.84	0.24	0.36	0.70	0.60	0.70	0.54	0.83	0.71	0.82	0.43	0.53	0.76	0.60
168	(4267.2)	0.55	0.32	0.89	0.73	0.81	0.22	0.32	0.66	0.55	0.63	0.45	0.78	0.64	0.77	0.35	0.45	0.70	0.51
192	(4876.8)	0.51	0.30	0.87	0.69	0.78	0.21	0.30	0.62	0.50	0.56	0.39	0.73	0.57	0.72	0.30	0.39	0.64	0.44
216	(5486.4)	0.47	0.28	0.84	0.65	0.75	0.19	0.28	0.58	0.47	0.49	0.34	0.68	0.50	0.67	0.27	0.34	0.58	0.39
240	(6096.0)	0.44	0.26	0.82	0.61	0.72	0.18	0.26	0.54	0.43	0.44	0.31	0.63	0.45	0.62	0.24	0.30	0.52	0.35
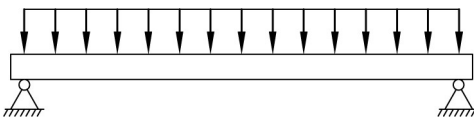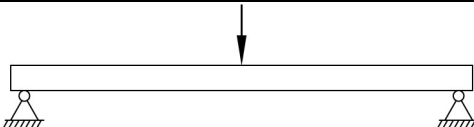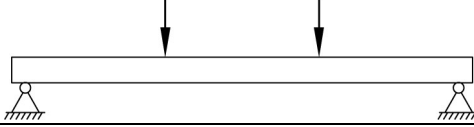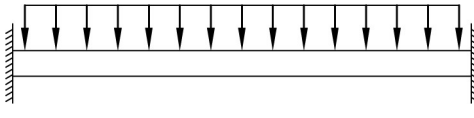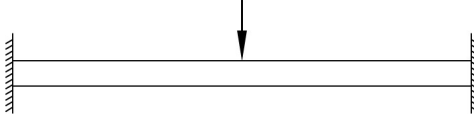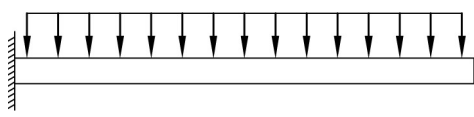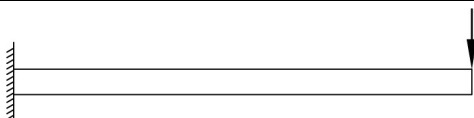
BEARING LOADS ON CHANNEL

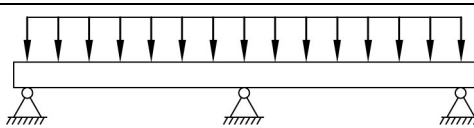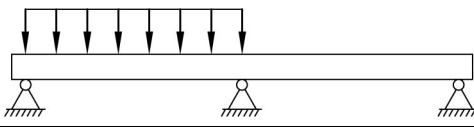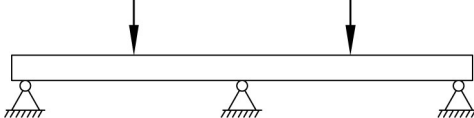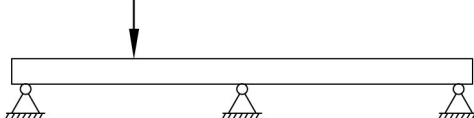| Channel	Bearing Length = 1⁵/₈ (41.3) Maximum Allowable Loads		Bearing Length = 1⁵/₈ (41.3) Maximum Allowable Loads		Bearing Length = 3¹/₄ (82.6) Maximum Allowable Loads	
	Lbs.	kN	Lbs.	kN	Lbs.	kN
1000	6700	(29.8)	3100	(13.8)	7700	(34.3)
1100	3500	(15.6)	1700	(7.6)	4000	(17.8)
1200	7300	(32.5)	3400	(15.1)	8400	(37.4)
1300	3500	(15.6)	1800	(8.0)	4100	(18.2)
1400	7300	(32.5)	3400	(15.1)	8400	(37.4)
1500	6500	(28.9)	3000	(13.3)	7500	(33.4)
1600	6600	(29.4)	3100	(13.8)	7600	(33.8)
1700	6700	(29.8)	3200	(14.2)	7700	(34.3)
1800	2600	(11.6)	1200	(5.3)	3000	(13.3)

Loads are calculated based on Specification For The Design Of Cold Formed Steel Structural Members published by AISI.

