DUCKBILL
Earth Anchor Systems

RECOMMENDED INSTALLATION GUIDELINES

FOR THE DUCKBILL ALUMINUM EARTH ANCHOR SYSTEM

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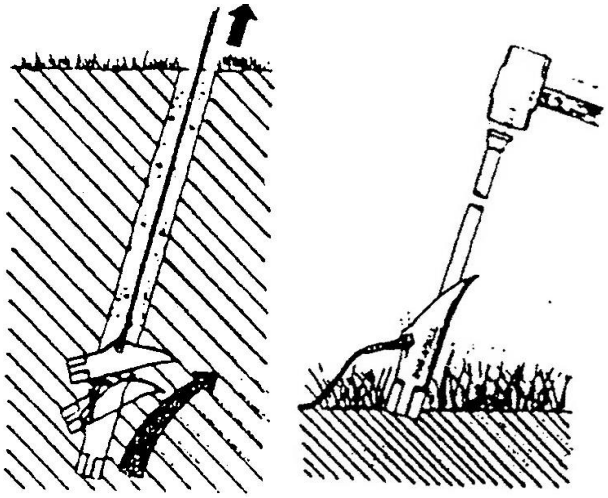
INTRODUCTION

This guide serves to aid suppliers and installers of DUCKBILL® earth anchors about installation methods and techniques. The DUCKBILL earth anchor has been developed to function in the total range of soils. Its design allows the installer much greater flexibility than competitive anchors offer. Installation details, tools and special soil conditions will be covered and should answer any questions that may arise. DUCKBILL anchoring systems offer an economic, lightweight solution to nearly any anchoring situation, big or small. Normally, wherever you can drive a stake or drill a hole you can use a DUCKBILL anchor.

THE DUCKBILL PRINCIPLE

The DUCKBILL anchor works very much like a toggle bolt. The anchor body is driven into the soil with a re-useable drive steel (drive rod). Once the anchor body is placed to the proper depth the drive steel is removed. A backward pull on the cable then rotates the anchor body in the ground until it is perpendicular to the cable. This is called anchor-locking the anchor. Because the DUCKBILL is driven into the earth, it is actually compacting the soil around it, not disturbing it. As the anchor is anchor-locked it cuts through the compacted soil into undisturbed soil and further compacts the soil above the anchor. As the soil above the anchor is compacted from below it forms an inverted cone of compact soil. This is called a cone of resistance. One of the most important features of the DUCKBILL anchoring concept is the ability to proof-test the anchor during normal installation. The anchor locking operation can be a proof-test of the anchor. By measuring the force required to anchor-lock the anchor the installer knows the actual holding capacity of the installation.



SOILS

CLASS	DISCRIPTION	PROBE VALUE
1	Solid Bedrock	
2	Dense Clay; Compact Gravel Dense Fine Sand; Laminated Rock; Slate; Schist; Sandstone	Over 600 in./lbs.
3	Shale; Broken Bedrock; Hardpan; Compact Gravel Clay Mixtures	500-600 in./lbs.
4	Gravel; Compact Gravel and Sand; Claypen	400-500 in./lbs.
5	Medium-Firm Clay; Loose Standard Gravel; Compact Coarse Sand	300-400 in./lbs.
6	Medium-Firm Clay; Loose Coarse Sand; Clayey Silt; Compact Fine Sand	200-300 in./lbs.
7	Fill; Loose Fine Sand; Wet Clays; Silt	100-200 in./lbs.
8	Swamp; Marsh; Saturated Silt; Humus	Under 100 in./lbs.

(Table provided by A.B. Chance)

Anchor holding capacity will vary in the different classes of soils. More capacity can be expected in the numerically lower classes and less capacity in the higher number classes. Knowing the type of soil does not always mean that the class is known. For example, a clay material can have a class ranging from 4 to 8 depending on whether the material is very stiff to hard or soft to very soft. Water content will also affect classification. Similarly, cohesionless soils such as sands and gravels have a wide range depending upon the density or compactness of the material.

