FIELD TESTS OF ANCHORS FOR EMERGENCY LIGHTWEIGHT SHELTERS

Field tests have been conducted by the Shelter Research Unit of the International Federation of Red Cross and Red Crescent Societies to address the question: “what are the major aspects to consider using anchors in the humanitarian sector?”. Influence of soil, weather, type and combination of anchors, installation, orientation, inclination, depth, displacement and price have been measured. Good anchoring is a prerequisite to reach the effective shelter lifetime, and it is relevant to economic and effective material usage.

Field tests on commercial anchors of three types (pegs, screws and buried anchors) have been conducted in five different soils measuring forces and displacements. The anchors were selected according to their appropriateness for emergency shelters and availability.

The materials used include:

a) Pulling system composed of a steel cable, a motorized winch and a triangular steel construction to control the angle of pull.

b) Measuring system: dynamometer.

c) Four soil trenches, dimensions $\ell=18$, $w=0.8$ and $h=0.6$ to 1.5m were filled with different kinds of soils, compacted in layers of 30cm. These soils were chosen in order to create a representative diversity (sand, silt, rocky sand and clay rocky sand). A fifth sample was provided by the original natural soil (clay + sand).

d) 18 Anchors belonging to three categories: 8 pegs, 3 screws and 7 percussion-driven ones. A total of 66 suppliers were contacted, 37 anchors were received, out of which 18 were finally selected for the final test sets.

Most important findings concern to:

**Weather** exists under the ground too. Different performances have been measured depending on temperature and precipitation.

**Limit states**. Two outputs were obtained with the tests: the overall peak performance without constraints and the peak performance reached with a constraint, a displacement limit of 5 cm
(+/-1). Big differences between the values, were sometimes observed. Pegs and screws show a difference smaller than 3 times while percussion-driven anchors can reach as much as 8. Thus, percussion-driven anchors can need substantially more displacement before reaching their maximum capacity.

Maximum resistance. The highest resistances were observed for percussion-driven anchors. Independently of the soil, the strongest anchors always reach 6 kN and in some cases the output was higher than 12 kN. For the case of screw anchors, forces measured were considerably lower: for all compatible soils, the most performing anchor reaches 3 kN in all of them. For pegs, only one model in one soil reaches the 3 kN threshold.

Incompatibilities. Observed incompatibilities were screw anchors in ‘Gravel-Sand’ and ‘Silt’ and the biggest percussion-driven anchors in ‘silt’ and ‘rocky-sand’ soil.

Ease of use. Pegs and screw anchors are relatively easy to set up. The only drawback which applies, especially for pegs is the hazard risk once installed (for instance with children playing). Therefore, sharp ends should be removed in pegs design. For percussion-driven anchors, the situation is clearly different: the arming process is a fundamental step which needs special skills. As it takes place invisibly, skilled experience is needed to correctly estimate whether the correct position is reached.

Removability, reusability. For pegs and screw anchors, removal is rather easy. For pegs, pulling on the axis is generally sufficient as resistance is weaker in that setting. For screws, repeating the set-up instructions in the opposite order is sufficient and if the anchor is not damaged, it can be reused for future endeavors. For percussion-driven anchors, removal is only possible using a shovel if the soil allows burying but it is very time-intensive. Therefore, percussion-driven anchors should be perceived as single-use. A wrong placed percussion-driven anchor becomes a spilled anchor. (Percussion-driven anchors with a second rope for disarming and removal are not recommended for use in the humanitarian sector as inverting the ropes can have dramatic consequences).

Warning indicators. In the case of screw and peg anchors, upward movements have a clear and strong visual impact, even if the displacement is only of a few centimeters. Strengthening measures must be taken urgently if anchors slide out. For percussion-driven anchors, the indicator is much subtler as only the distance between the eye-loop and the soil can serve as such. Regular measuring and recording is necessary.

Price is not a reliable indicator. The ratio between price and performance is not stable. Two anchors of the same type and with the same price can show significant differences in terms of performance.

X-crossing pegs is a limited improvement. The resistance of three anchors, one being the peg itself and the other two creating additional resistance, is 10% higher than the one of a single peg.

Combination of pegs. In order to increase forces, pegs can be combined by connecting several of them to the same guy rope. As, the same soil might be compressed twice, the force transferred per peg decreases.

Combination of percussion-driven anchors. The resistance of combined percussion-driven anchors increases but the ratio overall peak performance without constraints / peak performance reached with a displacement limit of 5 cm is unstable.
References


Tent Rental Division, 2006: “Pullout capacity of tent stakes”. Industrial Fabrics Association International, Roseville, MN.