BEAM LOAD & DEFLECTION CONVERSION FACTORS

The allowable beam loads listed for various spans of each channel assume that the beam is a simply supported, single span beam. Although this is the most common condition, it is not always true. For other support conditions, multiply the listed allowable load by the factors in this table to obtain the proper load for the given mounting type.

| Load & Support Configuration	Diagram	Load Factor	Deflection Factor
1) Simply Supported Beam, Uniform Load		1.00	1.00
2) Simply Supported Beam, Concentrated Load at Mid-span		.50	.80
3) Simply Supported Beam, Two Equal Concentrated Loads at $^1/_4$ Points		1.00	1.10
4) Fixed End Beam, Uniform Load		1.50	.30
5) Fixed End Beam, Concentrated Load at Mid-span		1.00	.40
6) Cantilever Beam, Uniform Load		.25	2.40
7) Cantilever Beam, Concentrated Load at End		.12	3.20
8) Continuous Beam, Two Equal Spans, Uniform Load Both Spans		1.00	.42
9) Continuous Beam, Two Equal Spans, Uniform Load on One Span		1.30	.92
10) Continuous Beam, Two Equal Spans, Concentrated Load at Mid-span of Each		.62	.71
11) Continuous Beam, Two Equal Spans, Concentrated Load at Mid-span of One		.66	.48

SAMPLE PROBLEMS

Problem 1 –

The beam at right is a PHD 1001 Channel, simply supported. What is the maximum allowable load P? How much will the beam deflect under that load?

Answer –

From the table of Beam and Column Loads for 1001 Channel, the load for this span is 851 lbs. and the deflection is .22". From the table of load factors, the load conversion factor is .50 and the deflection factor is .80. Therefore, the maximum load P = 851 X .50 = 425 lbs., and the deflection is .22" x .80 = .176".
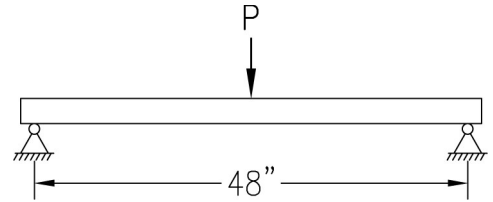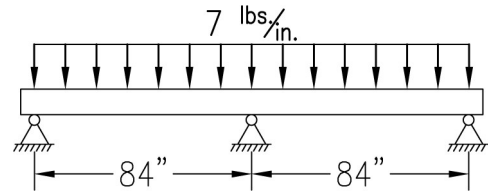
Problem 2 –

A PHD 1001 Channel is supported at 3 points as shown, making it a continuous beam with 2 spans. The required loading condition is a uniform load of 7 lbs. per inch over both spans. Is the Channel able to safely support this load?

Answer –

The entire load on one span of this beam is $7^{lbs.}/_{in.}$ X 84" = 588 lbs. The allowable load is 486, and the load factor is 1.00, so the allowable load remains 486 lbs. Therefore the beam is not acceptable, since the required load exceeds the allowable load. A different PHD channel must be used, or the load must be decreased.
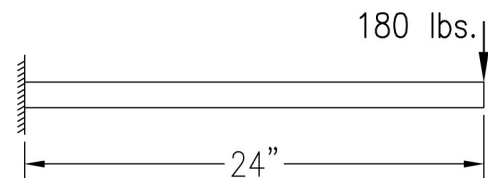
Problem 3 –

The cantilever beam shown at right carries a concentrated load of 180 lbs. at the end of the 24" PHD 1001 Channel. Is the load acceptable? Calculate the maximum bending moment and deflection.

Answer –

The maximum load is 1702 lbs., and the load factor is .12, so the maximum load is 1702 X .12 = 204 lbs. The desired 180 lb. load is within the allowable.

From the table of beam formulas, the maximum bending moment for this support condition is M = PL. For the beam show, then, M = 180 lb. X 24" = 4320 inch-pounds. Deflection for this cantilever beam = $PL^3/3EI$. E = Modulus of Elasticity, which is $30 X 10^6$ for steel. I is the Moment of Inertia, listed in the channel information as $.189 in^4$. The deflection then, is found by the equation $[180(24)^3]/[3(30 X 10^6)(.189)] = .146"$.

