



## SHACKLES

### DESIGN

The theoretical reserve capability of carbon shackles should be at a minimum 5 to 1, and alloy shackles a minimum of 4 to 1. Known as the Design Factor, it is usually computed by dividing the catalog Ultimate Load by the Working Load Limit.

The Ultimate Load is the average load or force at which the product fails or no longer supports the load.

The Working Load Limit is the maximum mass or force which the product is authorized to support in general service. The Design Factor is generally expressed as a ratio such as 5 to 1, or 5:1.

Also important to the design of shackles is the selection of proper steel to support fatigue, ductility, and impact properties.

#### Questions to ask your rigging provider

*What is the Working Load Limit and Design Factor for shackles?*

*Is deformation upon overloading a critical consideration in their design?*

*Do they jeopardize other properties by having high hardness in order to increase Working Load Limit or Design Factor?*

#### Why choose Crosby

Crosby carbon shackles have the highest design factor (6 to 1) in the industry. All Crosby Design Factors are documented.

Kito Crosby purchases only special bar forging quality steel with cleanliness and guaranteed harden ability. All material chemistry is independently verified prior to manufacturing.

The design of Crosby shackles assures that strength, ductility, and fatigue properties are met.

### CLOSED DIE FORGING

The proper performance of premium shackles depends on good manufacturing techniques that include proper forging and accurate machining. Closed-die forging of shackles assures clear lettering, superior grain flow, and consistent dimensional accuracy.

A closed-die forged bow allows for an increased cross section that, when coupled with quench and tempering, enhances strength and ductility.

Closed-die bow forgings combined with close tolerance pin holes assures good fatigue life. Close pin-to-hole tolerance has been proven to be critical for good fatigue life, particularly with screw pin shackles.

#### Questions to ask your rigging provider

*Are their shackles closed-die forged with close tolerance pin holes?*

*Do their shackles have good fatigue life?*

*Do their shackles have a fatigue life that meets the new world standards?*

Many forge bows utilize an open die forging process which allows for inconsistent dimensional accuracy and increased pin hole clearance, thus jeopardizing the fatigue life of the shackle in actual use.

#### Why choose Crosby

Each shackle is closed-die forged. Closed-die forging produces consistent dimensions. A closed-die forged bow allows for an increased cross section that, when coupled with quench and tempering, enhances strength and ductility.

Close tolerance holes and concentric pins with good surface finishes are provided by Kito Crosby and are proven to provide improved fatigue life in actual use.

Crosby shackles are fatigue rated as well as load rated. Close pin to hole tolerance has been proven to be critical for good fatigue life, particularly with screw pin shackles.

### FATIGUE PROPERTIES

The mechanical properties of steel when a load is repeatedly applied is known as its fatigue strength. Fatigue testing determines the ability of a material to withstand repeated applications of a load. The load by itself may be too small to produce a failure. There are three factors involved when considering fatigue strength: the number of cycles at which a crack initiates, the number of cycles at which the crack starts to grow, and the number of cycles at which the fitting fails. One accepted method of fatigue rating fittings is to test them to 1-1/2 times the working load limit for 20,000 cycles, without failure. This standard test is accepted as indicating indefinite life when used within the working load limit under normal circumstances.

#### Questions to ask your rigging provider

*Does the material selection process recognize fatigue properties?*

*Do they have an active program to design and test fatigue properties?*

*Is there a program in place to fatigue rate all load-bearing products that are used in critical applications?*

#### Why choose Crosby

Kito Crosby has an active program to determine fatigue properties. Included in this program is the use of finite element design methods to predict possible weak areas, which in turn allows us to design in superior fatigue properties.

Kito Crosby specifies material of specific cleanliness and guaranteed hardenability which enhances fatigue. We design and manufacture products with fatigue in mind and ensure all load-bearing products used in critical applications being fatigue rated.

### QUENCHED & TEMPERED

Quench and tempering assures the uniformity of performance and maximizes the properties of the steel. This means that each shackle meets its rated strength and has required ductility, toughness, impact, and fatigue properties.

The requirements of your job demand this reliability and consistency. This process develops a tough material that reduces the risk of brittle, catastrophic failure.

The shackle bow will deform if overloading occurs, giving warning before ultimate failure.

#### Questions to ask your rigging provider

*Are their bows and pins quenched and tempered?*

*If not, are they willing to accept inferior impact toughness, product deformation, and the increased risk of inconsistency?*

*Why do many manufacturers not recommend non-heat-treated shackles for overhead lifting?*

*Why do some recommend quench and tempering for alloy but not carbon grades?*

Many normalize the shackle bows. As a result, desired properties are not achieved. A few even provide bows in an 'as-forged' condition, resulting in the possibility of brittle failure.

