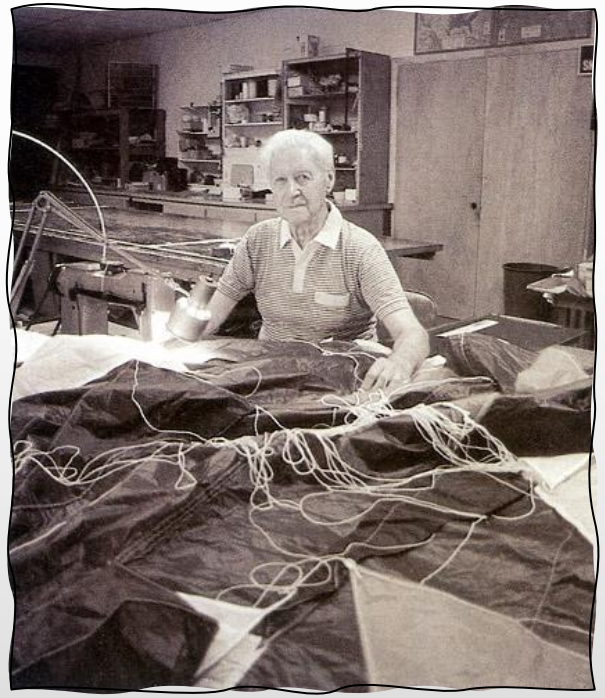
# Material Sciences

# Warm up

https://kahoot.it

# History of Paragliding



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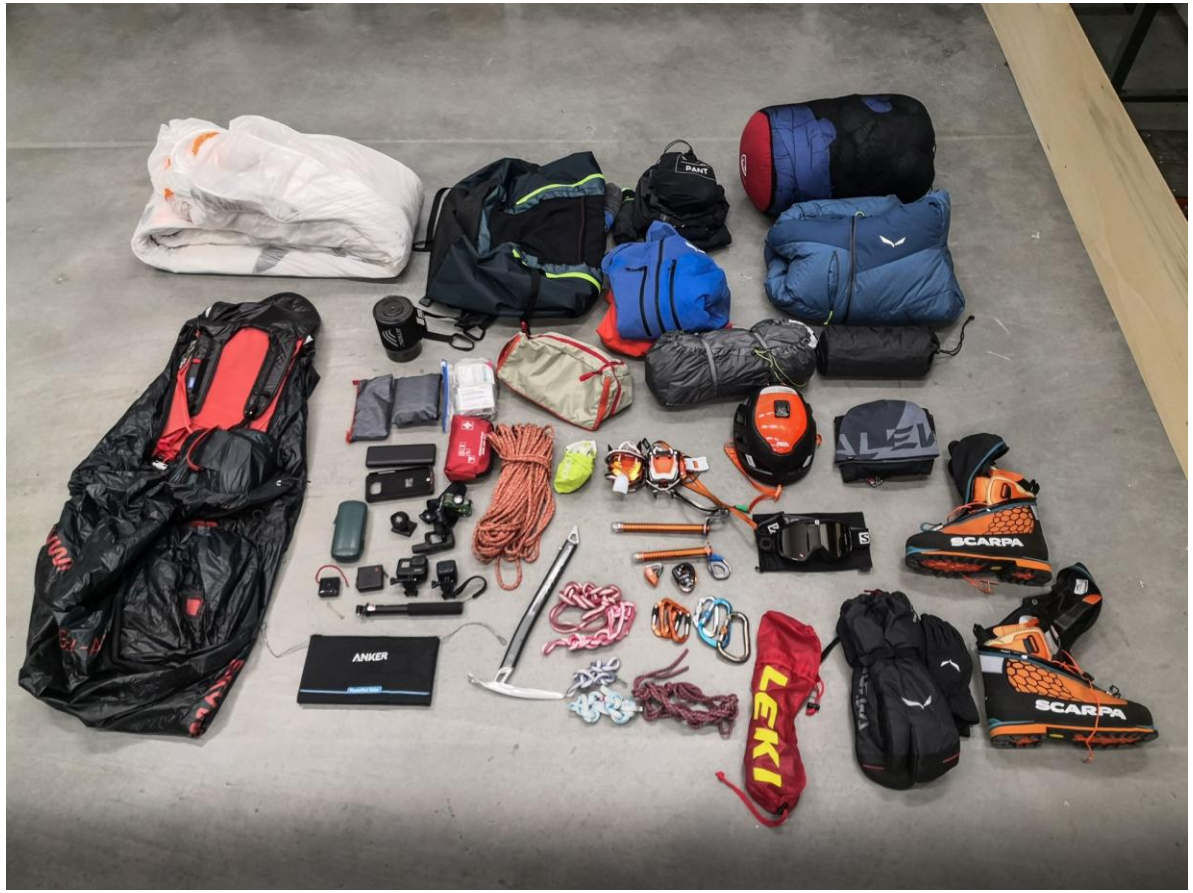
# Equipment