Problem 4 –

Determine the maximum load and deflection of a PHD 1001 Channel fixed at both ends and carrying a uniform load over its entire 60" span.
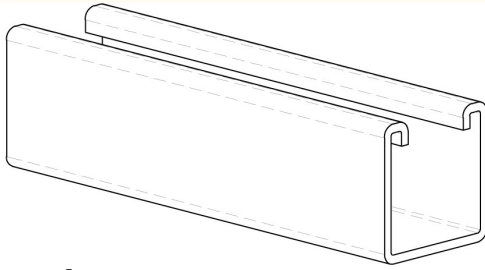
Answer –

The maximum load from the chart is 681 lbs., and the load factor is 1.50, so the maximum load for this beam is 681 X 1.50 = 1021.5 lbs. Similarly, the deflection for this beam is .35" and the deflection factor is .30, so the deflection = .35 X .30 = .105".
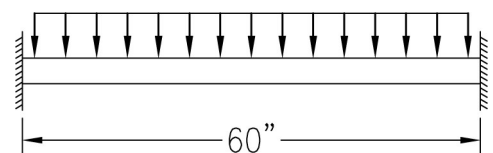
SELECTION CHART

Channel

PHD's metal framing channel is cold formed on our modern rolling mills from 12 Ga., 14 Ga., and 16 Ga. low carbon steel strips. A continuous slot with inturned lips provides the ability to make attachments at any point.

Lengths
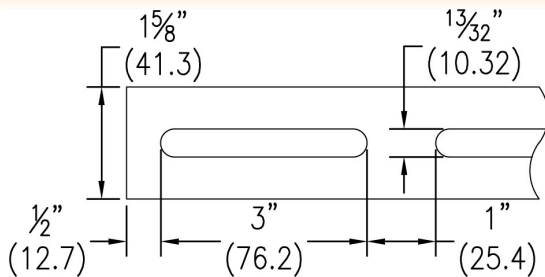
Standard lengths are 10' (3.05m) and 20' (6.09m) with length tolerance of $\pm\frac{1}{8}$" ($\pm$3.2mm). Custom lengths are available upon request.

Design Load (Steel & Stainless Steel)

The design loads given for strut beam loads are based on a simple beam condition using an allowable stress of 25,000 psi (172.37mPa). This allowable stress results in a safety factor of 1.68. This is based upon virgin steel minimum yield strength of 33,000 psi (227.53mPa) cold worked during rolling to an average yield stress of 42,000 psi (289.58mPa). For aluminum channel loading multiple steel loading by a factor of 0.38.
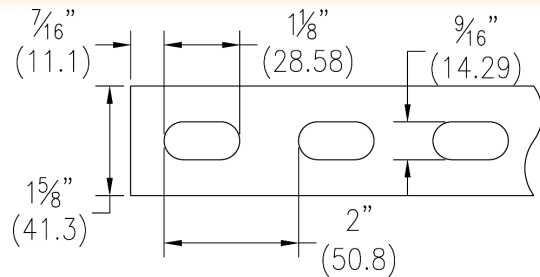
Figure Number	Width		Height		Material Gauge				See Page Number
					Carbon Steel	Stainless Steel	Aluminum		
1001 – 1042	1⅝	(41.28)	1⅝	(41.28)	12 Ga.	12 Ga.	0.105	(2.67)	30 - 31
1101 – 1142	1⅝	(41.28)	1⅝	(41.28)	14 Ga.	N/A	N/A	N/A	32 - 33
1201 – 1242	1⅝	(41.28)	13/16	(20.64)	12 Ga.	N/A	N/A	N/A	34 - 35
1301 – 1342	1⅝	(41.28)	13/16	(20.64)	14 Ga.	14 Ga.	0.075	(1.9)	36 - 37
1401 – 1442	1⅝	(41.28)	1	(25.40)	12 Ga.	N/A	N/A	N/A	38 - 39
1501 – 1542	1⅝	(41.28)	3¼	(82.55)	12 Ga.	12 Ga.	N/A	N/A	40 - 41
1601 – 1642	1⅝	(41.28)	2⁷/16	(61.91)	12 Ga.	12 Ga.	N/A	N/A	42 - 43
1701 – 1742	1⅝	(41.28)	1⅜	(34.93)	12 Ga.	N/A	N/A	N/A	44 - 45
1801 – 1842	1⅝	(41.28)	13/16	(20.64)	16 Ga.	N/A	N/A	N/A	46 - 47
1950	1⅞	(47.63)	1⅞	(47.63)	12 Ga.	N/A	N/A	N/A	48 - 49
1960	1⅝	(41.28)	1⅝	(41.28)	12 Ga.	N/A	N/A	N/A	48 - 49