#### Why choose Crosby

All Crosby shackle bows and pins are quenched and tempered, which enhances their performance under cold temperatures and adverse field conditions. Crosby carbon shackles are recommended for all critical applications including overhead lifting. Alloy shackles are recommended when specific dimensional requirements dictate a size that requires higher working load limits. Crosby shackles provide the tensile strength, ductility, impact, and fatigue properties that are essential if they are to perform time after time in adverse conditions.

These properties assure that the inspection criteria set forth by ANSI will effectively monitor the ability of the shackles to continue in service.

Watch our video on the Quench & Tempered process at [kitocrosby.com/QT](http://kitocrosby.com/QT).



### IDENTIFICATION & APPLICATION INFO

The proper application of shackles requires that the correct type and size of shackle be used. The shackle's Working Load Limit, its size, a traceability code, and the manufacturer's name should be clearly marked in the bow.

Traceability of the material chemistry and properties is essential for total confidence in the product. Material chemistry should be independently verified prior to manufacturing.

#### Questions to ask your rigging provider

*Do they have an active traceability system used in manufacturing?*

*Is the material chemistry independently verified?*

*What training support is provided?*

#### Why choose Crosby

We forge the Crosby name or "CG," the Working Load Limit, and the Product Identification Code (PIC) into each bow, and the Crosby name or "CG," and the PIC into each pin of its full line of screw pin, round pin, and bolt type anchor and chain shackles. Kito Crosby also provides training on the proper use of shackles.

Watch our training video on shackle identification at [kitocrosby.com/identification](http://kitocrosby.com/identification).

## CROSBY VALUE ADDED

- **Charpy impact properties:** Crosby shackles are quenched and tempered and have enhanced impact properties for greater toughness at all temperatures. If requested at the time of order, Kito Crosby can provide Charpy impact properties.
- **Fatigue properties:** Fatigue properties are available for 1/3 to 55 metric ton shackles. These Crosby shackles are fatigue rated to 20,000 cycles at 1-1/2 times the Working Load Limit.
- **Ductility properties:** Typical ductility properties are available for all sizes upon special request.
- **Hardness levels and material tensile strengths:** Typical values are available for all sizes of shackles, and actual values can be furnished if requested at the time of order.
- **Proof Testing:** If requested at the time of order, shackles can be proof tested with certificates.
- **Mag Certification:** If requested at the time of order, shackles can be magnetic particle inspected with certificates.
- **Certification:** Certification to world class standards is available upon special request at the time of order; American Bureau of Shipping, Lloyds Register of Shipping, Det Norske Veritas, American Petroleum Institute, RINA, Nuclear Regulatory Commission, and several other worldwide standards.
- **Applications:** **Round pin shackles** can be used in tie down, towing, suspension or lifting applications where the load is strictly applied in-line. **Screw pin shackles** can be used in any application where a round pin shackle is used. In addition, screw pin shackles can be used for applications involving side-loading circumstances. Reduced working load limits are required for side-loading applications. **Bolt type shackles** can be used in any application where round pin or screw pin shackles are used. In addition, they are recommended for permanent or long-term installations and where the load may slide on the shackle pin causing the pin to rotate.
- **Material analysis:** Kito Crosby can provide certified material (mill) analysis for each production lot, traceable by the Product Identification Code (PIC). Kito Crosby, through its own laboratory, verifies the analysis of each heat of steel. Kito Crosby purchases only **special bar** forging quality steel with specific cleanliness requirements and guaranteed hardenability.
- **Field inspection:** Written instructions for visual, magnaflux, and dye penetrant inspection of shackles are available from Kito Crosby. In addition, acceptance criteria and repair procedures for shackles are available.
- **QUIC-CHECK®:** Shackles incorporate two marking indicators forged into the shackle bow at 45° angles from vertical. These are utilized to quickly check the approximate angle of a two-legged hitch or check the angle of a single leg hitch. If the load is off vertical or side loaded a reduction in the Working Load Limit of the shackle is required.

### G-213

Round pin anchor shackles meet the performance requirements of Federal Specification RR-C-271G, Type IVA, Grade A, Class 1, except for those provisions required of the contractor.



### G-209

Screw pin anchor shackles meet the performance requirements of Federal Specification RR-C-271G, Type IVA, Grade A, Class 2, except for those provisions required of the contractor.



### G-2130

Bolt type anchor shackles meet the performance requirements of Federal Specification RR-C-271G, Type IVA, Grade A, Class 3, except for those provisions required of the contractor.



### G-215

Round pin chain shackles meet the performance requirements of Federal Specification RR-C-271G, Type IVB, Grade A, Class 1, except for those provisions required of the contractor.



