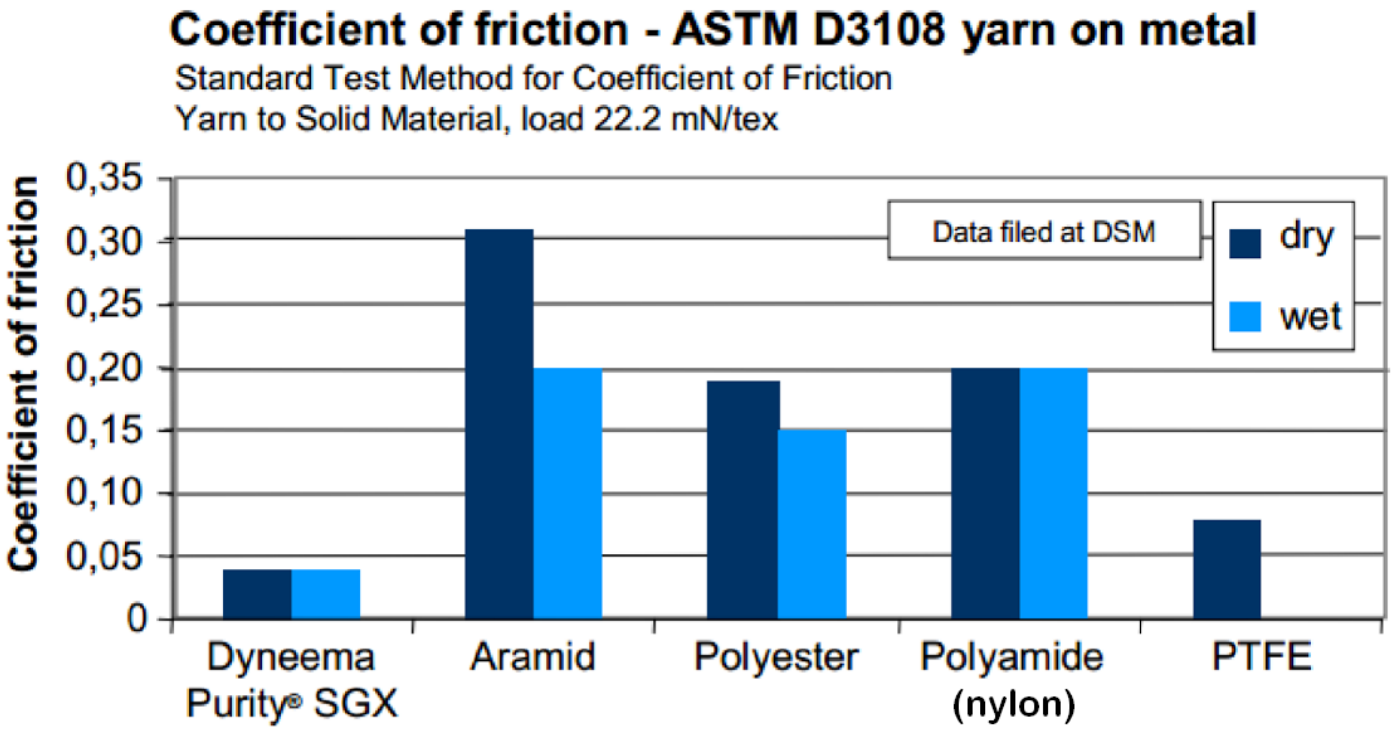
Section 2 of Dyneema and Not Dying

A) What Is Dyneema (or UHMWPE or HMPE or Spectra)?

Dyneema is a trademark for one make of ultra-high molecular weight polyethylene (UHMWPE). That particular trademark is owned by DSM Dyneema corporation. Spectra is another type of UHMWPE, trademarked by Honeywell. Many other companies make their own UHMWPE. UHMWPE is also referred to as high modulus polyethylene (HMPE), for the very large tensile modulus, compared to nylon and polyester fibers.

Chemically, UHMWPE is much like the polyethylene used in plastic bags and bottles; but instead of having short, unoriented molecular chains, it has very long individual molecules, arranged in parallel. UHMWPE is also characterized by a very low surface coefficient of friction (CoF), high axial heat conductivity, and low melting point (~148 C, 298 F) compared to nylon and polyester. UHMWPE loses strength above 70 C (158 F), more so than polyester and dry nylon; at 100 C (212 F) it retains just 55% of its strength (at 0 C).