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# Equipment

- Paraglider
- Harness
- Rescue
- Other equipment

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# Equipment

- Paraglider
- Harness
- Rescue
- Other equipment

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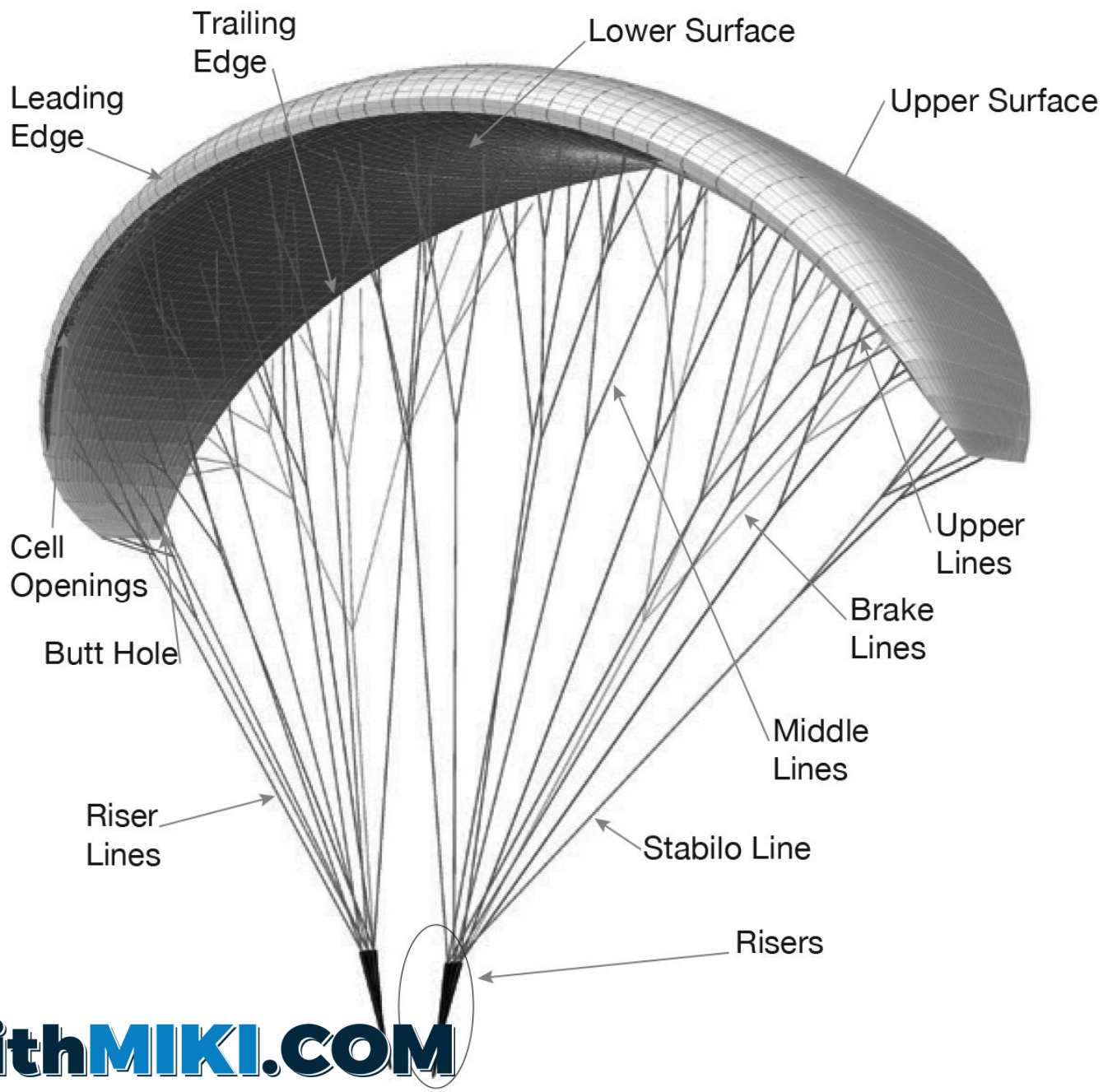
# Paraglider

- Canopy
- Lines
- Risers
- (Speed system)
- (Harness)

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# Paraglider - canopy

## Polyamide (Nylon) / Polyester

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# Paraglider - canopy

Polyamide (Nylon) / Polyester

Rip-stop material

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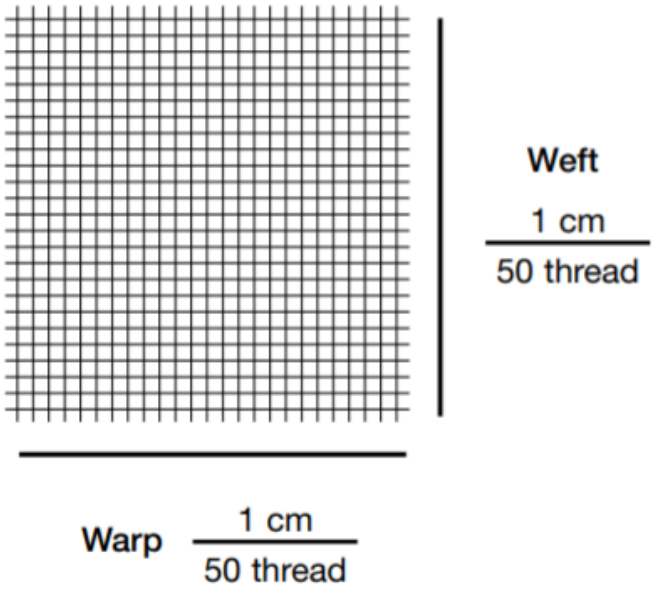
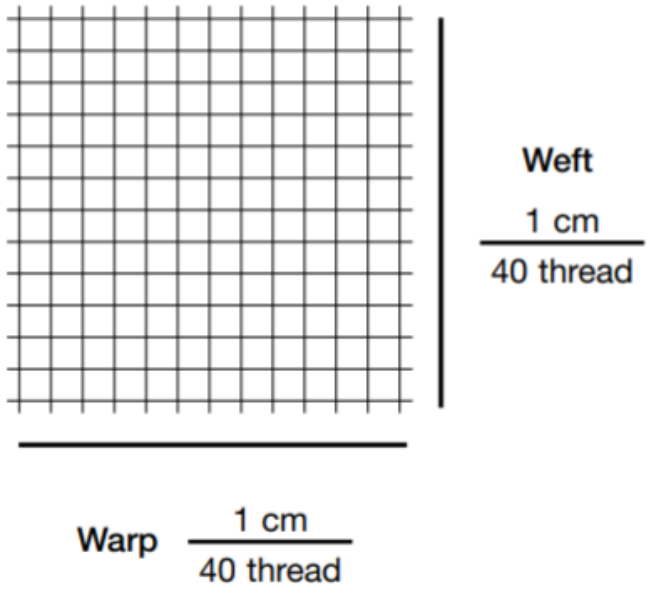
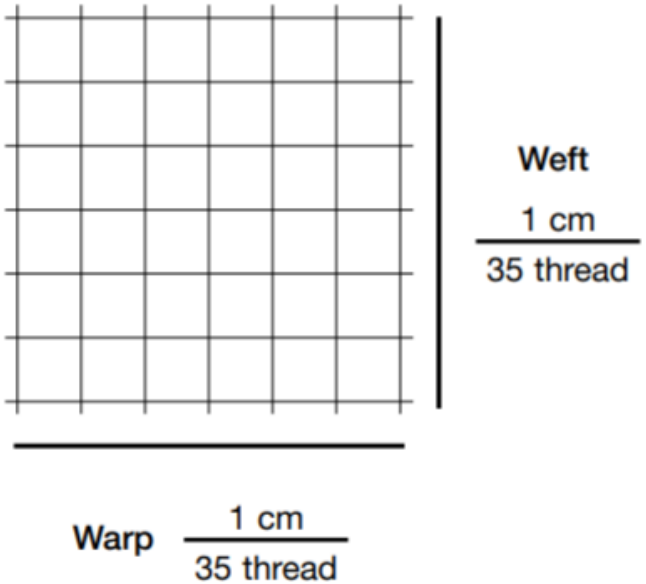
# Paraglider - canopy