There are various ways of testing soils. A torque probe is the best for quick classification in the field. Core samples are the best for detailed classification but are expensive and take time to obtain the test results. Generally resistance to driving the DUCKBILL is a good “seat of the pants” indicator of soil class. Stiff resistance will normally result in positive anchoring. f the anchor drives very easily, the soil is soft and

steps should be taken to assure adequate capacity. Keep in mind that simple anchor-locking will verify the capacity of the anchor in any soil class.

ANCHORS

DUCKBILL MODEL #	RATED CAPACITY	DRIVE ROD DIAMETER	NORMAL DEPTH OF INSTALLATION
40	300 lbs.	¼”	20”
68	1,100 lbs.	½”	2 ½’
88	3,000 lbs.	¾”	3 ½’
138	5,000 lbs.	1’ or 1 ⅛”	5’

The anchors are rated in an average (class 5) soil condition. gain, higher capacities can be expected in harder soils and lower capacities in softer soils. The rating is mainly useful as a reference for anchor selection. Proof-loading is the only way to insure the exact capacity of each installation. This is true for all anchors on the market today.

INSTALLATION

The first step in any installation is to select the proper anchor for the job. Keep in mind the maximum load expected and add a reasonable safety factor.

DRIVING THE ANCHOR

The DUCKBILL® can be driven to almost any depth at any angle. *In guy applications, the angle of the installation should closely match the angle of the guy line.* Start by inserting the drive steel into the anchor body. Use a sledgehammer, fence post driver or a power-driven jackhammer to drive the anchor to the proper depth. Fill hole made by anchor with soil. This will not allow water to seep down to the anchor, causing wedge out or hardening soil.

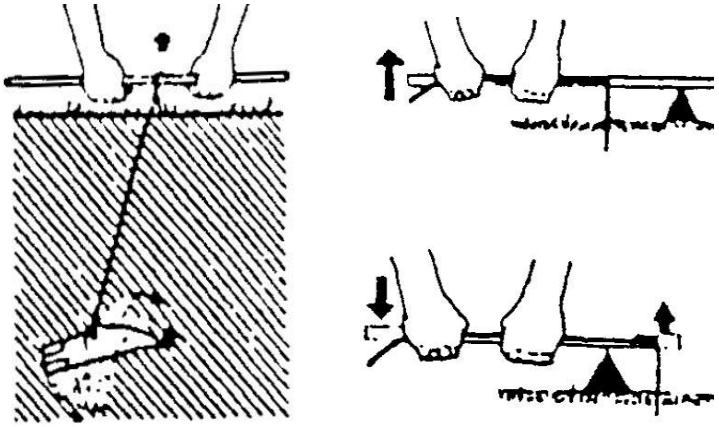
LOCKING THE ANCHOR

After the anchor has been driven to depth, the drive steel is retracted from the anchor. Pull back on the anchor cable to toggle the anchor into the perpendicular (anchor-locked) position. In average soils a rule of thumb is that the length of pull should equate to the length of the anchor.

For example: Model 88 anchor body measures 6” inches. A pull of 5-6” will rotate the anchor into a completely perpendicular position. *Several methods are used to anchor lock the anchors.*

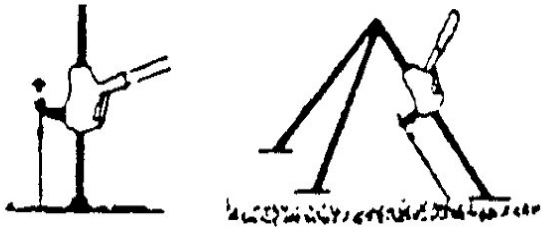
ANCHOR LOCKING BY HAND

The smaller DUCKBILL models may be locked by hand. Insert the drive steel through the cable loop or wrap the cable around the drive steel to fashion a “T” handle. Pull on the drive steel to anchor-lock the anchor. A fulcrum is also very useful in locking anchors by hand.