LONG SLOTS

1⅝" (41.3) 13/32" (10.32) ½" (12.7) 3" (76.2) 1" (25.4)

PHD's slotted series of channels offer full flexibility. A variety of pre-punched slot patterns eliminate the need for precise field measuring for hole locations. Slots offer wide adjustments in the alignment and bolt sizing.

SLOTS

7/16" (11.1) 1⅛" (28.58) 9/16" (14.29) 1⅝" (41.3) 2" (50.8)

HOLES

1⅞" (47.63) 1⅝" (41.3) 15/16" (23.81) 9/16" (14.29)
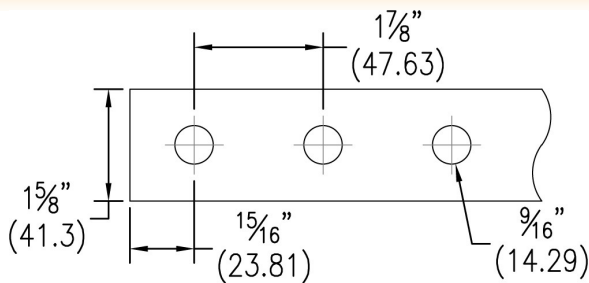
A pre-punched 9/16" (14.3mm) diameter hole pattern is available in most PHD channel. This hole pattern provides an economical alternative to costly field drilling required for many applications.

KNOCKOUTS

1⅝" (41.3) ⅞" (22.23) Dia. Knockouts 3" (76.2) 6" (152.4)
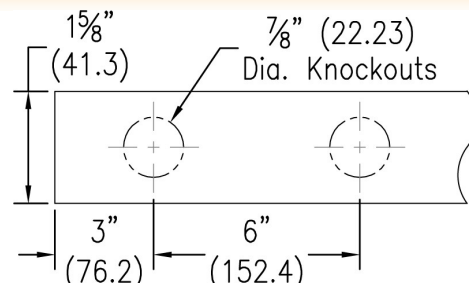
Most PHD channels can be furnished with ⅞" (22.2mm) knockouts on 6" (152mm) centers, allowing for perfect fixture alignment on spans up to 20' (6.09m).