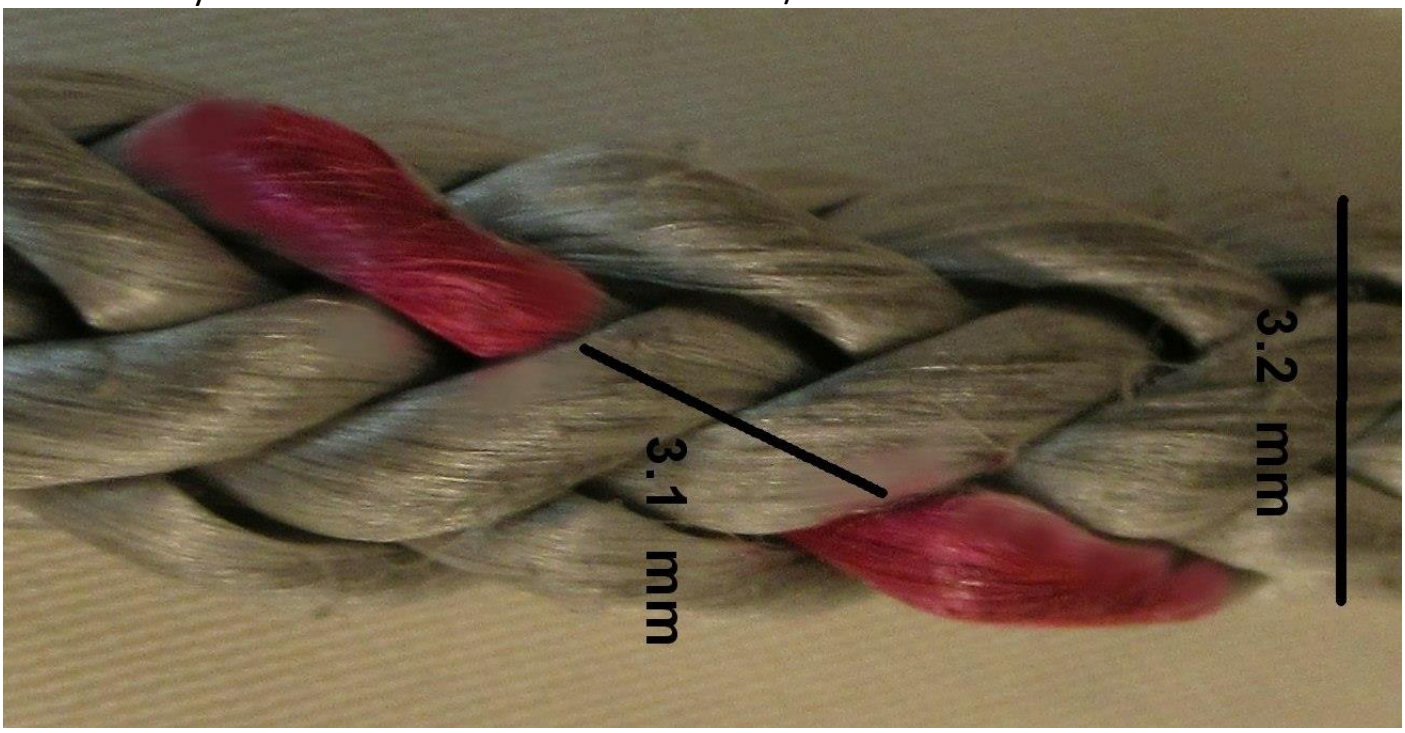
By itself, UHMWPE is not particularly UV-resistant. However, Dyneema and Spectra contain additives that make Dyneema more UV-resistant than polyester and nylon.

B) What I've Used

This document discusses two types of UHMWPE cordage: "bare" braided material; and "covered" UHMWPE that is encased in a thin sheath of another woven fiber, typically polyester. A polyester or nylon sheath increases the surface friction dramatically, makes the rope knottable, and offers a degree of melt protection. All the tests with braided Dyneema use

Amsteel BLUE, by Samson Rope. My experience is with BARE Amsteel in diameters of 7/64" and 1/8" (2.8 and 3.2 mm, mainly for emergency raps or pull line), 3/16" and 1/4" (6mm). (The quoted diameters of Amsteel may be slightly misleading, as the rope narrows considerably under slight tension.) I have also tested two brands of 1/4" (6mm) polyester-sheathed Amsteel, as well as an 8mm Bluewater Canyon Pro, a polyester-sheathed rope with Dyneema core that is NOT Amsteel Blue. I have tested New England Ropes Spyder line (polyester-covered Dyneema) in 3.8mm (1900 lb) and 4.8mm (2500 lb) for prusik loops. The thinnest Amsteel is an 8-strand, single braid cord; all others are 12-strand single-braid. All Amsteels are hollow-core, and easy to splice.