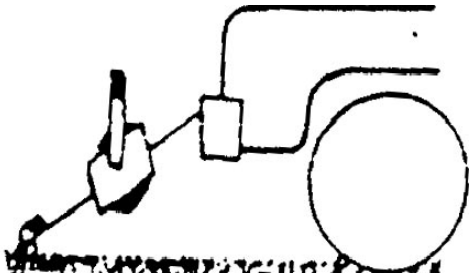
JACKS

Ordinary automotive bumper jacks or handyman jacks work well on medium and larger sized anchors. By adding legs to the jack to form a tri-pod angled pulls are achieved with greater ease.



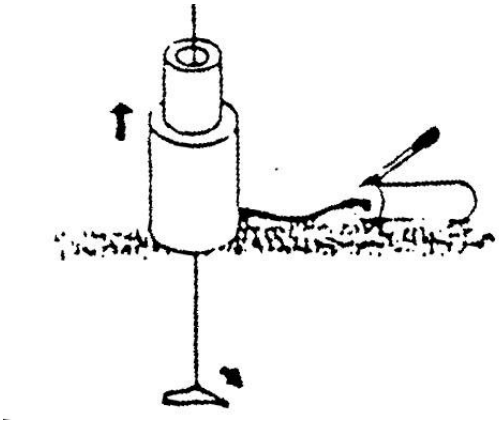
COME-ALONGS AND FENCE STRETCHERS

These tools work very well providing that there is a substantial counter anchor nearby. A truck bumper for example. In general, the object that is to be guyed is not acceptable as the counter anchor. It will deflect prior to the anchor reaching full anchor-lock position.



CENTER HOLE HYDRAULIC CYLINDERS

Although a specialized piece of equipment, the center hole hydraulic cylinder is a very good tool for someone who will install many anchors on a regular basis. Being small and lightweight they are ideal for horizontal installations. A hydraulic pressure gauge often accompanies this set-up so that every installation may be checked for capacity. (proof loading)



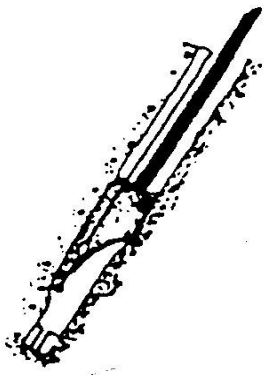
NO MATTER WHAT METHOD IS USED, IT IS CRITICAL THAT THE ANCHOR BE PROPERLY LOCKED BEFORE TYING OFF THE OBJECT TO BE ANCHORED.

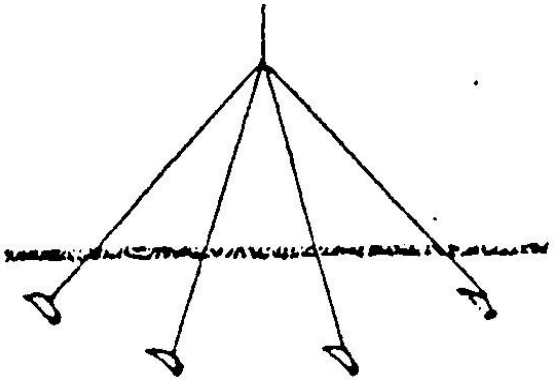
An anchor not properly locked prior to attaching will result in significant pull out before the anchor self-locks. Obviously, this is not desired. Failure to install and lock the anchor at the correct angle will result in the anchor cable cutting through the soil until the angles equalize. This will cause slack in guy lines, also not desired.

SPECIAL SOILS CONSIDERATIONS

SOFT SOILS

In areas where the soil proves to be softer than normal, steps should be taken to assure the capacity of the anchor. Proof-loading is especially useful in soft soils. Guesswork as to the capacity is eliminated. The installer will know immediately if the anchor point is adequate or if further steps are necessary. Backfilling and tamping the hole behind the anchor will yield somewhat higher capacity in most soft soils. Fill and tamp the hole in 3” lifts prior to anchor locking the anchor. Another option is to drive the anchor deeper in an effort to penetrate a harder layer of soil. Larger anchors may need to be placed to achieve the required load. As a last resort a number of anchors may be placed in a cluster and bridled together to form one point.





