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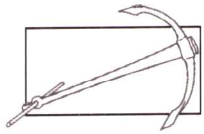

REFERENCE DATA FOR MAINTENANCE, REPAIR, & CRUISING

JOHN VIGOR

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JOHN VIGOR

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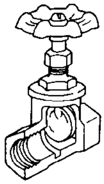
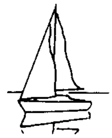
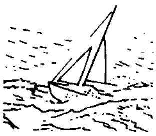
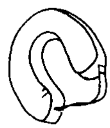








Preface

This book contains data needed sooner or later by anyone who cruises or races under sail. It's crammed with facts and figures relating to all aspects of designing, building, maintaining, repairing, and navigating a sailboat.

Active sailors and do-it-yourselfers constantly seek reference data: how much paint to buy, what size pilot holes to drill, what navigation lights to show, how much headroom to allow, how strong the rigging should be, what size propeller to order. Thousands of practical facts, figures, and timesaving tips are collated here in reader-friendly tables, lists, and charts catering to beginners, experienced hands, and amateur yacht designers.

No other similar work approaches it in scope. From the latest in high-tech electronics to the most humble cabin heater, you'll find it all here, right down to a list of sources of gear and information. The data is conveniently displayed for quick, intuitive access, and is backed up by a comprehensive index.

When might you need these facts and figures? When you're planning your dream boat. When you're buying a used boat, or taking delivery of a new boat. When you're comparing your boat with others. When you're on passage. When you're at anchor. When you're wondering where you'll find a replacement for your deteriorating plastic rubrail. And when you want to settle a bet.

This fingertip factfinder forms part of the International Marine Sailboat Library and complements the other volumes in the series.

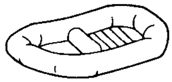
JOHN VIGOR
Oak Harbor, WA
September 1996

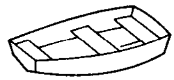
This symbol indicates a Rule of Thumb, or an estimation, tested by long experience, that brings results sufficiently accurate for the purpose.

The Golden Rule symbol draws attention to a rule more precise and less flexible than a Rule of Thumb. It often applies to safety and should not be broken lightly.

Dinghies

Inflatable or Hard Dinghy?





	Inflatable Dinghy	Hard Dinghy
PROS	Compact when deflated Fast with a small outboard Great load-carrying capacity Easy for swimmers to enter Doesn't damage your topsides	Better sea boat Easier to row and sail More durable Tows with less resistance More resistant to abrasion
CONS	Vulnerable to punctures Bouncy and wet under power Takes time to inflate/deflate	Less stable Heavier and bulkier Needs more stowage space

Inflatable Dinghy Facts

Durability

- DuPont's Hypalon skin, recommended for tropics, is usually guaranteed for 10 years
- Polyvinyl chloride (PVC) material, excellent in temperate climates, is usually guaranteed for five years
- Inflatables subjected to abnormally rough use by liveaboard cruisers usually wear out in three or four years

Typical Weights and Dimensions

These measurements include integral floors but not removable floorboards. On some models, permanently installed floorboards can add about 50 percent to the hull weight.

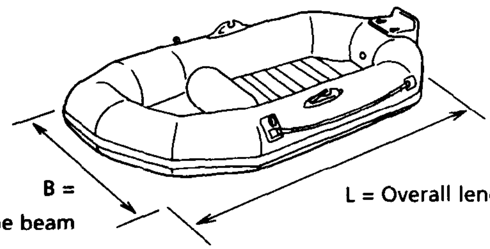
Typical Measurements

LOA	Beam	Weight	Stowed Size	Persons
7'7" 2.3 m	4'1" 1.24 m	32 lb. 14.5 kg	33 × 17" (dia.) 84 × 43 cm (dia.)	3
8'6" 2.6 m	4'7" 1.4 m	49 lb. 22 kg	37 × 20 × 12" 94 × 51 × 30 cm	4
9'6" 2.9 m	4'7" 1.4 m	55 lb. 25 kg	37 × 20 × 14" 94 × 51 × 36 cm	4
10'0" 3.0 m	4'11" 1.5 m	68 lb. 31 kg	37 × 19 × 15" 94 × 48 × 38 cm	4
11'0" 3.4 m	4'11" 1.5 m	73 lb. 33 kg	39 × 23 × 17" 99 × 58 × 43 cm	4

