DESIGN FOR THE FOUNDATION OF 150-TON SHEAR-LEGS.

By Leonard Goodday, C.E., M.E.
Late of the British Admiralty.

A FEW years ago the writer was associated with the construction of some new docks and basin accommodation in England. The work included the design and erection of shear-legs for the support of hoisting tackle, a most essential factor in dock yards where heavy weights are to be hoisted over the side of a wharf or lowered to the deck of a vessel. Guns and heavy machinery are easily and comparatively quickly handled by this means, and this manner of hoist is also frequently used in "stepping" masts.

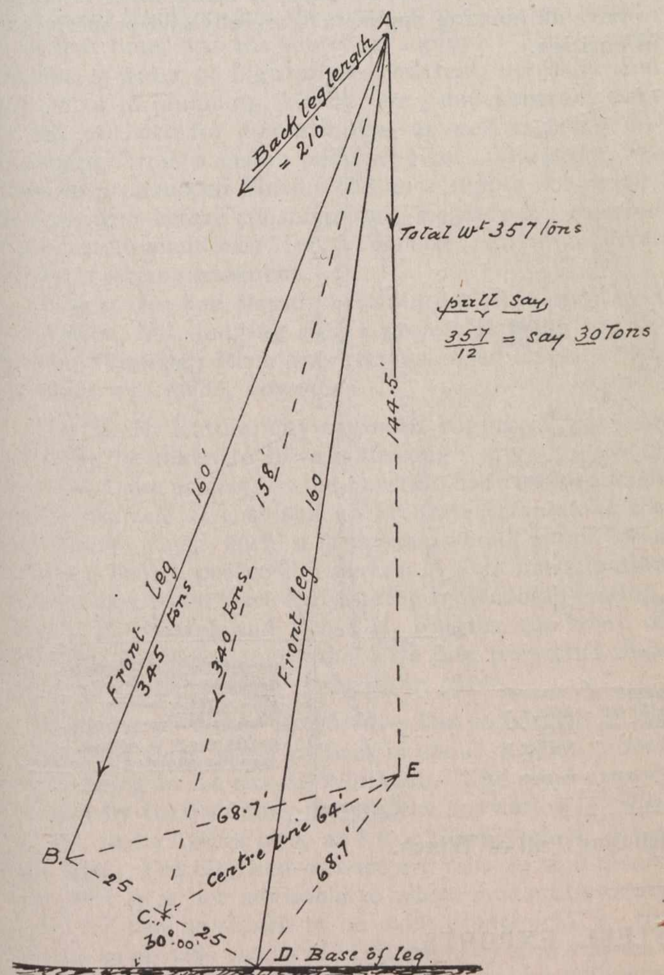

Fig. 2.—Isometric Sketch Showing Deduced Dimensions of Shear-legs.

The two front legs are necessarily close to the edge of the wharf; in the instance under consideration the distance therefrom being five feet. This necessitates a very solid wall and foundation, well tied in to counteract the outward thrusts from the toe of each front leg, while the rear leg is in compression. These foundations are connected to the concrete pit foundations for the back leg screw and thrust block gear by two counterforts, as shown on the plan in Fig. 1. The longitudinal and cross-sections illustrate the piling necessary in this particular case on account of the foundations resting upon "made" ground. The piles were carried down to gravel, as were also the foundations for the counterforts and basin wall, as will be seen in the drawing. Generally the back leg foundations are carried down in concrete unless the solid bed is of too great a depth, in which case footings, proportioned in size to the weight to be supported, would be used. Piling is not used unless absolutely necessary.

In the design the first step consists in fixing the maximum height required. This estimate is based upon the largest weight, the highest lift anticipated, the depth of load, and length of blocks, including tackle. The height, as shown in the diagram, of the case under consideration is 144 feet 6 inches, measured from the ground.

The necessary width between the footings for the front legs and the greatest overhang from the vertical are next deduced. These are found to be 50 feet and 64 feet respectively.

Referring to the isometrical sketch of Fig. 2: $\sqrt{CE^2 + CD^2} = \sqrt{64^2 + 25^2} = 68.7$ feet $= DE$; and $\sqrt{DE^2 + AE^2} = \sqrt{68.7^2 + 144\frac{1}{2}^2} = 160$ feet $= DA$, which is the length of front leg from point D to point A. $\sqrt{CE^2 + AE^2} = \sqrt{64^2 + 144\frac{1}{2}^2} = 158$ feet $= CA$. (See Fig. 2).

The weight of one front leg is arrived at by computing the volume from the dimensions given and the weight at 20.5 lbs. per sq. ft.

Weight of front leg	=	51,520 lbs.
Weight of four ribs	=	9,280 lbs.
Weight of blocks	=	13,120 lbs.
		73,920 lbs. or 33 tons, approximately, (2,240 lbs.).

Allowing for the weight of end blocks, etc., the estimate for each front leg may be considered 40 tons.

The weight of the back leg will be found by proportion to be 52 tons, its length being 210 feet.

The load increased by 50% over load is considered as a test weight = 150 + 75	=	225 tons
Tackle - - - - - - - - -	=	10 tons
Half the weight of the front legs (considered twice) - - - - - - - -	=	40 tons
Half the weight of the back leg - -	=	26 tons

making a total approximating 300 tons.

In considering the blocks themselves the double "purchase" must be taken into account, the test weight being $\frac{225}{12} = 19 \times 2 = 38$ tons

Friction, etc. (reckoned at 50%) = 19 tons

making a total of 57 tons, double "purchase," and a grand total of 357 tons, as the weight. The pull would therefore approximate 30 tons, or 1/12 of this.

Resolving the load when overhanging 64 feet, the tension on the back leg reaches 350 tons, and on the front legs 680 tons thrust, or 340 on each, if both were on the centre line (for calculation only), and 345 tons on each when splayed 50 feet apart at base.

Taking the pull into account, a block of concrete of sufficient weight to resist the tension of the back leg at its foot when the weight is at its greatest overhang, 64 feet, must be of the following depth:

$$\frac{189 \text{ tons, vertical pull,} \times 16 \text{ cu. ft. per ton of concrete}}{32 \text{ feet, length,} \times 13 \text{ feet width}}$$

$= 7.3$ feet. Therefore, the dimensions of the block might be 32′ 0″ × 13′ 0″ × 7′ 6″ depth.