Durability ⟷ Weight

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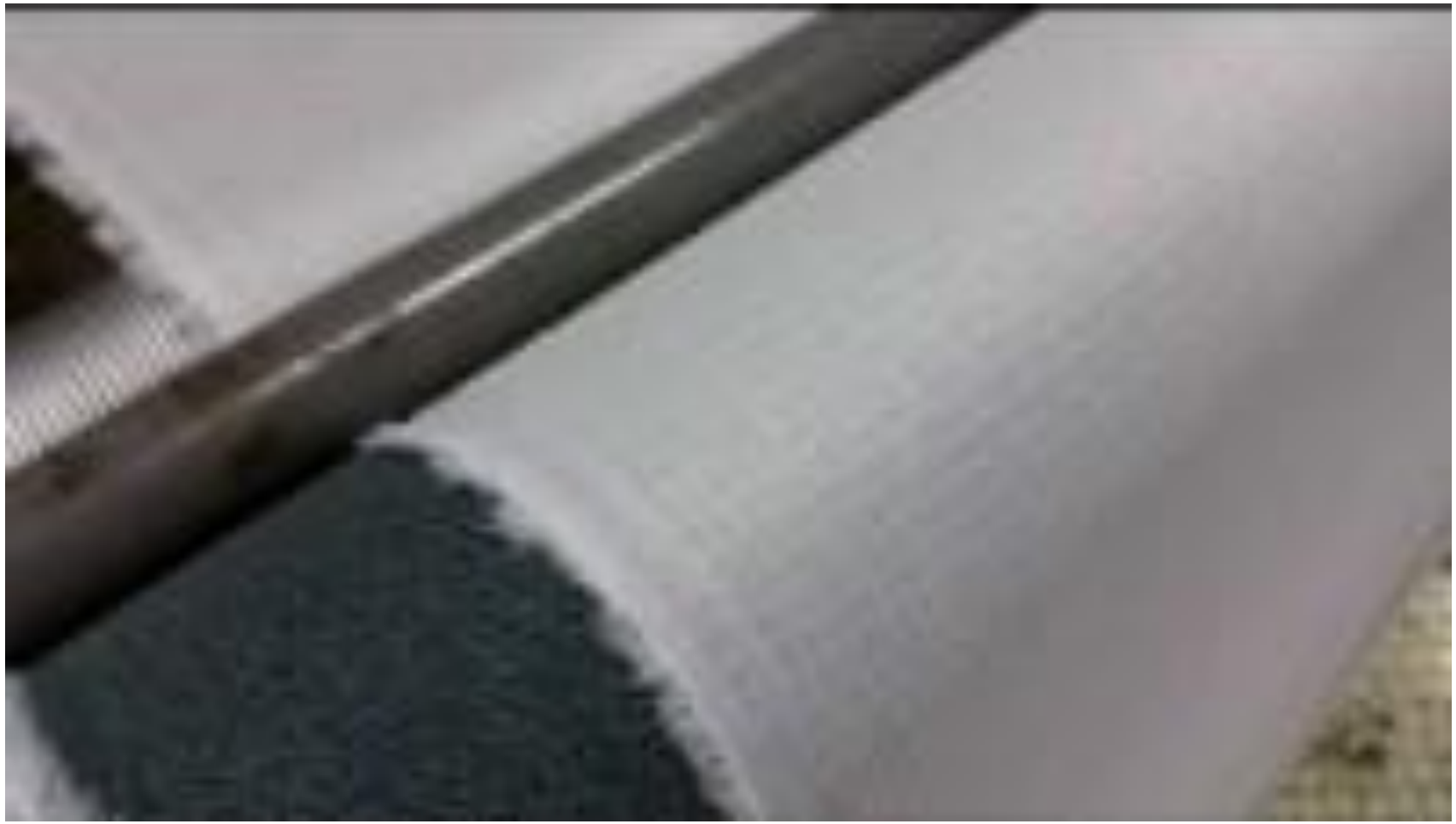
# Paraglider - canopy



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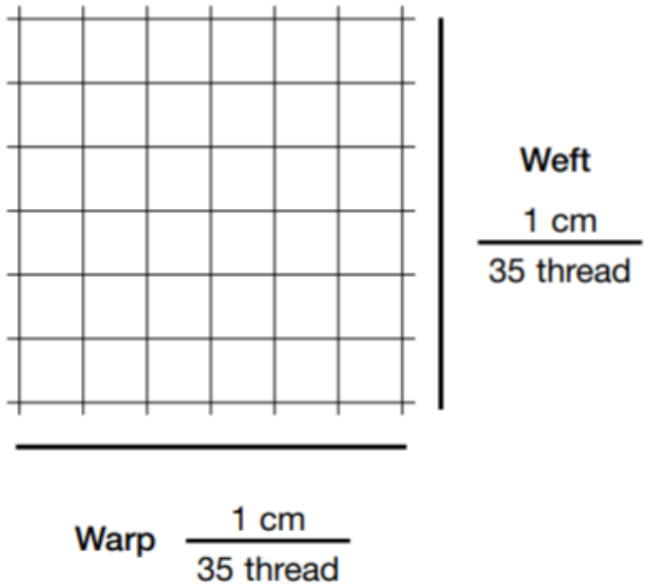
# Paraglider - canopy

Polyamide (Nylon) / Polyester

Rip-stop material

Coating

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# Paraglider - canopy

## Coating (acrylic, polyurethane, silicone, etc. )

### Criteriums:

- Light
- Has a certain elasticity
- Resistance (aging, delamination, etc)

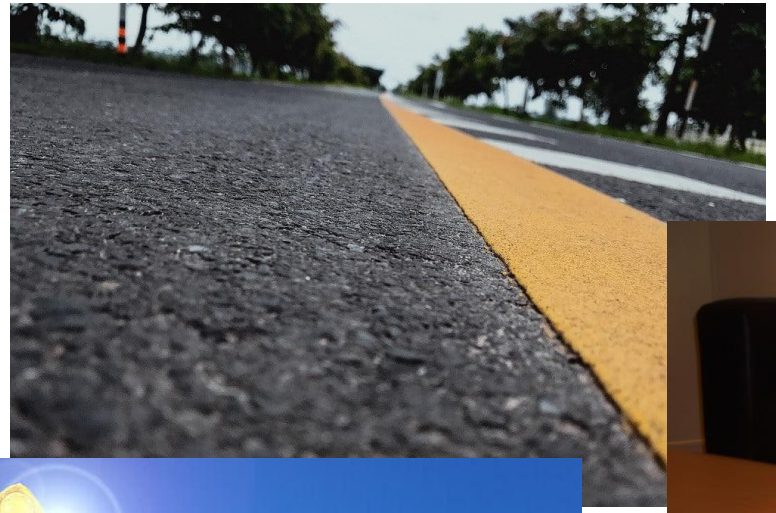
### Goals:

- Minimise Porosity (air permeability)
- Optimal weight (but no free lunch!!)
- Minimise elasticity (but not rigid - without cracking)
- Reduce UV sensitivity

# Protecting the coating

## Damage

- Mechanical (tar, concrete)
- Chemical (detergents, salty water)
- Exposure to sun (Ultra violet radiation)
- Moisture + temperature changes