Maximum Outboard Motor Power

(for inflatables with motor mount but no solid transom)

Length	Motor Power: Horsepower	Kilowatts
Less than 9′ (2.7 m)	3.0	2.2
9 to 12′ (2.7 to 3.6 m)	5.0	3.7
Over 12′ (3.6 m)	7.5	5.6



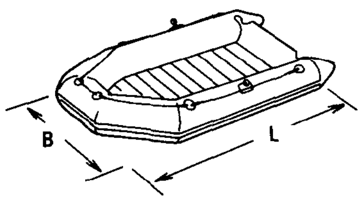
Maximum Outboard Engine Power

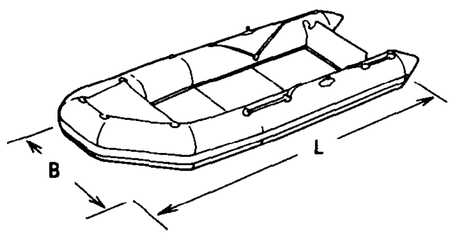
(with solid transom)

The maximum outboard horsepower for inflatables with a transom may be calculated by multiplying length in feet (L) by beam in feet (B). If L × B is less than 35, maximum horsepower is 3 (2.2 kW). If the result is between 36 and 39, maximum horsepower is 5 (3.7 kW). If it is between 40 and 42, maximum horsepower is 7.5 (5.6 kW).

If L × B is between 43 and 80, for maximum horsepower multiply the figure obtained by 10, divide by 9, and subtract 40.

If L × B is more than 80, maximum horsepower is L × B divided by 2, plus 10. Examples are shown below, rounded up or down to the nearest appropriate engine size.





Length × Beam	Engine Power: Horsepower	Kilowatts
40 to 42	7.5	5.6
43	8.0	6.0
50	15.0	11.2
60	25.0	18.6
70	40.0	29.8
80	50.0	37.3
90	55.0	41.0

Note: Multiply horsepower by 0.7457 to convert to kilowatts.

HARD DINGHY FACTS

Minimum Size

The smallest practical hard dinghy for two 160-pound (72-kg) people is a 7-foot (2-meter) pram weighing about 70 pounds (32 kg).

Safe Carrying Capacity

Refer to the "U.S. Coast Guard Maximum Capacities" label inside the transom of your dinghy for information about safe carrying capacity and maximum engine horsepower.

If there is no capacity label, the following formula approved by the U.S. Coast Guard Boating Education Branch determines the number of persons of average weight a boat under 20 feet (6 meters) will safely carry in calm weather. Weight for this purpose is usually taken to be 160 pounds (72 kg) per person.

$$\text{Number of people} = \frac{\text{overall length} \times \text{beam (in feet)}}{15}$$

OR

$$\text{Number of people} = \frac{\text{overall length} \times \text{beam (in meters)}}{1.4}$$

Example:

1. A 10-foot dinghy has a beam of 4.2 feet.
2. $10 \times 4.2 = 42 \div 15 = 2.8$ people.
3. Round up to 3 people.

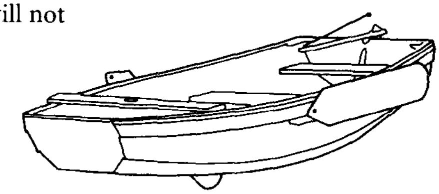
Example:

1. A 3.6-meter dinghy has a beam of 1.28 m.
2. $3.6 \times 1.28 = 4.62 \div 1.4 = 3.3$ people.
3. Round down to 3 people.

