

1990 Sandy Bottom Anchor Tests

Conducted by NAV-X Corporation
(manufacturers of the Fortress Marine Anchors)
Approved to present by Brian Sheehan of [NAV-X](#)

Anchor tests were conducted on February 17-18, 1990 by NAV-X Corporation of Ft. Lauderdale, FL, manufacturers of FORTRESS Marine Anchors. All tests and procedures were verified by the Author of "Chapman's Piloting * Seamanship," Elbert S. Maloney. The tests were also witnessed in part by invited members of the marine industry, including Paul Thompson and Bill Glass of Simpson Lawrence, Ltd., manufacturers of the "CQR," "Delta," and "Harborfast" anchors.

The tests were also witnessed at various times by editorial representatives of the following marine publications: Burleigh Magazines, Ltd. (UK), Cruising World/Sailing World Magazines, Motor Boating & Sailing, Multihulls Magazine, Power & Motoryacht, Practical Sailor, Sail, and Yachting Magazine. A photographic and videotape record of the tests was obtained.

PURPOSE:

The tests were conducted in order to establish a controlled comparative database of straight line anchor test results reflecting the performance of major recreational marine anchor designs and brands, including the FORTRESS Marine Anchor, which had not previously been included in any such open testing. Secondly, the tests sought to establish the most reliable and credible database to date, through careful calibration of the actual test area, procedures, and multiple-pull averaging, with the intention of creating a useful reference for the boating public in the years to come. These tests are "Part One" of a series of anchor tests conducted by NAV-X Corporation aimed at establishing a reliable reference for the performance of different anchors in various bottoms under the many situations and conditions pleasure boaters can expect to encounter while cruising.

DESCRIPTION OF THE TEST SITE

These tests were conducted in an area of Biscayne Bay, in Miami, FL. The site is located along the southwest seawall of Fisher Island (Approx: 25 45.5' - 80 08.7'). The tests were conducted using four arbitrary lanes approx. 200 yds. long, running parallel to the seawall in East to West, and West to East directions. Water depths in the test area had been previously sounded and charted by NAV-X Corporation, and found to average between 13' and 15' deep. Samples of the bottom has been described as "fair to good" by NAV-X Corporation. ("Good to Excellent" being firmly compacted fine grained coral sand...)

TEST VESSELS

The vessels utilized for the testing included the main test vessel, the 70', twin screw (2X450HP) diesel tug "Hercules," chartered from Florida Marine Towing, Inc., and commanded by Captain Thomas C. White. In addition, three 30' class workboats were chartered to serve as passenger shuttles, anchor recovery vessels, and photography platforms. In addition, a helicopter was chartered on the second day of testing for the purpose of aerial photography and video.

SCOPE AND ANCHOR RODE

6 lengths of 1-1/4" three strand nylon line were precut with thimbles spliced into each end for testing. The finished lengths of 95' each, when coupled to a 6' length of 1/2" high test (Grade 40) chain, were designed to provide a scope of 5 to 1 in this particular anchorage, as measured from the tug's deck to the sea bottom. ($5' + 15' = 20' \times 5 = 100'$). For safety during the maximum pull test on the 65lb FORTRESS FX-125, a larger length of 1-1/2" line was added to insure that the weaker 1-1/2" line would be entirely below water, which would absorb the rope's stored energy should the line break during testing at loads approaching 20,000 lbs. (Such a break did occur during a pull of the FORTRESS FX-125). The diameters of the rope and chain used was larger than that normally specified for use with anchors of the main size category. The larger size was chosen for safety during testing.

LOAD MEASURING

Test loads were measured on two calibrated "Dillon" analog dynamometers, each having a certificate of accuracy traceable to the U.S. Bureau of Standards. The first, which measures loads from 0-10,000 lbs (12,000 maximum), was used for all anchors except the larger FORTRESS FX-85/125. for which the larger 0-20,000 lb. unit was sometimes used.

ANCHORS TESTED

10 anchors in all were tested and are described and illustrated below. Actual weight varied from 19 lbs. to 65 lbs. Generally, the test involved anchors in the 35-40 pounds steel "Danforth Type" size class. This size class was selected for testing because it represents the size often chosen for service aboard cruising boats in the 35' to 50' class. Generally speaking, a given anchor's "performance ratio" or holding power per pound of anchor weight, can be used to determine the performance that can be expected from different sizes of the same model and design. All anchors, including the FORTRESS models, were purchased by NAV-X Corporation, and chosen randomly from the stocks of local retailers and distributors (Sailorman, and Lewis Marine Supply, Ft. Lauderdale, FL). AL anchors were inspected prior to testing, and found to be generally within their manufacturer's advertised specifications, except where noted below.

