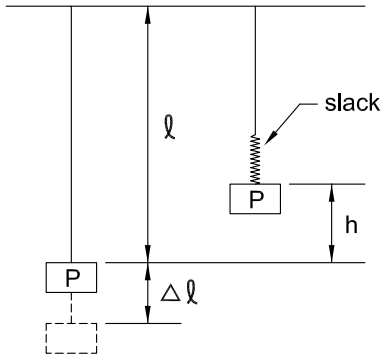
SHOCK LOADING:

Definition: A sudden or unexpected load that is imposed upon a system.

There are a variety of stresses that can be added unexpectedly into any rigging system. If these stresses are within the elastic limit (the point at which the material deforms permanently) of the wire rope the system is still usable. If the stresses exceed the elastic limit the system may not immediately fail, but the wire rope has been overstressed and must be replaced before the eventual accident occurs.

All wire ropes are designed and manufactured to a specific catalog minimum breaking strength. This breaking strength is the load at which a tensile failure occurs in a test sample. Depending on the type of wire rope used the elastic limit of the material is between 55-65% of the breaking strength.

Most equipment is designed upon normal operation with a design factor calculated in. This design factor does not normally include shock loading since shock loads are outside the realm of normal operating conditions. However, during the life of a system the odds suggest that any system will experience a shock load of some type. With this in mind, the overall design factor used in the design of the wire rope in a rigging system should be conservative. Commonly, a working load on 1/4" galvanized aircraft cable will be designated at 700 pounds for use in a stage rigging system.



Calculating Shock Loads:

ℓ = length of wire rope in inches
P = static load in pounds
h = slack in inches
$\triangle\ell$ = elastic stretch of wire rope
A = metallic area of wire rope (in^2)
D = wire rope diameter
E = modulus of elasticity
Pf = stress at impact in pounds

Sample Problem: #1

P = 500 lbs.
ℓ = 75 ft.
h = 6 in.
$A = .476D^2$
$E = 1.5 \times 10^7$ psi

use 1/4", 7x19 small diameter (galvanized) specialty cord.

formula: $\frac{Pf}{P} = K$

$$K = 1 + \sqrt{1 + \frac{2h}{\triangle\ell}} = 1 + \left[\sqrt{1 + \left(\frac{2h \times A \times E}{P \times \ell}\right)}\right]$$

$$Pf = P \times 1 + \sqrt{1 + \frac{2h}{\triangle\ell}}$$

$$Pf = 500 \text{ lbs.} \times \left[1 + \sqrt{1 + \left(\frac{2 \times 6 \text{ in.} \times .02975 \text{ in.}^2 \times 1.5 \times 10^7 \text{ psi}}{500 \text{ lbs.} \times 75 \text{ ft.} \times 12 \text{ in./ft.}}\right)}\right]$$

Pf = 2296 lbs.

Formula: Wire Rope Corporation of America, Macwhyte Wire Rope, Catalog G-18, 4th Edition, St. Joseph, MO, 1992, page 197
Values for A & E: Provided by Macwhyte Wire Rope Company, 1983

Sample Problem: #2

P = 500 lbs.
ℓ = 25 ft.
h = 6 in.
$A = .476D^2$
$E = 1.5 \times 10^7$ psi

use 1/4", 7x19 small diameter (galvanized) specialty cord.

formula: $\frac{Pf}{P} = K$

$$K = 1 + \sqrt{1 + \frac{2h}{\Delta \ell}} = 1 + \left[\sqrt{1 + \left(\frac{2h \times A \times E}{P \times \ell}\right)}\right]$$

$$Pf = P \times 1 + \sqrt{1 + \frac{2h}{\Delta \ell}}$$

$$Pf = 500 \text{ lbs.} \times \left[1 + \sqrt{1 + \left(\frac{2 \times 6 \text{ in.} \times .02975 \text{ in.}^2 \times 1.5 \times 10^7 \text{ psi}}{500 \text{ lbs.} \times 25 \text{ ft.} \times 12 \text{ in./ft.}}\right)}\right]$$

Pf = 3529 lbs.

Sample Problem: #3

P = 500 lbs.
ℓ = 5 ft.
h = 6 in.
$A = .476D^2$
$E = 1.5 \times 10^7$ psi

use 1/4", 7x19 small diameter (galvanized) specialty cord.

formula: $\frac{Pf}{P} = K$

$$K = 1 + \sqrt{1 + \frac{2h}{\Delta \ell}} = 1 + \left[\sqrt{1 + \left(\frac{2h \times A \times E}{P \times \ell}\right)}\right]$$

$$Pf = P \times 1 + \sqrt{1 + \frac{2h}{\Delta \ell}}$$

$$Pf = 500 \text{ lbs.} \times \left[1 + \sqrt{1 + \left(\frac{2 \times 6 \text{ in.} \times .02975 \text{ in.}^2 \times 1.5 \times 10^7 \text{ psi}}{500 \text{ lbs.} \times 5 \text{ ft.} \times 12 \text{ in./ft.}}\right)}\right]$$

Pf = 7199 lbs.

NOTE: 1/4", 7X19 small diameter (galvanized) specialty cord conformes to ASTM A1023M-02.
This material is currently being used in place of 7X19 galvanized aircraft cable.

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