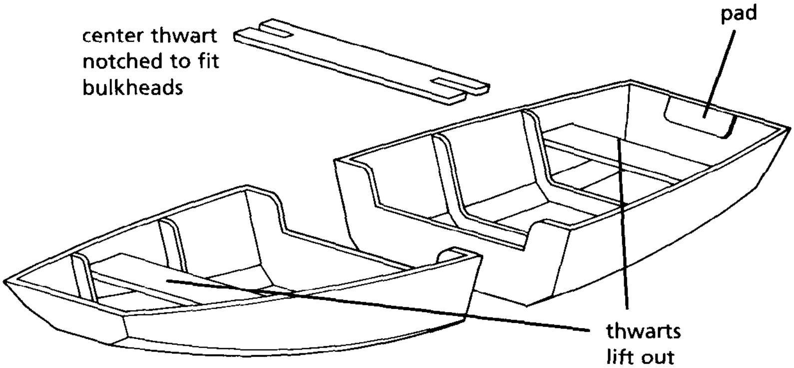
Ideal Hard Tender

L. Francis Herreshoff's ideal tender would:

- row easily, light or loaded
- be light enough to be hoisted aboard easily
- be stiff enough to get into and out of easily
- be constructed strongly so she will not leak and will take some abuse
- tow steadily, always holding back on her painter and never yawing around



Saving Space Some modern nesting designs stow compactly on the deck of a small yacht. The two halves fit one inside the other, and bolt or latch together before or after launching. For example, an 11-foot (3.3 m) nesting dinghy stows in a space only 5 feet 10 inches (1.78 m) long.



Small folding dinghies made of plywood, canvas, and/or plastic may be bought or built from plans. They usually fold gunwale to gunwale. Typically, a 6-foot 8-inch (2.03-m) LOA folding boat with a beam of 4 feet 2 inches (1.27 m) will measure 7 feet 1 inch (2.16 m) × 1 foot 9 inches (533 mm) × 4.5 inches (114 mm) when folded.

Oar Length (for average tenders)

This rule of thumb gives a "low gear" for easy pulling in a headwind or chop:

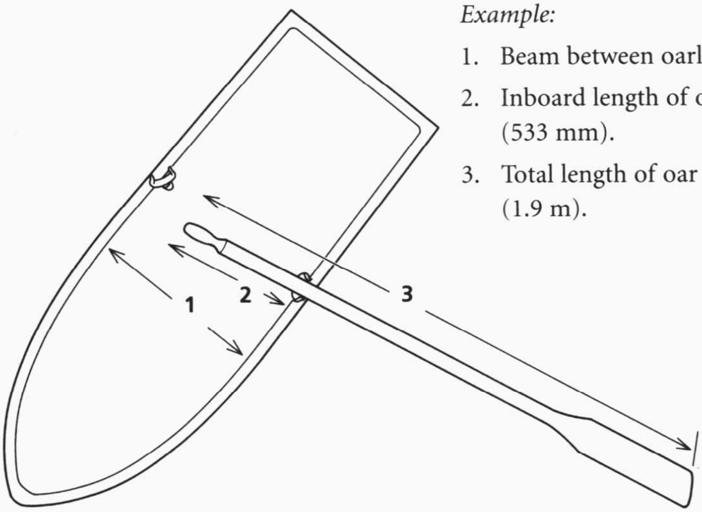
The overall length of each oar should be roughly one and a half times the distance between oarlocks.

Example:

1. Beam between oarlocks = 48 inches (1.2 m).
2. Overall length of oar = 48 × 1.5 = 72 inches (1.8 m).

Oar Length (for serious rowers in serious rowing boats)

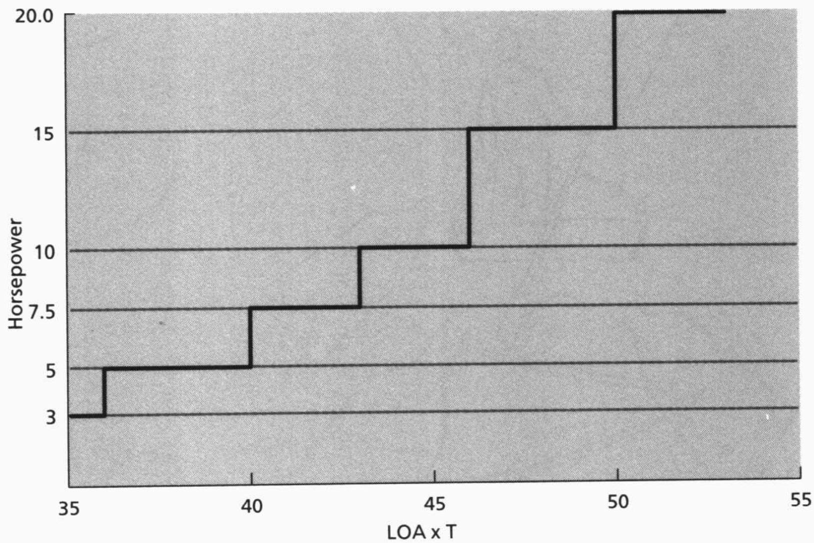
1. Measure beam between oarlocks.
2. To find the inboard length of the oar, divide the beam measurement by 2, and add 2 inches (50 mm).
3. To find the total length of the oar, divide the inboard length by 7; then multiply by 25.