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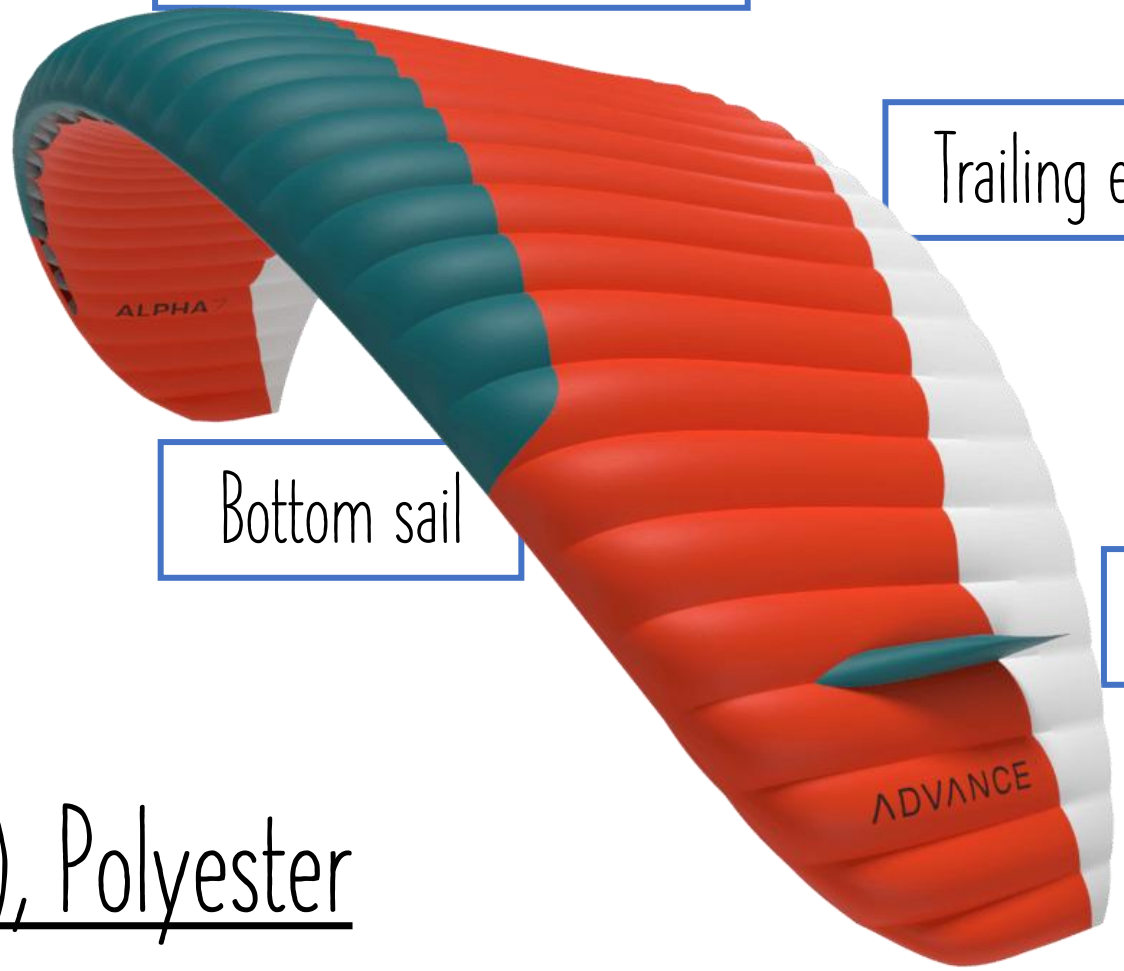
# Paraglider - canopy




Polyamide (Nylon), Polyester

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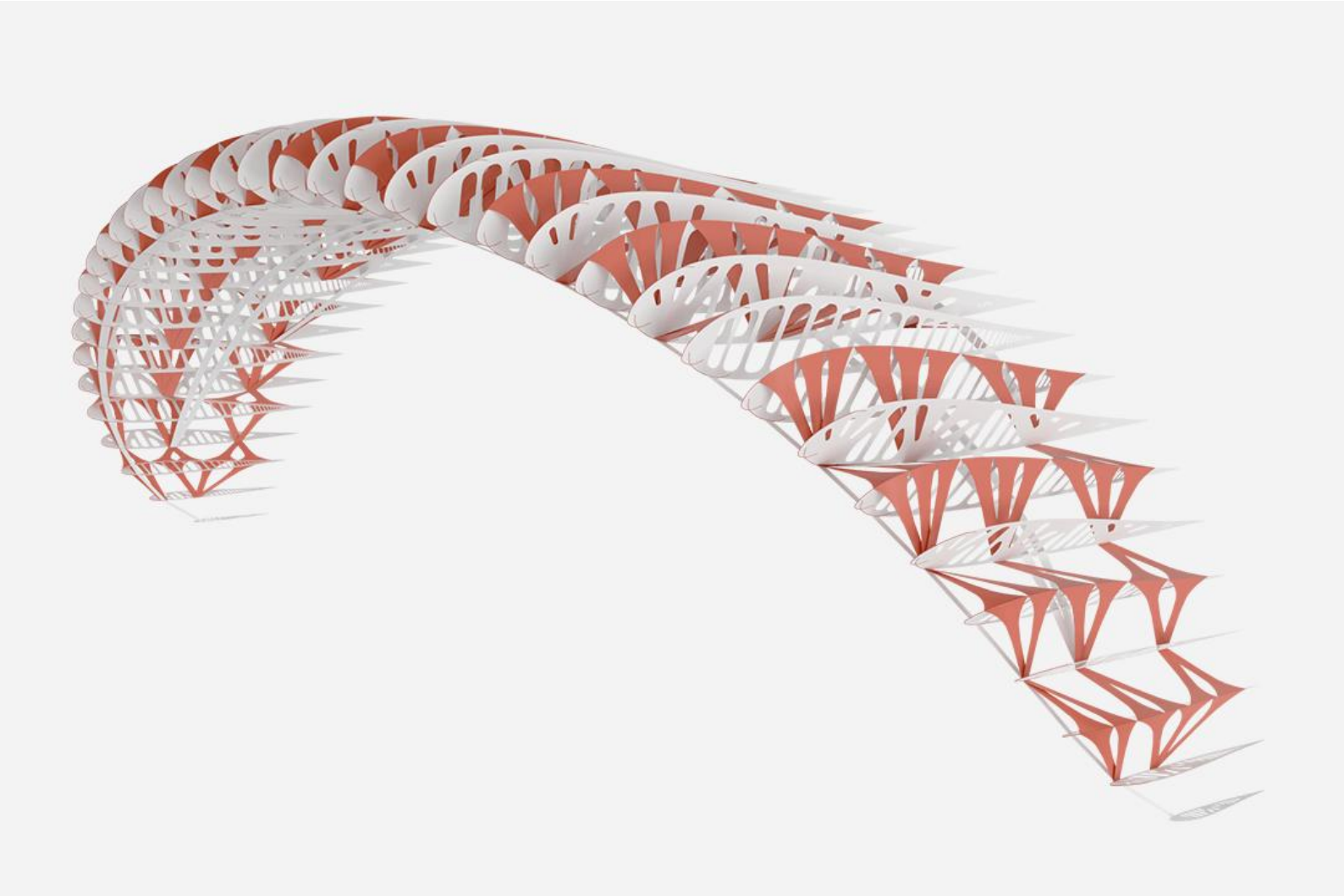
# Paraglider - canopy