It is very important to understand the structure of hollow-core braided rope, such as Amsteel, versus traditional kernmantle rope, in the context of heat transmission, abrasion, and deformability. Below we look at a short section of 1/8" Amsteel:



One strand has been marked pink; it starts on the outside of the rope, dives under two other strands where it is effectively in the "center," then remerges after on the surface just ~3mm later.

The lay angle of Amsteel is very low, and the cordage is very loose and deformable, and quick to snag. For example, with minimal force, it can be deformed to many times its original diameter:

Dyneema Corporation has produced many types of the fiber, with different characteristics; some have been obsoleted. The more recent tend to be SK75, SK78, and SK99. Amsteel Blue is made from SK78; Marlow Ropes makes a similar cord from SK99. Both SK75 and SK78 have the same approximate breaking strength, but the more expensive SK78 has lower "creep." SK99 is relatively new, and is 15-20% stronger than SK78, and currently much more expensive.

The strength reported (by Samson) for Amsteel is a range from multiple tests, on sections with a buried eye splice at each end. Buried eye splices (when properly made) leave the rope near 100% native strength (as might be measured with a capstain clamp). Most knots tremendously reduce the strength of UHMWPE, in part because the CoF is so low, and in part because they involve very small bend radii, compared to polyester or nylon ropes of equivalent strength.

C) Where Do I Use UHMWPE?

My main uses of Dyneema are as 1) eye-to-eye slings and anchor extenders; 2) rappels up to 100' (using just carabiners and super Munters or wrap-Munters); and 3) cores of small, extremely strong friction knots for ascending thin ropes. I also use Dyneema to make a variety of items, such as rap-ring size adjusters, soft shackles, and whoopie slings. Compared to traditional rope fibers, there is a large weight and bulk savings—but there are other benefits. The low weight and low CoF mean that pulls of long rap ropes are much easier. And often one can thread thin Dyneema slings through places that would be impossible for 1" tubular webbing. We'll discuss each use in more detail in later sections.

I have some very thin Dyneema arborist throw lines (DynaGlide by Teufelberger Ropes) that are 1000 lb test, and are slicker than normal Amsteel. I use Spectra fishing line, up to 300 lb

test, for high strength sewing. I have 650 lb test "Zing-it" from Samson, that I use for lifting bear bags. I use 6 lb test Dyneema fishing line to floss my teeth (really).

D) Have People Actually Used this Stuff in Rappels?

Dyneema braided rope, similar to Amsteel, IS used for rappels in some European rescue groups, with special cautions. The longest recorded rap on BARE Dyneema rope is 760 METERS. ALL RAPS are done with Munters and superMunters; devices specifically for rappels, such as ATCs, are not allowed, because of the heating issue (Munters get part of braking force from rope-rope contact). In rope rescue systems, the low CoF means much less rope drag than with nylon or polyester. Since rescues may require hundreds of meters of rope, the low weight of Dyneema (per unit strength) is a significant advantage. However, the high modulus means that short falls can generate large forces, so energy dissipaters are used in-line. The material doesn't absorb water, and is very resistant to damage from UV light, which is advantageous when material must be left out for days. Note the ropes used in rescue are much higher diameter than what I use for emergency raps.

The EFC (French) have experimented with a different kind of Dyneema, made by Beal, for canyoneering. They use 5 mm cord and have found ways to use devices such as figure 8s and Piranhas with extra wraps, and have even used ascenders on this thin cord. The Beal cord is 100% Dyneema, with a tightly-woven sheath. Such a construction will not have the snagging problems of Amsteel. EFC are well aware of the low melting point, and report an average device temperature of 40C (104F), with an observed maximum of 72C (158F) on a 100 METER rap. These are similar to the temperatures I have seen with BARE Amsteel, but then again, they do longer raps, and use "real" rappel devices (not Munters). I will not discuss this use further.