Example:

1. Beam between oarlocks = 38 inches (965 mm).
2. Inboard length of oar = (38 ÷ 2) + 2 = 21 inches (533 mm).
3. Total length of oar = (21 ÷ 7) × 25 = 75 inches (1.9 m).

Maximum Outboard Motor Power for Hard Dinghies For hard dinghies of less than 20 feet, multiply length overall (LOA) by the width of the transom (T), both in feet and to the nearest whole number. Check the result in the following table for maximum horsepower:



LOA × T	Horsepower
Up to 35	3.0
36 to 39	5.0
40 to 42	7.5
43 to 45	10.0
46 to 49	15.0
50 to 52	20.0

Example:

1. LOA = 10 feet.
2. T = 3 feet 10 inches.
3. LOA × T = 10 × 3.8 = 38.
4. Maximum outboard engine size = 5 hp.

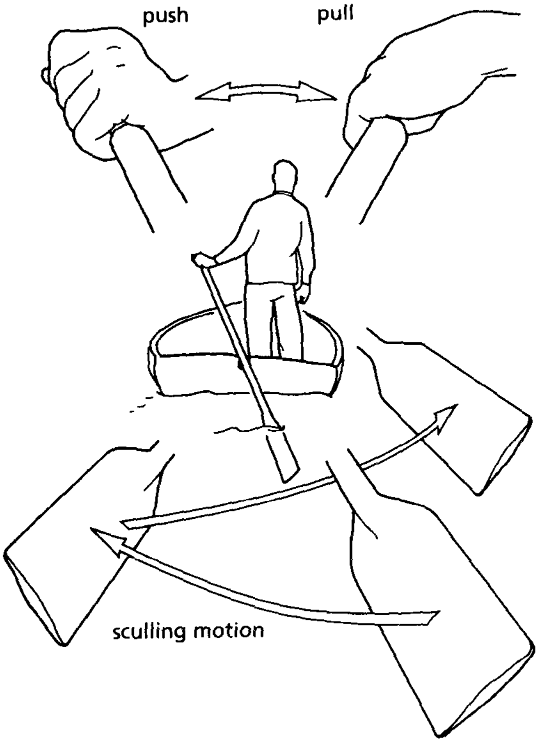
Sculling a Dinghy

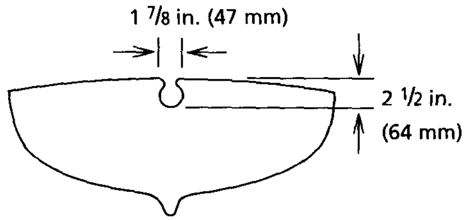
A sculling notch in the transom provides a way of getting home with one oar. Sculling over the stern is slower than rowing, and more tiring, but it is smoother and more powerful.

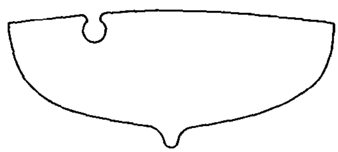
Because the oar blade is not exposed to the wind, sculling is especially useful over short distances in strong headwinds and choppy seas. The steady power of a sculling stroke obviates snatching when you are towing a heavier boat. Light, shallow dinghies need to be sculled with short, sharp strokes.