PULL LIMITS

Limits on the maximum pull each anchor would be subjected to were established prior to testing. This limit was established at 2.5 times the anchor's rated working load or holding power, because this is a reasonable margin of safety. Secondly, the ABYC's "Typical Ground Tackle Design Horizontal Loads Table" equates that 63 knots of wind places about 7500 pounds of load on a 50' boat. Finally, preliminary testing of these same anchors at this site, demonstrated that structural damage would occur to some at loads less than 2.5 times their rating. On these anchors, the pull limit was reduced to about 15% less than the load under which damage occurred. All the FORTRESS anchors, and Danforth H-1800 were able to withstand pulls of 2.5 their ratings. The Bruce and CQR limits were arbitrarily set at 7,599 lbs. since the manufacturers do not give such ratings. Danforth's Deepset Hi-Tensile T-4000, Standard S-2000 and U.S. Anchor's Sentinel 40 test limits reflect their demonstrated structural strength.

TEST PROCEDURE

Anchors were scheduled for testing in a revolving order. The anchor to be tested would be attached to its rode, and staged for deployment at the stern of the tug "Hercules." After the tug had maneuvered into the proper lane and test direction, the standing end of the rode was then attached to the dynamometer, and the anchor thrown into the water. The tug would then move forward under minimal power as the rode was payed out. Prior to reaching the end of the rode, the tug was shifted into neutral, allowing its gentle momentum to drift against the anchor to set it. When a "set" was established: i.e.: when some load was registered upon the dynamometer, the transmission was engaged and RPM's slowly increased while the registered loads were carefully observed and recorded. Loads were then slowly increased until the anchor being tested had either reached its pre-established test limit and held, "dragged" under constant load, or "pulled out," resulting in the dynamometer needle falling to a substantially lower reading as the tug moved through the water. Bearings taken on the nearby seawall established whether an anchor dragged, pulled out, or held. When each test was completed, the standing end of the rode was then disconnected from the dynamometer, attached to a buoy, and thrown into the water for recovery by one of the attending workboats. This enabled the next anchor to be tested immediately. using the recovery boat system allowed a new anchor to be tested approximately once every 15 minutes. After each anchor was recovered it was then returned to the tug "Hercules" to be staged for its next test.

TABULATION OF RESULTS

When the two days of testing were completed, and the recorded test results compiled, each anchor's performance was then scored and rated into three categories: (1) "Average Test Pull," or, all pulls added up and then divided by the number of pulls to establish an average. (2) "Holding Power Per Pound Of Anchor Weight" sometimes referred to as a "performance ratio" of how many times an anchor's actual weight it is capable of holding in a given bottom, and (3) "Cost Per Pound Of Holding Power" to establish useful "value index," based upon advertised list prices divided by the Average Test Pull. The results of these tabulations can be examined in the charts on the next page. A summary of raw test

data, as verified by Mr. Maloney and Captain White, is provided on the last page of this report.

Part One: Miami. February 17-18, 1990 (Sandy Bottom Tests) Raw Test Data Verified by E.S. Maloney, Author of "Chapman's Piloting & Seamanship."				
ANCHOR:	Pull No.	LANE/ DIR:	HOLDING Lbs.	RESULT:
Bruce 20 Kg	1	2W	600	500/300/600: Pulled Out
Actual Wt. 46 Lbs	2	3W	1,900	1000/1900/500 Dragged
AVG PULL: 1,883 LB	3	3W	2,100	800/1200/2100 Pulled Out
	4	3E	500	500/500/500 Dragged
	5	4E	5,800	1200P/800D
	6	E	400	200D/400P/400 Dragged
CQR 45	1	2E	2,200	200D/1600P/2200 Pulled Out
Actual Wt: 47 Lbs	2	2E	4,200	700P/900P/2000P/4200 Held
AVG PULL: 3,350	3	3E	N/A*	See explanation*
	4	3E	3,200	Dragged
	5	3W	4,000	Hooked on something: Req. 180 Deg. turn to free
	6	4W	2,700	Pulled Out
	7	2W	3,800	Pulled Out
Danforth Deepset	1	2E	4,000	
Hi-Tensile "T-4000"	2	3W	1,000	1000P/600P/500P: Pulled Out
Actual Wt. 30 Lbs.	3	2W	1,800	150P: Pulled Out
AVG PULL: 2,200 LB	4	3W	2,400	800P/600P: Pulled Out.
	5	2W	1,800	
Danforth Hi-Tensile	1	3E	1,000	1,000P/400P/500P Pulled Out
H-1800 (35H)	2	4W	4,500	Held
Actual Wt 33 Lbs.	3	2W	2,200	Pulled Out
AVG PULL: 3,700	4	3W	5,000	Held
	5	2E	4,500	Held
	6	2W	5,000	Held 1000P/800P/5000P
Danforth Standard	1	4W	4,200	Held
S-2000 (40S)	2	3E	4,000	Held