### G-210

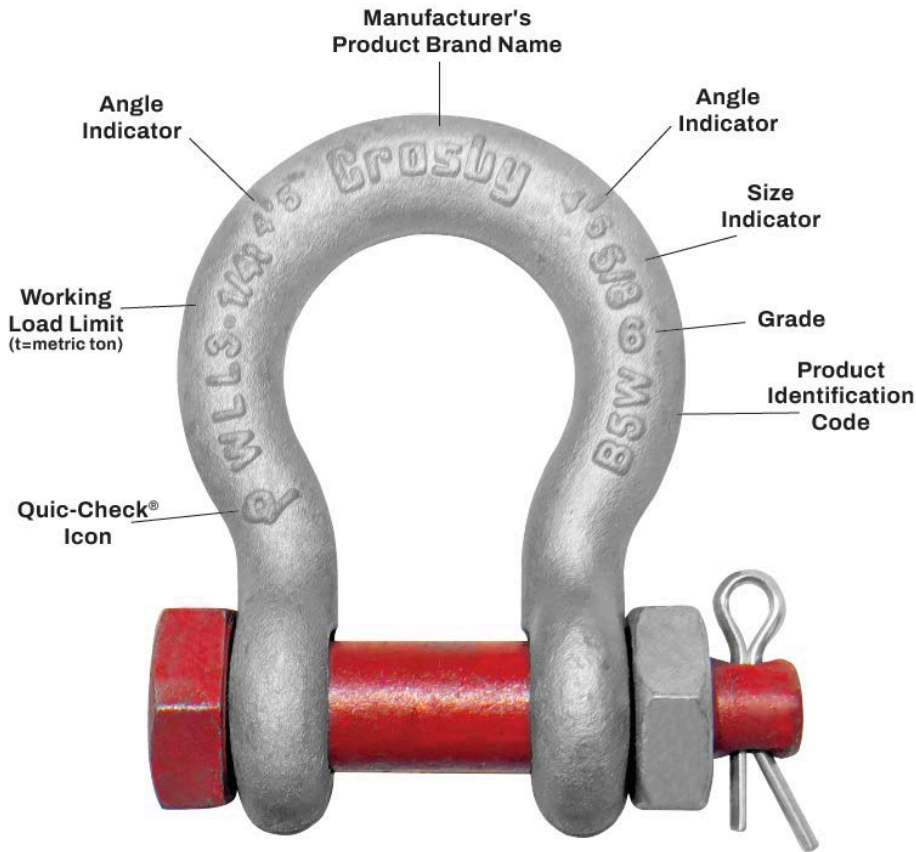
Screw pin chain shackles meet the performance requirements of Federal Specification RR-C-271G, Type IVB, Grade A, Class 2, except for those provisions required of the contractor.



### G-2150

Bolt type chain shackles meet the performance requirements of Federal Specification RR-C-271G, Type IVB, Grade A, Class 3, except for those provisions required of the contractor.





QUIC-CHECK® is a patented concept developed by Kito Crosby's research and development department that represents our ongoing commitment to quality. QUIC-CHECK incorporates the strategic placement of marking indicators on traditional rigging hardware to indicate reference points designed to enhance the safe and proper use of Crosby products.



Load Rated® is a registered trademark that identifies products that have the Working Load Limit indicated or affixed to them.



Fatigue Rated® is a registered trademark that identifies products that have proven to provide improved fatigue life (fatigue resistance) in actual use.



Quenched & Tempered® is a registered trademark that identifies products that are heat treated utilizing our perfected quench and tempering methods.



MAXTOUGH® is a registered trademark identifying products that are statistically verified to meet or exceed impact values of 42 Joules at -20° C (31 ft•lbf at -4° F) based on a high level of confidence. The confidence level is an index of certainty.



The CE marking is an administrative marking with which the manufacturer or importer affirms its conformity with European health, safety, and environmental protection standards for products sold within the European Economic Area (EEA).



The IECEx symbol indicates a product is approved by the International Electrotechnical Commission and meets certification to standards relating to equipment for use in explosive atmospheres.



This symbol indicates Kito Crosby's Engineered Solutions department provides custom-designed variations of the product to meet your specific project requirements. Engineered Solutions designs simple variations of off-the-shelf products, as well as fully custom solutions for challenging applications.



Type Approved is a symbol that identifies products that have been type approved by a third party organization. Meeting a standard can be declared as a result of Type Approval by a third party organization. Type Approval requires:

1. A Type Approval certificate that verifies that the product design complies with the referenced standard(s) and,
2. A manufacturing survey (MSA) that verifies that the manufacturing location has been verified as capable of making the product.
3. A product certificate must be made available that verifies that the product shipped meets the requirements of the Type Approval and MSA. This product certificate must reference a serial number or PIC and is issued for each product produced.