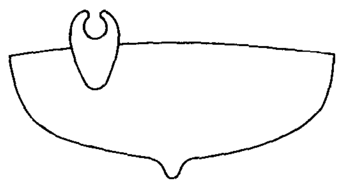
The usual size for a sculling notch is 1⅞ inches (47 mm) wide by 2½ inches (64 mm) deep. Typically, the notch is somewhat egg-shaped, widening slightly from top to bottom to discourage the oar loom from jumping out, and all edges are well rounded.

The notch may be offset slightly to one side or the other to allow an outboard motor to occupy the center of the transom. This offset is easily compensated for when you are sculling.



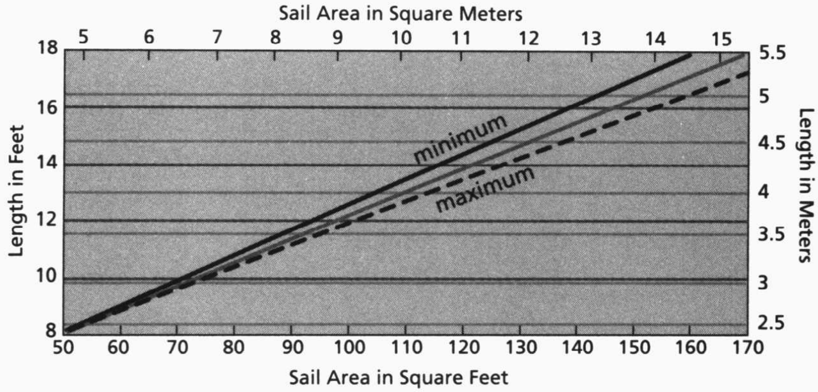



offset notch


raised notch

SAIL AREAS FOR DINGHIES

These are average sail areas for nonplaning dinghies, used for cruising or daysailing, between 8 feet (2.4 m) and 18 feet (5.5 m) long. Racing dinghies, obviously, will carry more sail.



Planing Speed of Hard Dinghies

The approximate speed in knots at which most planing dinghies start to plane may be calculated as follows:

Find the square root of the waterline length in feet and multiply by 2.2.

Example:

$$\sqrt{10} = 3.162$$

$$3.162 \times 2.2 = 6.9564$$

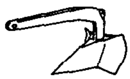
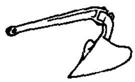
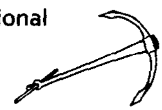
$$= 7.$$

A 10-foot-waterline dinghy will start to plane at just under 7 knots.

Deck Gear

Anchors and Rodes

Common Anchor Types and Uses

Anchor Type	Trade Name	Bottom Type: Weeds/Grass	Rock	Sand	Mud
Plow, non-pivoting 	Delta	adequate	poor	good	poor
Plow, pivoting 	CQR	adequate	adequate	good	adequate
Winged scoop 	Bruce	poor	adequate	good	adequate
Lightweight, pivoting fluke 	Danforth	poor	poor	good	adequate
	Fortress	poor	poor	good	adequate
	Guardian	poor	poor	adequate	poor
	Performance	poor	poor	good	adequate
Fisherman, traditional 	Herreshoff	good	good	adequate	poor
	Luke	good	good	adequate	poor

Anchor and Rode Sizes Relative to Boat Length

These sizes are conservative minimums for plow-type anchors on boats of medium displacement under normal conditions. Boats with heavier displacement, or greater windage than normal, or boats experiencing rougher than normal conditions, will need heavier ground tackle.

Pivoting-fluke anchors (Danforth type) give greater holding power for much less weight, provided they can dig into sand or mud.

Fisherman-type anchors should weigh about 2 pounds per foot of waterline length (3 kg per meter of waterline length).

In all cases, storm anchors should be two sizes bigger.

The chain part of the rode should be at least as long as the boat. Boats over 25 feet (8 m) in length may benefit from an all-chain rode.

Three-strand nylon, which has the ability to stretch and absorb shock loading, is recommended for the rope part of the rode.

