

# MATERIAL PROPERTIES

## PROCESS

The material used in a forged fitting, such as carbon or alloy steel, determines the potential properties. The manufacturing processes determine what the properties will actually be. The material must be special bar forging quality steel and fine grained. The heating of steel to forging temperature must be properly controlled to ensure that the steel is not 'injured' by overheating. Proper forging equipment and techniques must be employed to assure proper material flow in the dies and tooling. The heat treatment process must be well defined and precisely controlled.

### Questions to ask your rigging provider

*What processes do they consider important, and how do they select their material?*

*Is the steel fine grained?*

*Are standards established to ensure sufficient cleanliness of the steel?*

### Why choose Crosby

The Crosby Group's attention to material selection, forging techniques, machining, and heat treatment processes assures the properties required will be attained, thus providing superior performance of the product. Crosby has specific and demanding cleanliness requirements.

## TENSILE STRENGTH & DUCTILITY

The mechanical properties that are important when lifting a load under normal conditions are tensile strength and ductility. The ability to carry a load increases with the tensile (pulling) strength of the steel. The ability of steel to deform in an overload condition is known as its ductility.

Both of these factors enter greatly into determining the working load limit of a forging. Ductility is measured by standard engineering tests of elongation and reduction of area. It is also measured by how much deformation the fitting incurs when overloaded. The tensile strength determines the actual working load, while ductility allows the product to deform significantly when overloaded, thus giving warning before ultimate failure.

### Questions to ask your rigging provider

*Do they have an active program to determine tensile and ductility properties?*

*Are testing audits performed continuously on all products?*

*Is the actual deformation of a fitting when overloaded a major consideration for their shackles?*

### Why choose Crosby

The Crosby Group has an active program to determine tensile and ductility properties, and testing audits are continuously performed on all products. Crosby's design philosophy considers the deformation of a fitting when loading is a key requirement.

## 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

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.

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.

## IMPACT PROPERTIES

The mechanical properties of steel when a load is rapidly applied is known as its impact strength. Impact tests are made by applying a sudden load to a test piece and measuring the energy absorbed when the specimen breaks. The tougher the material, the greater the energy required to break the piece. A brittle piece can absorb virtually no energy upon breaking. The Charpy V Notched Impact test is one common method of performing the testing and measurement. Fittings must be able to have impact strengths that match the requirements of their application at all temperatures, even low temperatures commonly found in winter conditions. The difficulty of crack initiation and crack growth under impact is an important consideration.

### Questions to ask your rigging provider

*Does the material selection process recognize impact properties?*

*Do they have an active program to perform actual testing of impact properties?*

*Do they recognize the need for good impact properties?*

### Why choose Crosby

Crosby recognizes the importance of impact properties and has an active program to determine impact properties at various temperatures of each material used in the various heat treat conditions.

Our products are designed to be used in a wide range of temperatures. Crosby specifies material of specific cleanliness and guaranteed hardenability which enhances fatigue and impact properties.

## PERFORMANCE

Performance of a fitting requires a tensile strength that meets working load limits, ductility that allows deformation when overloaded, fatigue properties that support repeated use, and impact properties that provide toughness. All of these properties are essential if the product is to perform time after time in adverse conditions. They are also important to assure that the inspection criteria set forth by ANSI will effectively monitor the ability of the fitting to continue in service.

### Questions to ask your rigging provider

*Does the fitting have required tensile strength, ductility, fatigue, and impact properties?*

*Are all material properties met?*

### Why choose Crosby

Crosby designs its fittings to include required working load limits and design factors. Equally important are the ductility, fatigue, and impact properties. We provide you with material properties that minimize the risk of failure. No shortcuts in processing are made to save cost while sacrificing any of these performance elements.

## Material properties by product group (value added qualities)

**Tensile Strength** – Hooks, Shackles, Turnbuckles, Chain Fittings (*Crosby can provide typical hardness, tensile, and typical yield strength values.*)

**Ductility** – Hooks, Shackles, Turnbuckles, Chain Fittings (*Crosby can provide typical reduction of area and elongation values upon special request.*)

**Impact Properties** – Hooks, Shackles, Turnbuckles, Chain Fittings (*Crosby's quenched and tempered products have enhanced impact properties for greater toughness at all temperatures. Charpy impact properties are available if requested at time of order.*)

**Fatigue Properties** – Hoist Hooks, Shackles, Eye Bolts, Turnbuckles, Swivel Hoist Rings, Chain Fittings, Snatch Blocks are fatigue rated to 20,000 cycles at 1-1/2 times the WLL. (*Crosby products are designed to meet specific fatigue performance levels. If requested at time of order, these fatigue properties can be provided.*)

**Proof Testing** – All products (*Proof testing and certification are furnished standard with some products. If requested at time of order, proof testing certification is available for most of Crosby's remaining product line, with the exception of swage sockets and sleeves, spelter sockets, thimbles, etc.*)

**QC 1400 Audits** – Hoist Hooks only (*Crosby's QC 1400 program provides reduction of are and elongation values, as well as hardness, tensile, and yield strength values for each production lot of hoist hooks. These factors are traceable by the Product Identification Code (PIC).*)

**MAG Certification, Ultrasonic, X-Ray & Dye Penetrant Testing** – All products (*If requested at time of order, different non-destructive testing and certification is available.*)

**Chemistry Analysis** – All products (*Each heat of steel is individually verified to confirm chemical analysis prior to manufacturing.*)