

Working Load Limit (WLL)

There is a difference between the tensile strength of a rope and the Working Load (WL). Tensile strength is the force required to break it, which can be determined by testing. The Working Load (WL) is the weight or force applied to rope or cordage in a given application. The Working Load Limit (WLL) is a guideline for the maximum allowable capacity of a rope product and **should not be exceeded**. Applied loads higher than a specified Working Load Limit (WLL) can overstress and damage fibers, resulting in premature rope failure. The Working Load (WL) of an application should not exceed the Working Load Limit (WLL) of the rope for optimal product performance and the safety of personnel and property. The Working Load Limit (WLL) is provided to help in the selection and safer use of cordage products. Compliance with Working Load Limit (WLL) guidelines does not guarantee safe use under all circumstances, and Aamstrand Ropes & Twines Inc. disclaims any responsibility for any accidents that may occur. If in doubt, consult an experienced engineer or other qualified individual regarding the design, application and selection of a rope product.

There are many factors that impact or reduce the strength of any rope. These include; tying a knot in the rope, its age, environmental deterioration (hot and cold), abrasion and rubbing on objects, harmful substances, water and sand/grit, and the rope's previous use and care. There are inherent risks in the use of rope and cordage due to the highly variable conditions that change over time. Therefore, Design Factor (DF) selections and Working Load Limits (WLL) must be calculated with consideration of exposure to risk and actual conditions of use for each application. To factor in the above variables we use an arbitrary number to reduce the actual load that is placed on the rope. This number is called the Working Load Limit (WLL). The ratio between the Working Load (WL) and the rope's tensile strength is termed the safety margin or Design Factor (DF). If a rope is rated at 5000 lbs tensile and we wanted to maintain a 10:1 safety margin which is equivalent to a Design Factor (DF) of 10, the maximum working load would be 500 lbs

Design Factors

Design Factors range from 5 to 12 for non critical applications. The Design Factor (DF) is the ratio between the ropes tensile strength and Working Load (WL). This value is the margin of safety for an application. For a particular application, the factors affecting rope behavior and the degrees of risk to life, personnel and property must be considered when setting a Design Factor (DF). Commercial and industrial users must determine a Design Factor (DF) based on actual service conditions and establish operating procedures for a specific application. A "general use" consumer must also assess his application and determine conditions of use and hazards that may apply. As a rule, the more severe the application, the higher the Design Factor (DF) needs to be. Selection of a Design Factor (DF) in the general range between 5:1 (DF = 5) and 12:1 (DF = 12) is recommended. A Design Factor (DF) at the low end of this range should only be selected with expert knowledge of conditions and professional estimate of risk. Design Factor (DF) at or above the high end of the range should be used for more severe conditions of use. When in doubt, always select the highest practical DF, or contact the manufacturer for additional guidance. Engineering assistance may be necessary to determine the service loads and risks and to set the appropriate Design Factor (DF). Once a Design Factor (DF) is chosen the Working Load Limit of a new rope is determined by dividing the tensile strength by the Design Factor for a given application. $\text{Tensile} \div \text{DF} = \text{WLL}$. A range of Working Load Limits (WLL), based on Design Factors (DF) ranging from 5 to 12 or a 5:1 ratio to a 12:1 ratio are given in our product catalog and specifications. The range of Working Load Limits (WLL) listed is for new ropes with standard terminations.

Considerations in the Selection of a Design Factor

- Experience is the best guide for determining a DF. Select a DF value used in a similar application that proved successful.
- Consider increasing the Design Factor if:
 - Problems have previously been observed in similar applications
 - Injury, death or loss of property may result if rope fails
 - Loads are not accurately known
 - High or continuous dynamic loads are anticipated
 - Shock loads are anticipated
 - Extensive cyclic loads are likely to occur
 - Tension is on the rope for long periods
 - Knots are used, as knots can reduce strength by as much as 50%
 - Operators are not well trained
 - Operation/use procedures are not well defined and/or controlled.
 - Severe abrasion is likely to occur from exposure to rough surfaces or cutting edges, or by contamination from dirt and grit.

Expert Guidance is Strongly Suggested for the Following Situations

- Rope is used constantly over pulleys or around a small bend.
- Rope is used at elevated temperature that may glaze, weaken or melt the fibers.
- Rope is used in the presence of hazardous chemicals.
- Rope is not new and is of unknown properties and/or prior use.
- Rope is not inspected frequently or adequately.
- Rope will be in service for long periods that may lose strength due to fatigue.