CHANNEL COMBINATIONS

1000 SERIES	1100 SERIES	1200 SERIES	1300 SERIES	1400 SERIES	1500 SERIES	1600 SERIES	1700 SERIES	1800 SERIES

1000 A	1000 B	1000 C	1000 D	1000 E-3	1000 F-3	1000 G-3	1000 H-3	1000 I-4

1100 A	1100 B	1100 C	1100 D	1200 A	1300 A	1400 A

1500 A	1600 A	1700 A	1800 A	1960	1950	1950 & 1960
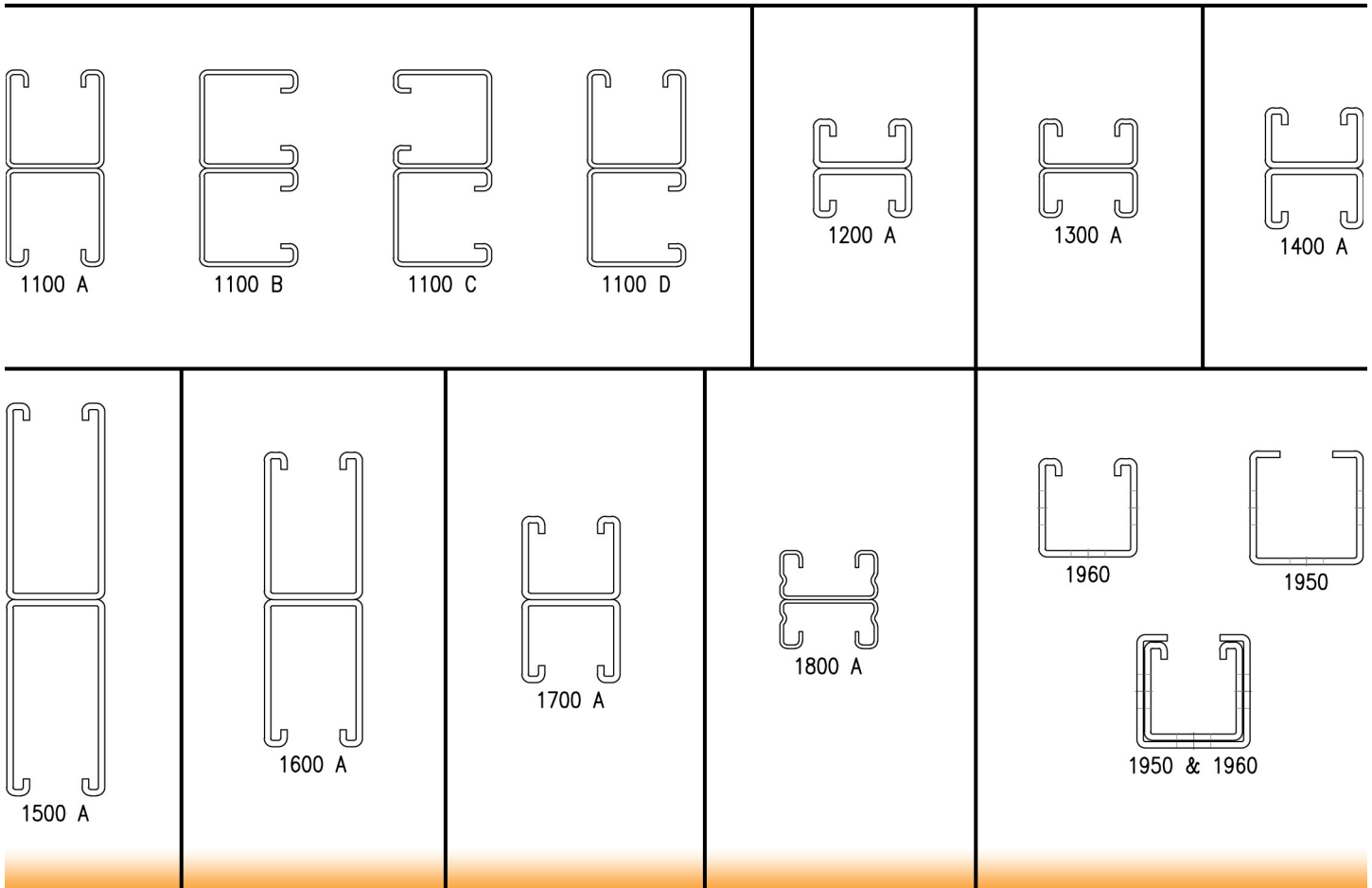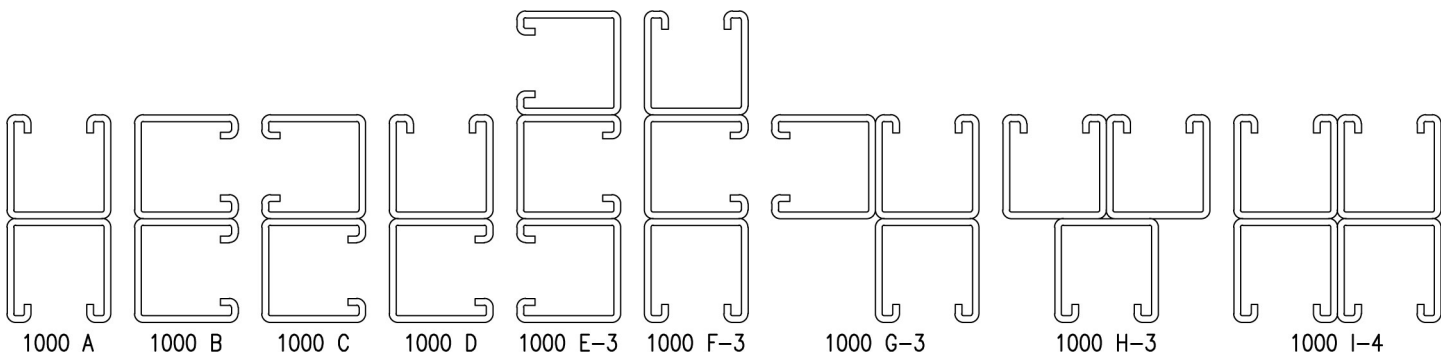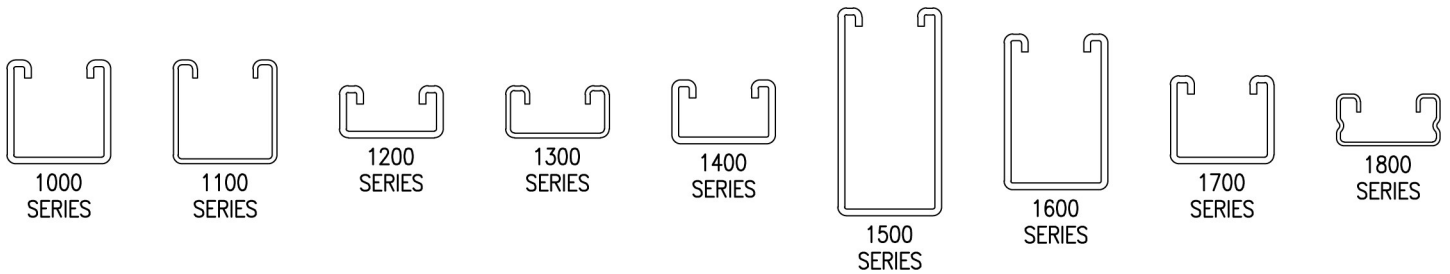
STRUT NUT LOAD DATA
MAXIMUM ALLOWABLE PULL-OUT, SLIP LOAD AND DESIGNED TORQUE VALUES