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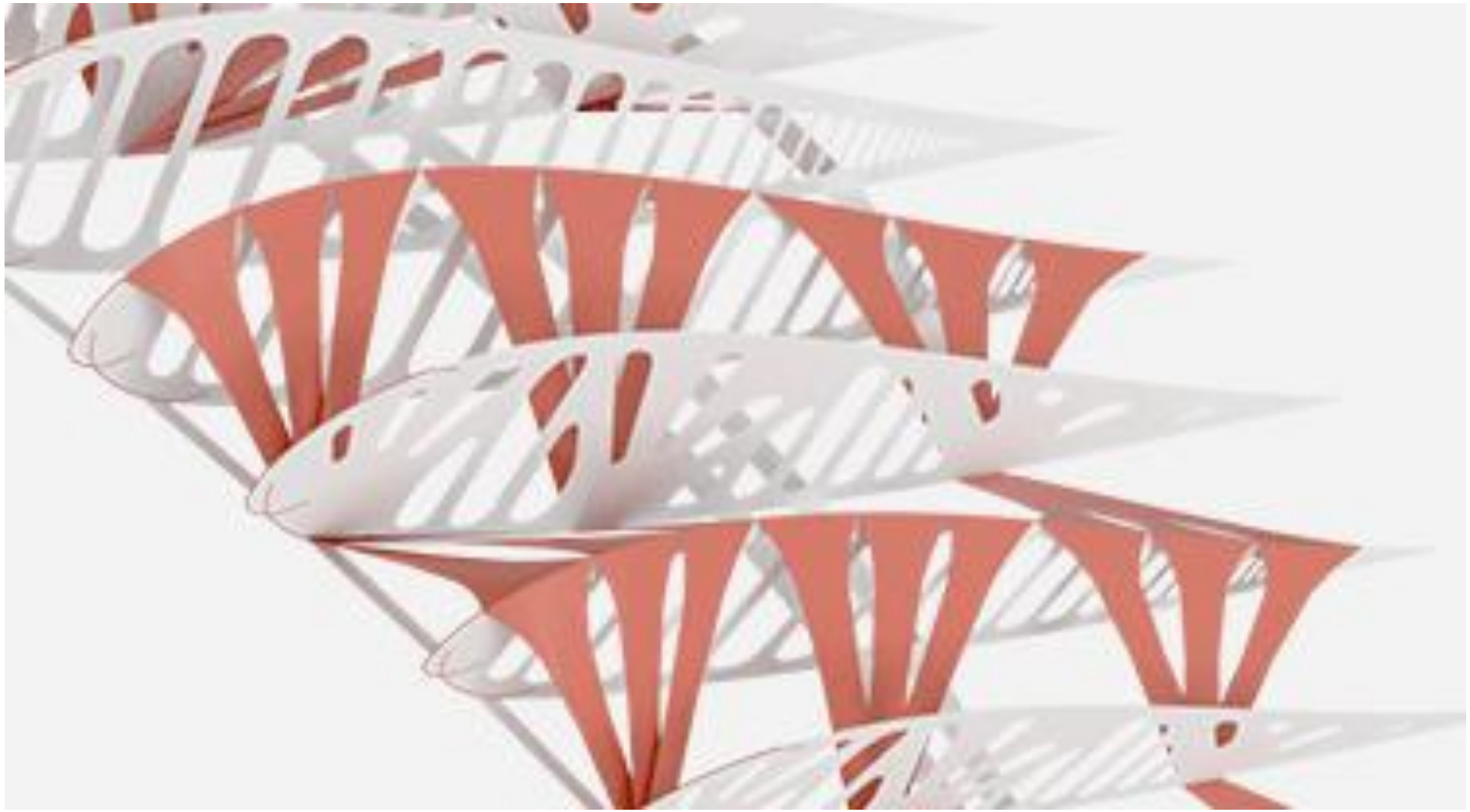
# Paraglider - canopy



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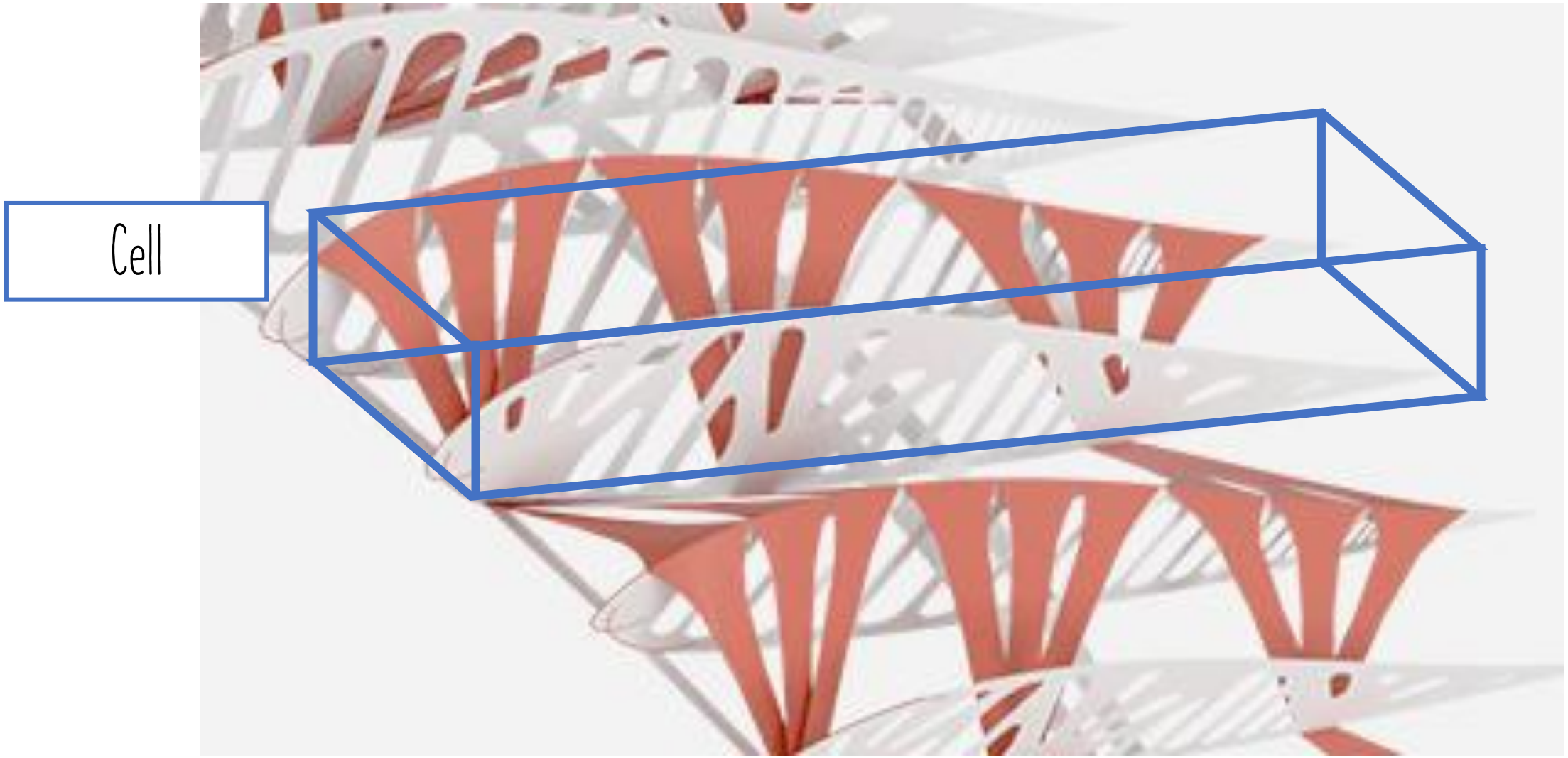
# Paraglider - canopy