HARD SOILS AND ROCK

If excessive resistance to driving occurs, it may be necessary to drill a hole for anchor placement. If the anchor stops moving and is subjected to excessive pounding (especially from power equipment) metal fatigue can occur and the anchor body can fracture. The DUCKBILL® anchor may be placed in a pre-drilled hole in hard dirt or rocky material and achieve very good results. Hand augers and gasoline or hydraulic powered earth drills can be used to form the hole. A PIONJAR 120 gasoline powered breaker/drill is very useful due to the fact that it performs both drilling and driving operations.

SIZES OF PRE-DRILLED HOLES

MODEL 40	¾” TO 1”
MODEL 68	1 ¼” TO 1 ½”
MODEL 88	2” TO 2 ¼”
MODEL 138	2 ½” TO 2 ¾”

The small end of the range is satisfactory in hard dirt situations. The high end of the range must be used for anchoring in extremely hard soils.

The information included in this publication is only for general purposes. The conditions on each individual job site will dictate the proper anchor and tools necessary to achieve a quality installation.

MEMORANDUM

FROM: Thomas E. Jewett, Vice President Engineering

SUBJECT: **CERTIFIED INDEPENDENT STRENGTH TEST OF DUCKBILL ®**

The following chart summarizes the results of these tests:

PRODUCT	RATED CAPACITY (NORMAL SOIL)	FAILURE MODE	TESTED ULTIMATE BREAKING STRENGTH (LBS)	SAFETY FACTOR
40-DB1	300	ANCHOR EYE	489 (1/16" cable)	1.63
68-DB1	1,100	CABLE	1,956 (1/8" cable)	1.78
88-DB1	3,000	ANCHOR EYE	6,750 (1/4" cable)	2.25
138-DB1	5,000	ANCHOR EYE	12,210 (5/16" cable)	2.44

DUCKBILL ® ANCHOR MATERIALS

ANCHOR	CASTING METHOD	ALUMINUM ALLOY	TENSILE YIELD (PSI)	TENSILE ULTIMATE (PSI)	ELONGATION (%)
40-DB	DIE-CAST	K-9	20,700	26,500	3 ½
68DB	DIE CAST	K-9	20,700	26,500	3 ½
88-DB	PERMANENT MOLD	356	24,000	32,000	3
138-DB	PERMANENT MOLD	356 T-G	24,000	33,000	3

· PROPRIETARY ALLOY SIMILAR TO 369

DUCKBILL HAND DRIVE STEEL MATERIAL

DRIVE STEEL	PRODUCTION METHOD	MATERIAL	TENSILE YIELD (PSI)	TENSILE ULTIMATE (PSI)	ELONGATION
DS-40	COLD FORMED	AISI 1038 STEEL WIRE GRD-2	57,000	74,000	18
DS-68	COLD FORMED	AISI 1038 STEEL WIRE GRD-2	85,000	74,000	18
DS-68-HD	FORGED	AISI 1045 COLD ROLLED STEEL ANNEALED	85,000	95,000	12
DS-88	FROGED	AISI 1045 COLD ROLLED STEEL ANNEALED	85,000	95,000	12

MacLean™ POWER SYSTEMS

CLEARANCE HOLE DIAMETERS AND HARD SOIL PILOT HOLE DIAMETERS

FOR DUCKBILL® EARTH ANCHORS

INSTALLATION OF DUCKBILL ANCHORS IN HARD SOILS CAN BE GREATLY HELPED BY THE USE OF A PILOT HOLE. TYPICALLY, THE PILOT HOLE HAS NO SIGNIFICANT AFFECT ON THE HOLDING POWER OF THE ANCHOR. THERE ARE MANY ACCEPTABLE METHODS OF DRILLING PILOT HOLES AND MANY MANUFACTURES OF EQUIPMENT TO DO SO. RECOMMENDED HARD SOIL PILOT HOLE DIAMETERS AND CLEARANCE HOLE DIAMTERS ARE CHARTED BELOW.

MODEL	CLEARANCE HOLE DIAMETER	MINIMUM PILOT HOLE DIAMETER FOR HARD SOIL
40-DB	1.0”	0.75”
68-DB	1.50”	1.25”
88-DB	2.25”	2.00”
138-DB	2.75”	2.50”