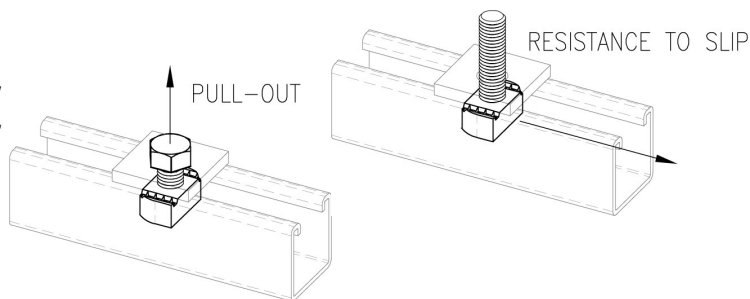| Strut Nut		Channel Gauge	Channel Series	Allowable Pull-out		Resistance To Slip		Bolt Torque	
Thread Size	Figure Number			lbs.	kN	lbs.	kN	ft-lbs	N-m
1/4-20	3004, 3104, 3204, 3304, 3404	12	1000, 1200, 1500, 1600, 1700, 1960	450	(2.00)	300	(1.33)	6	(8)
		14	1100, 1300	450	(2.00)	300	(1.33)		
		16	1800	450	(2.00)	300	(1.33)		
5/16-18	3005, 3105, 3205, 3305	12	1000, 1200, 1500, 1600, 1700, 1960	800	(3.56)	500	(2.22)	11	(15)
		14	1100, 1300	750	(3.34)	400	(1.78)		
		16	1800	750	(3.34)	400	(1.78)		
3/8-16	3006, 3106, 3206, 3306, 3406	12	1000, 1200, 1500, 1600, 1700, 1960	1000	(4.45)	800	(3.56)	19	(26)
		14	1100, 1300	1000	(4.45)	600	(2.67)		
		16	1800	1000	(4.45)	600	(2.67)		
7/16-14	3007, 3107, 3207, 3307	12	1000, 1200, 1500, 1600, 1700, 1960	1400	(6.23)	1000	(4.45)	35	(47)
		14	1100, 1300	1200	(5.34)	800	(3.56)		
		16	1800	1000	(4.45)	800	(3.56)		
1/2-13	3408	12	1000, 1200, 1500, 1600, 1700, 1960	1000	(4.45)	800	(3.56)	50	(68)
	3208, 3351	12	1000, 1200, 1500, 1600, 1700, 1960	1500	(6.67)	1500	(6.67)		
	3008, 3108, 3308	12	1000, 1500, 1600, 1700, 1960	2000	(8.90)	1500	(6.67)		
	3008, 3108, 3208, 3308, 3351	14	1100	1400	(6.23)	1000	(4.45)		
	3208, 3351	14	1300	1400	(6.23)	1000	(4.45)		
		16	1800	1000	(4.45)	1000	(4.45)		
5/8-11	3209, 3352	12	1000, 1200, 1500, 1600, 1700, 1960	1500	(6.67)	1500	(6.67)	100	(136)
	3009, 3109, 3309	12	1000, 1500, 1600, 1700, 1960	2500	(11.12)	1500	(6.67)		
	3009, 3109, 3209, 3309, 3352	14	1100	1400	(6.23)	1000	(4.45)		
	3209, 3352	14	1300	1400	(6.23)	1000	(4.45)		
		16	1800	1000	(4.45)	1000	(4.45)		
3/4-10	3210, 3353	12	1000, 1200, 1500, 1600, 1700, 1960	1500	(6.67)	1500	(6.67)	125	(170)
	3010, 3110, 3310	12	1000, 1500, 1600, 1700, 1960	2500	(11.12)	1700	(6.67)		
	3010, 3110, 3210, 3310, 3353	14	1100	1400	(6.23)	1000	(4.45)		
	3210, 3353	14	1300	1400	(6.23)	1000	(4.45)		
		16	1800	1000	(4.45)	1000	(4.45)		
7/8-9	3011, 3111, 3311	12	1000, 1500, 1600, 1700, 1960	2500	(11.12)	1700	(6.67)	125	(170)
		14	1100	1400	(6.23)	1000	(4.45)		