Boat Length	Plow Anchor Weight	Rope Diameter	Chain Diameter
Up to 21 ft. Up to 6.4 m	11 lb. 5 kg	7/16 in. 11 mm	3/16 in. 5 mm
22–25 ft. 6.7–7.5 m	22 lb. 10 kg	1/2 in. 13 mm	1/4 in. 6 mm
26–30 ft. 8.0–9.0 m	25 lb. 11 kg	9/16 in. 14 mm	1/4 in. 6 mm
31–40 ft. 9.4–12.0 m	35 lb. 16 kg	9/16 in. 14 mm	5/16 in. 8 mm
41–45 ft. 12–14.0 m	44 lb. 20 kg	5/8 in. 16 mm	3/8 in. 10 mm
46–50 ft. 14–15.0 m	55 lb. 25 kg	3/4 in. 19 mm	3/8 in. 10 mm

Length of Anchor Rode

How long should your anchor rode (rope plus chain) be? The rule of thumb is a minimum of 1 fathom (6 feet) for every foot of the boat's overall length. In metric terms, that is 6 meters of rode for every meter of boat length.

Example:

1. Boat is 34 feet (10.4 m) long.
2. Minimum anchor rode required = 34 × 6 = 204 feet (62.4 meters).

Anchor Rode Stowage Space

The size of a self-stowing chain locker may be estimated thus:

$$\text{Volume in cubic feet} = (\text{fathoms chain} \times \text{diameter in inches}^2) \times 0.85$$

To find the volume needed for every 10 fathoms (60 feet) or 18 meters of chain, refer to the table that follows on page 14.

Chain Stowage Space

Diameter of chain		Cubic feet	Cubic meters
3/16 in.	5 mm	0.30	0.008
1/4 in.	6.5 mm	0.53	0.015
5/16 in.	8 mm	0.83	0.023
3/8 in.	10 mm	1.20	0.034

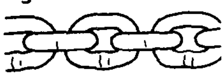
Note: Rope typically requires more locker space than chain of equal length and equivalent strength because it does not compact itself as chain does to take advantage of all the space available. The amount of extra space depends on the rope's material and its method of construction, both of which affect its flexibility and therefore its natural tendency to fake down tightly, but the three-stranded nylon rope usually used for anchoring will normally require at least 25 percent more locker room if it is self-stowing.

Chain Strength and Weight

proof coil

BBB chain

high-test chain



Proof-coil chain is made from low-carbon steel. It has relatively long links. Breaking strength is three and a half to four times the working load limit.

BBB chain is made from the same material as proof-coil, but has shorter links and works better in windlasses. Breaking strength is three and a half to four times the working load limit.

High-test chain has a higher carbon content and is stronger than proof-coil and BBB chain. It is therefore lighter for the same strength but rusts faster. High-test chain can be one size smaller than proof coil or BBB. Breaking strength is about three times the working load limit.

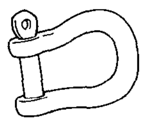
All three types are supplied ready galvanized and all three are suitable for anchor chain. BBB is most popular on cruising boats with windlasses and all-chain rodes. Proof-coil is usually used in conjunction with nylon rope on boats without windlasses, and the lighter high-test chain is used extensively on performance cruisers.

BBB Chain

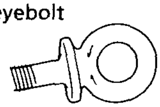
Diameter		Working Load		Weight	
Inches	mm	Pounds	kg	Pounds/Foot	kg/m
3/16	5	800	363	0.43	0.64
1/4	6.5	1,325	601	0.76	1.13
5/16	8	1,950	884	1.13	1.68
3/8	10	2,750	1,247	1.64	2.44
7/16	11	3,625	1,644	2.22	3.30
1/2	13	4,750	2,155	2.85	4.24
9/16	14	5,875	2,665	3.55	5.28
5/8	16	7,250	3,288	4.25	6.32
3/4	19	10,250	4,649	6.15	9.15

Shackle and Hook Strength

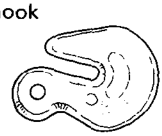
shackle



eyebolt



hook



These formulas give a rough estimate of the maximum working load for galvanized steel shackles and hooks. These loads, based on industrial safety standards, are about 11 to 12 percent of the breaking loads. (For less rigorous, more occasional use on non-commercial boats, working loads of 25 percent to $33\frac{1}{3}$ percent are often recommended by retailers.)

D = the pin diameter in inches, and results are in tons. Multiply tons by 1,016 to convert to kilograms.

