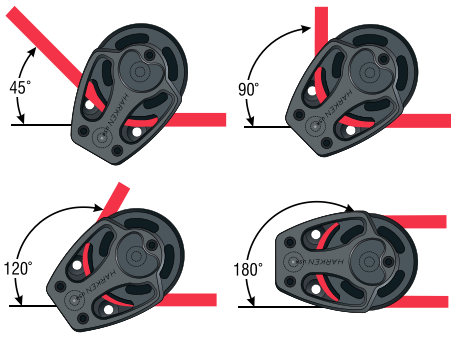
Loading Formulas

Block Loading vs Angle of Deflection

Load on a block is a combination of the load on the line passing through the block, plus a block-loading factor, which is determined by the angle by which the block turns the sheet. For example, a foot-block that turns a sheet 180 degrees will see a load equal to twice the load on the sheet. A deck organizer, which turns a halyard only 30 degrees, will see just 52 percent of the load on the halyard.

Boat Type

Most load formulas assume a medium displacement monohull, but you can easily correct for other boat types. Multihulls and boats with canting keels or water ballast have great form stability and speed and will often carry sails very high in the apparent wind speed, so calculations must be done with this wind speed in mind. ULDBs are typically tender and often change sails or reef quite early, so loading may be done at relatively low wind speeds. For example, a modern trimaran may carry its blade jib in 25 knots of wind at speeds over 15 knots for an apparent wind of nearly 40 knots, whereas a ULDB will probably remove its #1 genoa at about 15 knots of apparent wind.



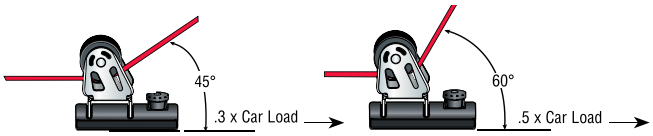
Angle of deflection	Load factor	Angle of deflection	Load factor	Angle of deflection	Load factor
30°	52%	90°	141%	150°	193%
45°	76%	105°	159%	160°	197%
60°	100%	120°	173%	180°	200%
75°	122%	135°	185%		

Genoa System Loading

Because wind speed is squared, it is the most important variable and can greatly influence loading. Wind speed (the apparent wind) should be calculated for the specific sail being analyzed. For example, the #1 genoa on a 7 m (25') boat might only be carried in 15 knots of wind, while the #3 blade on a Maxi-boat could well be carried in 40 knots.

To calculate loading on a genoa lead car, multiply sheet load by the load factor of the sheet. Most #1 genoas will deflect about 45 degrees, while a #3 genoa may deflect 75 degrees or more.

Lead car adjuster tackle load is dependent on the angle of deflection of the sheet in the lead car, but is generally assumed to be 0.3 of lead car load when deflection is 45 degrees and .05 of lead car load when deflection is 60 degrees.



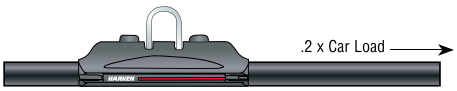
Genoa sheet load			
English		**Metric**	
$SL = SA \times V^2 \times 0.00431$		$SL = SA \times V^2 \times 0.02104$	
SL	Sheet load in pounds	SL	Sheet load in kilograms
SA	Sail area in square feet	SA	Sail area in square meters
V	Wind speed in knots	V	Wind speed in knots

Formulas are for typical cruising monohulls with fixed keel and Dacron® sails, sheets, and halyards. For all other types, please contact Harken for technical assistance in calculating loads.

Mainsheet System Loading

The formula for mainsheet loading is not as widely accepted as that for genoa sheet loads and should only be used as a rough guide for offshore boats from 9 - 18 m (30 - 60').

Traveler car adjuster load is generally considered to be 0.2 times car load.



Mainsheet load			
English		**Metric**	
$ML = \frac{E^2 \times P^2 \times 0.00431 \times V^2}{(\sqrt{P^2 + E^2}) \times (E - X)}$		$ML = \frac{E^2 \times P^2 \times 0.02104 \times V^2}{(\sqrt{P^2 + E^2}) \times (E - X)}$	
ML	Mainsheet load in pounds	ML	Mainsheet load in kilograms
E	Foot length of main in feet	E	Foot length of main in meters
P	Luff length of main in feet	P	Luff length of main in meters
V	Wind speed in knots	V	Wind speed in knots
X	Distance from aft end of boom to mainsheet attachment point in feet	X	Distance from aft end of boom to mainsheet attachment point in meters

Formulas are for typical cruising monohulls with fixed keel and Dacron sails, sheets, and halyards. Assumes standard roach of 7.5%. For large roach sails such as "flattops" multiply calculated load by the percentage of the mainsail roach. If a sail has 25% roach, multiply the calculated load by 1.25. For all other types, please contact Harken for technical assistance in calculating loads.

Rig Dimensions

The following abbreviations are often used to describe various measurements on a sailboat. Precise technical definitions exist for each abbreviation, but the following is a list of simple descriptions:

LOA	Length overall - overall tip-to-tip length of the boat	I_2	Height of staysail halyard above deck
LWL	Length waterline - length of waterline of the boat	J	Base of the foretriangle measured from the front of the mast to the intersection of the forestay and deck
DWL	Design waterline - theoretical waterline length of boat as opposed to LWL, which is actual waterline length	J_2	Base of staysail triangle
BMX	Beam maximum - width of the boat at the widest point	P	Luff length of the mainsail
BWL	Beam waterline - widest beam of boat at the waterline	E	Foot length of the mainsail
I	Height of the foretriangle measured from the top of the highest sheave to the sheerline	LP	Shortest distance from headstay to the clew of the jib