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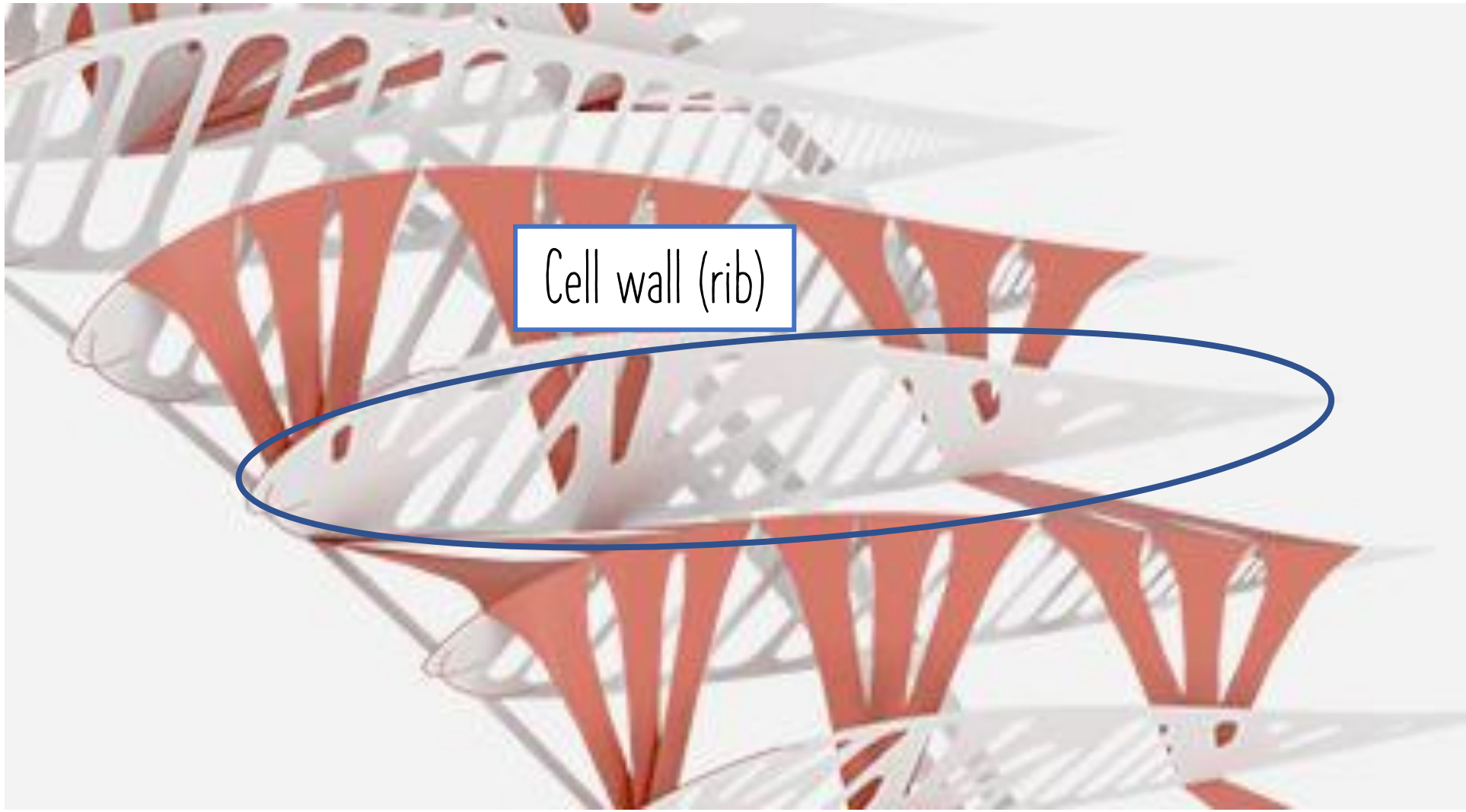
# Paraglider - canopy

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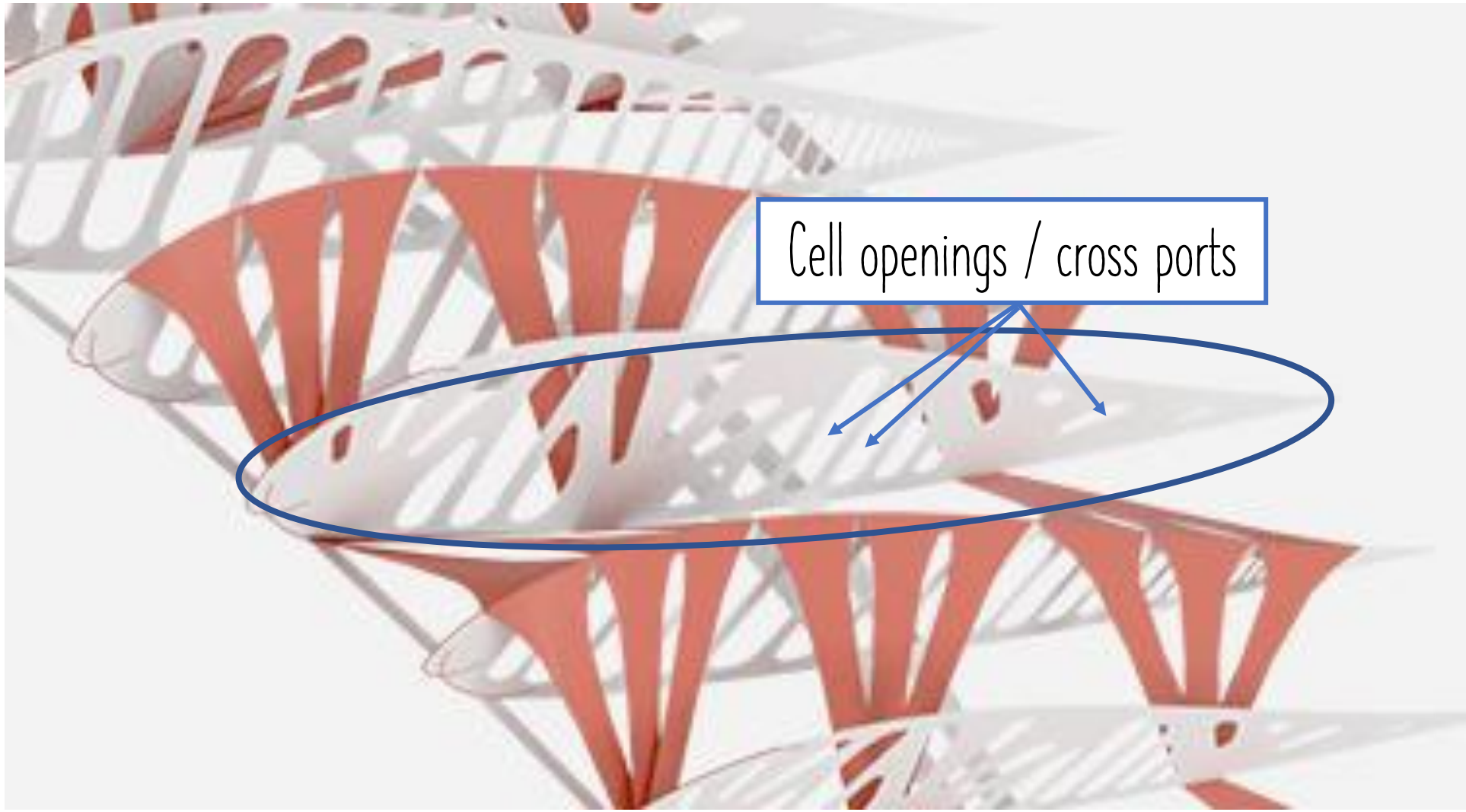
# Paraglider - canopy