Note: When used in conjunction with a Fig. 5000 series square washer.

Using stainless steel channel nuts in stainless steel channel, reduce slip loads by 50% due to hardness of material.

Using stainless steel channel nuts in aluminum channel, reduce slip loads and pull out loads by 70% due to hardness of material.

PULL-OUT

RESISTANCE TO SLIP

Unless otherwise specified, all dimensions on drawings and in charts are in inches and dimensions shown in parentheses are in millimeters.

Design Load Data
FOR TYPICAL CHANNEL STRUT CONNECTIONS

90°FITTINGS (WHEN USED IN POSITION SHOWN)

ORIENTATIONS										
FITTING	5112		5112		5130 & 5131		5130 & 5131		5120 & 5121	
CHANNEL GAUGE	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn
12	1500	(6.67)	1000	(4.45)	2000	(8.90)	2000	(8.90)	1500	(6.67)
14	1000	(4.45)	650	(2.89)	2000	(8.90)	1650	(7.34)	1000	(4.45)
16	750	(3.34)	500	(2.22)	1500	(6.67)	1250	(5.56)	1000	(4.45)

90° FITTINGS (WHEN USED IN POSITION SHOWN)

ORIENTATIONS										
FITTING	5122		5165		5165		5110		5121	
CHANNEL GAUGE	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn
12	2000	(8.90)	3000	(13.34)	2500	(11.12)	500	(2.22)	500	(2.22)
14	1500	(6.67)	2000	(8.90)	1650	(7.34)	500	(2.22)	500	(2.22)
16	900	(4.00)	1500	(6.67)	1250	(5.56)	500	(2.22)	500	(2.22)

90° FITTINGS (WHEN USED IN POSITION SHOWN)   FLAT PLATE FITTINGS

ORIENTATIONS										
FITTING	5120 & 5121		5122		5121		5010		5010	
CHANNEL GAUGE	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn	Lbs.	Kn
12	1000	(4.45)	1200	(5.34)	1500	(6.67)	1000	(4.45)	1000	(4.45)
14	650	(2.89)	1200	(5.34)	1150	(5.12)	800	(3.56)	800	(3.56)
16	500	(2.22)	1000	(4.45)	650	(2.89)	600	(2.67)	600	(2.67)

Assumptions:
Both ends of beams were assumed supported (used in pairs)
Load data based on carbon steel Fig. 3008 strut nut and $1/2$" bolt
Safety factor = $2\,1/2$ based on ultimate strength

Unless otherwise specified, all dimensions on drawings and in charts are in inches and dimensions shown in parentheses are in millimeters.