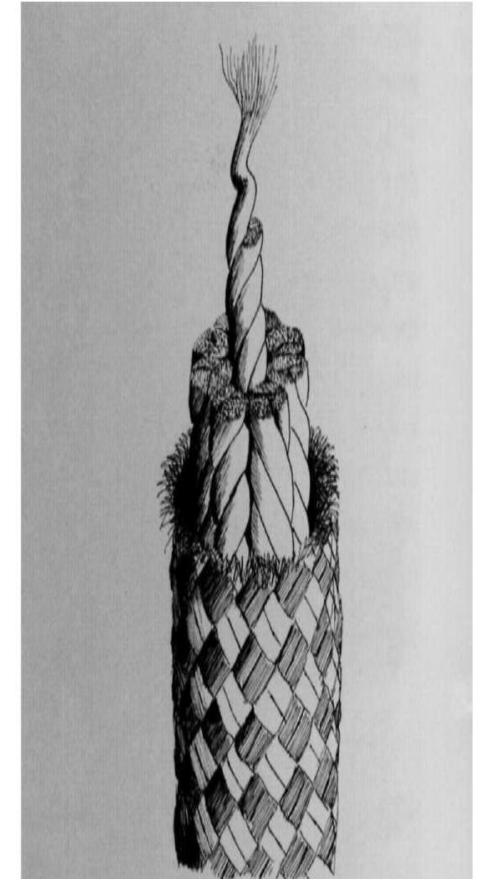
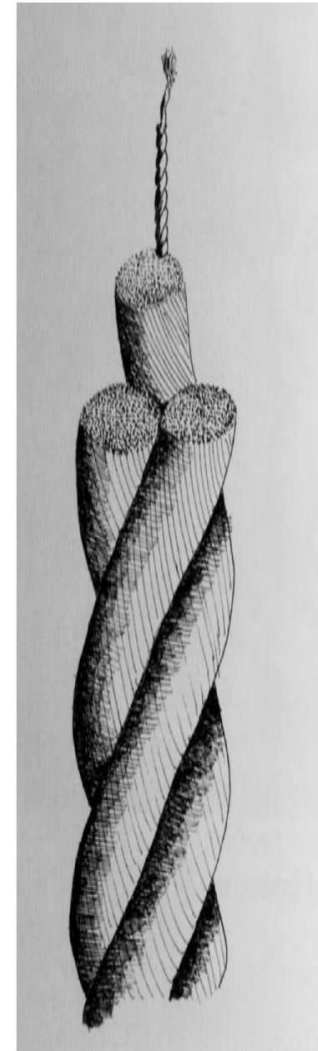


Materials in Mountaineering

- Move away from siege tactics to lightweight approaches
- Rock protection that damages rock (hammered-in pitons etc) often not allowed
- Modern ropes mean people can fall in relative safety
- 'sticky' boots mean less skill is needed
- Materials often developed in other industries
 - E.g. aluminium used for karabiners developed in the aerospace industry

Ropes

- Originally produced from natural fibres such as hemp
- Introduction of synthetic fibre by DuPont during WW2
- 'Modern' climbing rope in 1951 with the 'Kernmantel' construction
- Must withstand dynamic forces
- Must not exert unacceptably high forces on the body
- The body can withstand 12kN without serious injury.
- Continuous drawn nylon since 1960s
 - Strengthens and stiffens the nylon as polymers are aligned
 - Spun for "low-stretch" (static) ropes
 - Yarn can be heat treated to lose polymer alignment
 - Reduced Young's Modulus
 - Increases energy absorption
 - Reduces impact force
- Strength is significantly reduced when wet.
- Fibres coated with a Hydrophobic layer



Harnesses

- Made from a textile webbing
- Developed in the 1960s
- Prior to this the rope was simply tied to the waist!
 - Damaging internal organs if loaded



Karabiners

- Classified by shape and gate
 - Snap gate v locking gate v twistlock
 - “Offset D” etc
- Gates
 - Ease of operation
 - Accidental opening



Table 11.9 Karabiners: types of connector and minimum values from EN 12275

Type	Description	Major axis gate closed (kN)	Major axis gate open (kN)	Minor axis (kN)
B	Basic, general purpose	20	7*	7
H	HMS, for dynamic belaying	20	6*	7
K	Klettersteig, higher strength for ‘via ferrata’ use	25	–	7
D	Directional, with captive sling, e.g. DMM Mamba	20	7*	–
A	Specific anchor, for use with a specific bolt hanger	20	7*	–
Q	Screwed-closure, Quicklink or Maillon Rapide	25	–	10
X	Oval, for aid climbing use	18	5*	7

* No requirement if gate fitted with an automatic gate-locking device.

Karabiners

- Mainly 7000 series Aluminium
- Simple shapes are Circular cross section and cold forged
- Complex shapes are hot forged
- Heat treated the ground and polished
- New alloys with higher specific strength likely to replace these



<https://www.youtube.com/watch?v=aBaQV8Kg1Ck>

Belays, ascending/descending and rock protection devices

- Bend rope around radii creating friction
- Direct belays
 - Wrapping rope around a rock etc!
- In-direct belays
 - The person belaying is part of the system



- Passive (chocks) or active (camming)
- High strength aluminium alloys
 - Slings tied in the rope and looped over rocks
 - Knots tied in ropes and jammed in cracks
 - Wedging pebbles into cracks
 - Drilled out machine nuts (late 1950s)
 - Aluminium alloy wedges (early 1970s)
 - Camming devices (1970s)



Ice climbing

- On mixed terrain 'rock' protection is used
- On ice: Ice screws, ice axes, hammers and crampons
- Ice screws
 - Tubular
 - Machined with coarse thread on the outside
 - Mostly steel, e.g. 4130
- Ice axes and hammers
 - Axe: A pick and adze (for cutting steps etc)
 - Hammer: A pick and hammer
 - Typically steel, e.g. 4340
- Crampons
 - 12 point crampon (with front spikes) developed in 1930s
 - Typically steel, e.g. 4340



Notes adapted from/further reading

- Materials in sports equipment, Mike Jenkins, 2003