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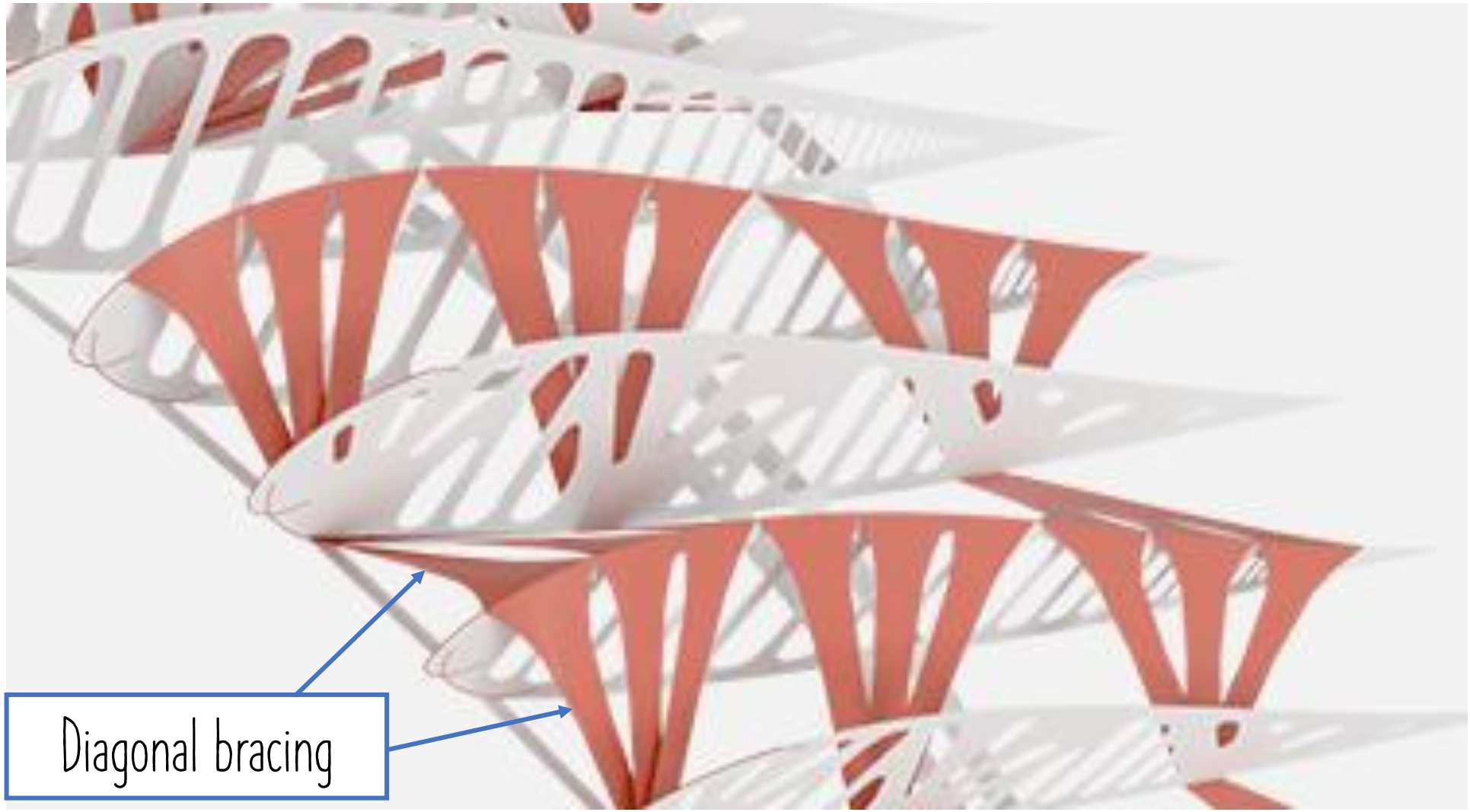
# Paraglider - canopy

