Boing! The Up & Down of Stretch in Rescue Ropes

Some rescuers are concerned that the potential force that a patient and attendant might see if they take a fall on a rescue rope is too high. So high, in fact, that some rope manufacturers are developing, or have already redesigned some rescue ropes with greater energy absorbing characteristics. Greater energy absorption means lower peak forces, but at a trade-off of greater fall distance. This study examines the effects of stretch in kernmantle ropes with respect to peak force and stop distance. The results are eye-opening and build a compelling argument as to which rescue rope to use for which purpose.

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Rescue Belays are not Leader Falls

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How much stretch, or elongation should our rescue ropes have? Rescuers should understand the diametrically opposed needs of a rescue rope. An advantage of greater rope elongation is reduced peak force in the event of a large shock force. A disadvantage of this is increased stop distance. There is a significant difference in the amount of elongation that exists between the various kinds of kernmantle rescue ropes available in North America. This presentation is about the considerations of rope stretch in rope rescue systems and what we need to think about to make better decisions in the choice of ropes we use.

If an accidental drop of a rescue load occurs, the resulting peak force is directly related to a number of factors such as the configuration and mass of the load, how floppy it is, and the angle and roughness of the terrain. Also affecting peak force is how the rope is terminated and anchored, and the amount of elongation the rope exhibits. While there are many factors that can reduce the resultant peak force, we still need to consider the potential severity of a relative worst-case event. Many believe this to be a failure of the mainline system, resulting in a fall onto the belay system.

In the early eighties, the *British Columbia Council of Technical Rescue* (BCCTR) developed minimum performance criteria for the assessment of belay competence for rope rescue. In order to pass the belay competence criteria, their standards required that the belay must be

able to withstand a minimum 1 metre (m) drop of a 200 kilogram (kg) mass onto 3 m of rope, with no more than 1 m of additional travel (including belay unit elongation, any slippage, knots tightening up and rope elongation—pre-rebound), and with no more than 15 kilonewtons (kN) of peak force. The total distance a load falls, pre-rebound, is often referred to as the Fall Arrest System (FAS) extension, and the resulting peak force of such a drop is often referred to as the Maximum Arrest Force (MAF).

While the objective of the BCCTR test criteria was to compare and evaluate the suitability of various rescue belays, the common element always seemed to be the rope. Though differences in rope elongation have always existed between manufacturers, recently we are seeing some ropes being deliberately made with greater elongation in order to reduce the forces that the patient and rescuer might be subjected to during fall arrest.

Of interest to rescuers then, is to understand how these changes in rope properties will affect what we do in the field. Are the peak forces of the stiffer ropes too high? And, have these 'stretchier' low-stretch ropes appropriately addressed balancing the opposing needs of reduced MAF and limited FAS extension to minimize serious risk of injury to the patient and/or attendant during fall arrest?

To provide some insight to these questions, tests were conducted to provide some indication of the magnitude and severity of MAF of ropes with different elongation properties. The BCCTR model was used as a basis for testing under relative worst-case conditions. Ropes of 11.1 mm diameter were tested using a 200 kg mass to represent a 2-person mountain rescue load. Ropes of 12.7 mm diameter were tested with a 280 kg mass to represent a 3-person mountain

rescue load, or to approximate the National Fire Protection Association's (NFPA) two-person (600 lbf) load.

Additional drops were conducted to determine the significance of factors that might affect MAF such as the effects of a belay and mass rigidity. The obtained MAF values of the various rope types and influencing factors were then compared to currently accepted MAF limits established by various standard-setting bodies. This comparison will help rescuers understand what amount of rope elongation is suitable to keep peak force values to acceptable levels for relative worst-case shock forces.

In addition to measuring the peak forces, the total rope elongation, or FAS extension was also measured for the various types of ropes to determine how far the load would fall during fall arrest. Obviously, the greater the FAS extension, the greater the risk is of serious injury to the patient and attendant of striking a ledge, beam, object or the ground. It is fairly well understood that this can be a risk in rope rescue, but how bad is this risk?

The data shared from these drop tests is intended to provide rescuers with a better indication and perspective for quantifying these risks, and therefore highlight what we need to think about to make better decisions in the choice of ropes we use.

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