E) Before You Read More: Where BARE Amsteel Sucks

Amsteel works well as an emergency item for what I do; namely, scrambling in rough terrain were there are often no anchors near the cliffs we want to protect or use as rappel points. The bulk reduction is a huge benefit at times; I've chimneyed up abrasive, tight slots with 250' of Dyneema tucked in a corner of a very small pack. But a lot of people can't help but think I am proposing Dyneema for some mondo adventure on a big wall, a multi-pitch trad climb, or a classic canyon descent. So let's spend some time immediately discussing where you shouldn't use bare Dyneema.

First, Dyneema is static (though Amsteel is, in practice, nowhere as stiff as the reported modulus would imply; see "construction stretch" in a later section), and is definitely not for belaying. Because of the very high moduli, one can generate large forces in a short fall. Amsteel can be used for a haul rope, or a pull line (many canyoneers use it to pull fiddlesticks). But if you really want a light pull line, consider arborist throw lines. Like all thin

cords, 1/8” Amsteel is tangly, and the very-loosely-woven braid tends to catch on rough rocks when not tensioned. When it catches, it abrades quickly. It makes a very poor handline, because it is slick and very thin for its strength. BARE Amsteel is not good for canyoneers, as a general rope; because: 1) of the abrasion and catching issue; 2) it is hard to knot securely; and 3) it cannot be used with "normal" rap devices without extra wraps and a chance of over-heating. In canyons, unsheathed Dyneema would be mainly for escape situations, *used with a superMunter*; 200’ of 1/8”Amsteel Blue weighs one pound and has a test strength (static) of 2500 lbs. I find people are more likely to take emergency gear if it is light.

A VERY important consideration: if you use bare Dyneema as a pull line, NEVER, NEVER put it through a belay device with a “main” rope that is sheathed in nylon, polyester or aramid. The device heating will be determined by the much higher coefficient of friction of the main rope, and you may melt the pull rope.

I have rapped a lot on Dyneema using Munters (brake hand up position), supermunters, or wrap-Munters. The speed of a rap on a plain Munter is harder to control, than a rap with (e.g.) a Piranha on a polyester-, technora-, or nylon-sheathed rope. Ironically, the large, round-cross-section HMS carabiner gives the lowest brake factor for a Munter on thin Dyneema. A small D-shaped biner, such as Grivel’s Plume dual wire-gate, is far more suitable for thin bare Dyneema; the tight turns cause the rope at the bottom of the Munter to run over itself in opposite directions, yielding another rope-rope contact and also providing more “internal friction.” With a large HMS, your speed is either slow and perhaps bouncy (superMunter) or near-catastrophic (Austrian-position regular Munter on thin cord). You MUST test with the type of carabiner you will use. With a dual wire-gate, I can quickly put in an extra wrap, before I plan to go down an overhanging section; but that option is tough with screwgates. *I highly recommend the superMunter* with bare Dyneema; this knot does NOT twist the rope, and provides a safer experience. More on carabiners in the next section.

If you intend to use a urethane-treated rope, such as Amsteel, it is wise to run the entire rope through a Munter several times to remove the outermost urethane; this reduces friction, but avoids surprises later.

G) A Very Good Use for Amsteel: A Light Anchor-Extender.

Often we have short sections of class 4-5 on rather fast cross-country trips; typically these are over dolostone strata in dryfalls. Usually, the most confident climber free climbs these sections and may drop a handline of 15mm tubular climbspec nylon webbing. Rarely is it necessary to protect more than 30-40’ of a cliffy face.

The trouble is, any trustworthy anchor may be 50’ or even 100’ back from the section that needs to be protected. It doesn’t make a lot of sense to carry the bulk and weight of an extra 100-200’ of nylon, when a piece of Amsteel, with an eye splice on each end, can extend the reach to the anchor for much less weight. If the Amsteel is too long, it can usually be wound

around a tree or rock horn anchor to get the right length; and it is much easier to fit the Amsteel into thin cracks than say, 15 tubular webbing. Note that 2500 lb Amsteel, with bury eye splices on each end, is functionally as strong as 1" nylon webbing (4000 lb test) tied with a figure eight on each end, as the knots reduce strength. Because of the low CoF, it easier to pull the Amsteel slings back and forth to adjust length, in a tight crack (than it would be with frictional nylon webbing). I may tie the nylon to the two eyes, or even girth-hitch the extender at top, and get the full(er) length.

A down side of using slings or extenders that will be left behind: They should be labelled clearly, with tags at each splice, explaining that the material is Dyneema, along with the force rating. Else the next person to come along will remove the sling in a flash, certain it is too thin to be trusted.

That's it for section 2.