Actual Wt. 42 Lbs.	3	2E	2,500	Pulled Out
AVG PULL: 3,160 LB	4	2E	-0-	Not Set/No Load (Not counted in AVG)
	5	2W	1,100	750/600/1000: Pulled Out
	6	1W	4,000	Held, Disabled
FORTRESS FX37	1	3W	7,800	Held
Actual Wt. 19 Lbs.	2	2E	7,000	Held
AVG PULL: 7,580	3	2E	7,600	Held
	4	2E	8,000	Held
	5	3W	7,500	Slipped at 4000, reset within 10 yds
FORTRESS FX-55	1	3E	9,500	Pulled Out
Actual Wt. 31 Lbs	2	4W	10,000	Held
AVG PULL: 8,857 LB	3	3E	8,000	Dragged
	4	3E	4,500	Pulled Out
	5	3W	10,000	Held
	6	2E	10,000	Held
	7	4W	10,000	Held
FORTRESS FX-85	1	3W	12,000	Held
Actual Wt. 44 Lbs.	2	2W	12,000	Held
AVG PULL: 12,716 LB	3	2W	12,000	Held
	4	3E	12,800	Held++
	5	3E	12,000	Pulled Out++
	6	2W	15,500	Pulled Out-Disabled++
FORTRESS FX-125	1	1W	12,000	Dragged
Actual Wt: 65 Lbs.	2	2E	20,000	Broke Line: Held. Hooked Cable. ++
AVG PULL: 15,975	3	3E	15,500	Pulled Out
	4	1W	16,400	Broke Line: Held++
Rule Deep Set T-4000	1	2E	4,000	Pulled Out
	2	3W	1,000	1000P/600P/500D: Pulled Out
Actual Wt. 30 Lbs	3	2W	1,800	150P: Pulled Out
AVG PULL: 2,200	4	3W	2,400	800P/600P: Pulled Out
	5	2W	1,800	Pulled Out
Actual Wt. 30 Lbs	2	3W	1,000	100P/600P/500D: Pulled Out
AVG PULL: 2,200	3	2W	1,800	150P: Pulled Out
	4	3W	2,400	800P/600P: Pulled Out

	5	2W	1,800	Pulled Out
Rule Deep Set H-1800	1	3E	1,000	1000P/400P/500P: Pulled Out
Actual Wt. 33 Lbs	2	4W	4,500	Held
AVG PULL: 3,700	3	2W	2,200	Pulled Out
	4	3W	5,000	Held
	5	2E	4,500	Held
	6	2W	5,000	1000P/800P/5000H: Held
Rule Standard S-2000	1	4W	4,200	Held
Actual Wt. 42 Lbs	2	3E	4,000	Held
AVG PULL: 2,633	3	2E	2,500	Pulled Out
	4	2E	No Set	No Set/No Load
	5	2W	1,100	750P/600P/1100P: Pulled Out
	6	1W	4,000	Held
U.S. Anchor Sentinel 40	1	2E	4,000	Held
Actual Wt 50 Lbs.	2	2W	2,200	2,200/400 Pulled Out
AVG PULL: 3,400 LB	3	2W	4,000	Held
	4	2E	3,400	Pulled Out
	2	2W	2,200	2,200/400 Pulled Out
	3	2W	4,000	Held
	4	2E	3,400	Pulled Out
<p>*CQR attached to 15:1 scope. Began dragging at approx. 1,200 lbs. Loads increased to approx 10,000lbs @ 1 kt speed. KEY: +++=20:1 SCOPE P=PULLED OUT D=DRAGGED H=HELD R=RESET</p>				