Straight shackle	$3 \times D^2$
Bow shackle	$2.5 \times D^2$
Ring bolt	$2 \times D^2$
Eyebolt	$5 \times D^2$
Hook	$0.67 \times D^2$ when D is the diameter in inches at the base, where the main shank enters the throat.

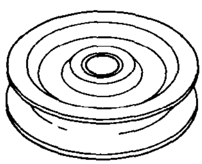
For working loads in kilograms, measure the diameter in millimeters, apply the formulas above, and multiply the result by 1.58.

Example:

1. A bow shackle on an anchor rode has a diameter (D) of $\frac{3}{8}$ inch.
2. Safe working load (SWL) = $2.5 \times (\frac{3}{8})^2 = 0.35$ tons.
3. $SWL = 0.35 \times 2{,}240 = 784$ pounds (356 kg).

Blocks, Sheaves, and Tackles

Sheave Diameters for Wire and Rope



Ideally, wire rope sheaves should have a diameter of not less than 40 times the wire diameter for long life and easy rendering. In actual use, such ideal proportions are rarely achieved. In extremis, and for short periods, the ideal sheave diameter may be halved, but the wire's strength will be severely compromised and its life shortened.

Similarly, fiber rope needs a sheave diameter of not less than eight times the rope diameter if undue stress and premature wear are to be avoided. But, once again, smaller sheaves and more frequent replacement of lines are choices often forced upon us.

The table on page 16 shows the recommended diameter of that part of the sheave upon which the rope bears.

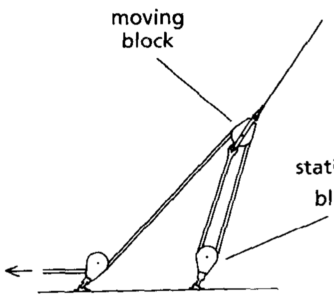
Line Diameter		Wire Sheave Diameter		Rope Sheave Diameter	
Inches	mm	Inches	mm	Inches	mm
1/8	3	5	127	1	25
5/32	4	6 1/4	160	1 1/4	32
3/16	5	7 1/2	190	1 1/2	38
7/32	5.5	8 3/4	225	1 3/4	45
1/4	6.4	10	250	2	50
5/16	8	12 1/2	320	2 1/2	65
3/8	9	15	380	3	75
7/16	11	—	—	3 1/2	90
1/2	12.7	—	—	4	100
5/8	15.8	—	—	5	130
3/4	19	—	—	6	150
7/8	22	—	—	7	180
1	25			8	200

Block and Tackle Mechanical Advantage

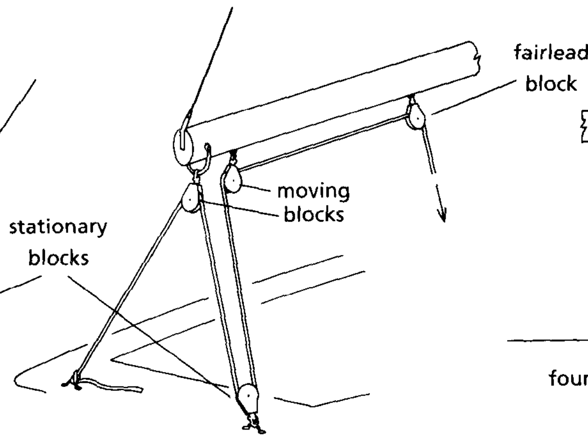
To calculate the mechanical advantage of a block and tackle, first separate the moving blocks from the stationary blocks.

Then count the number of parts in the moving block or blocks. The number of parts equals the mechanical advantage.

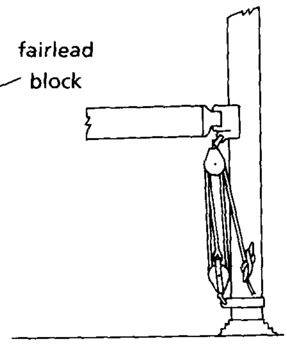
A *part,* in this instance, means a line where it enters, or where it leaves, the block. (One line entering a block, rounding a sheave and then exiting again counts as two parts.) A line attached to the shell or becket of a moving block is a part, but a line attached to the load is not.



three-part purchase



four-part purchase



four-part purchase