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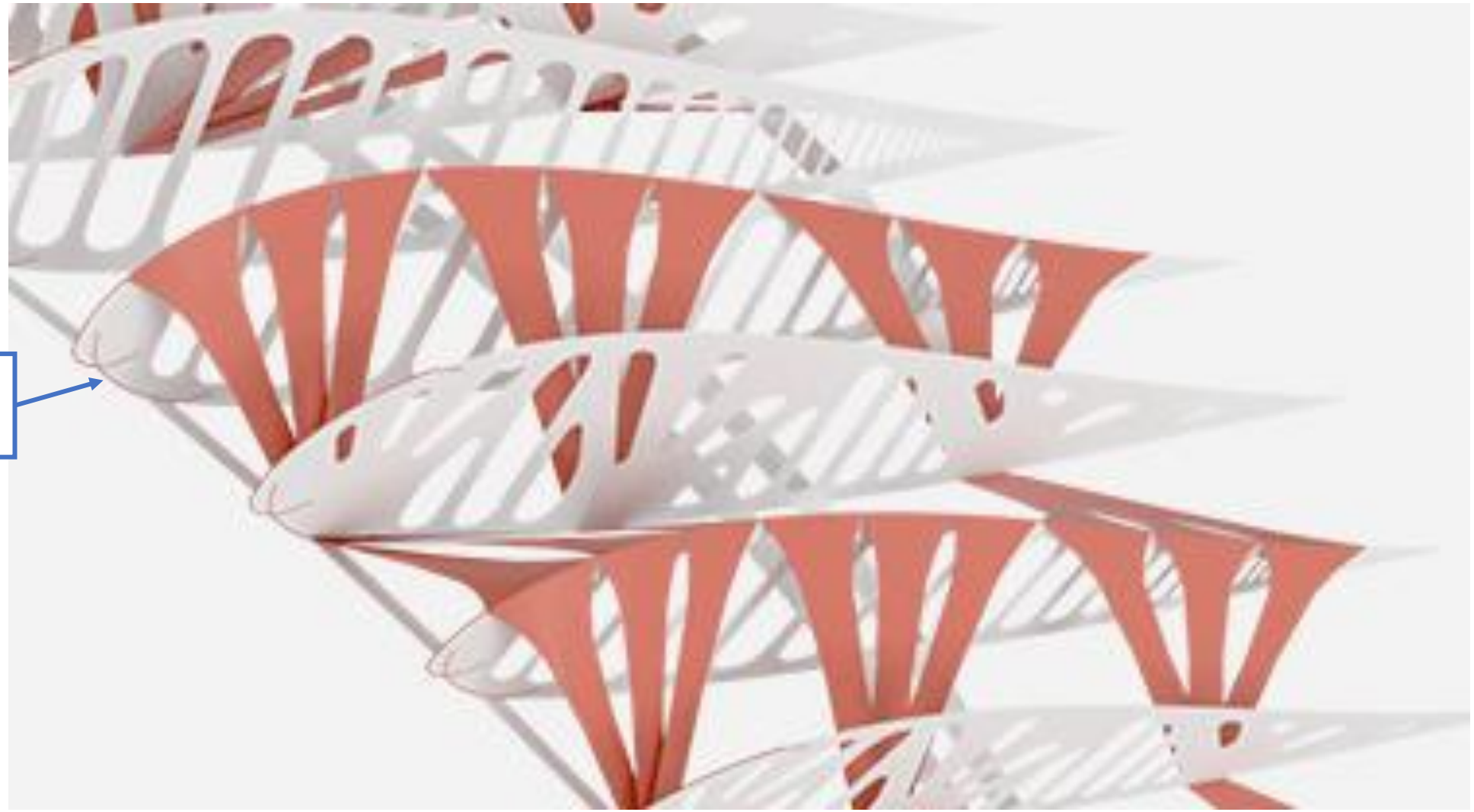
# Paraglider - canopy

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# Paraglider

- Canopy
- Lines
- Risers
- (Speed system)
- (Harness)

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# Paraglider - lines

Material:

- Polyethylene (Dynemma, Spectra)
- Aramid (Kevlar, Technora)

- Liquid crystal polymer LCP (Vectran)
- PBO (Zylon)

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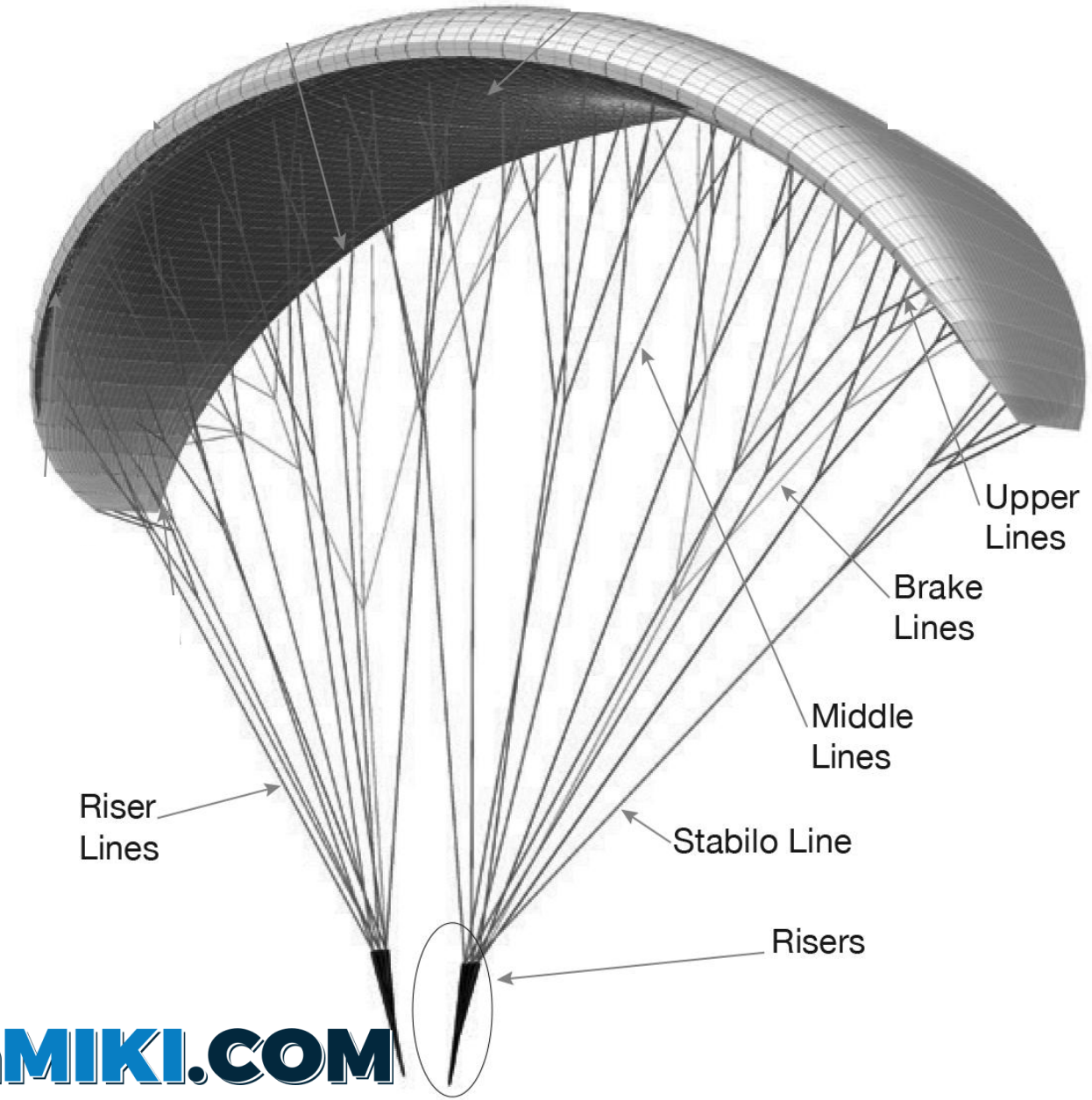
# Paraglider - lines

- Upper (cascade) lines / gallery
- Middle (cascade) lines
- Main lines (riser lines)

- Stabilo
- Break

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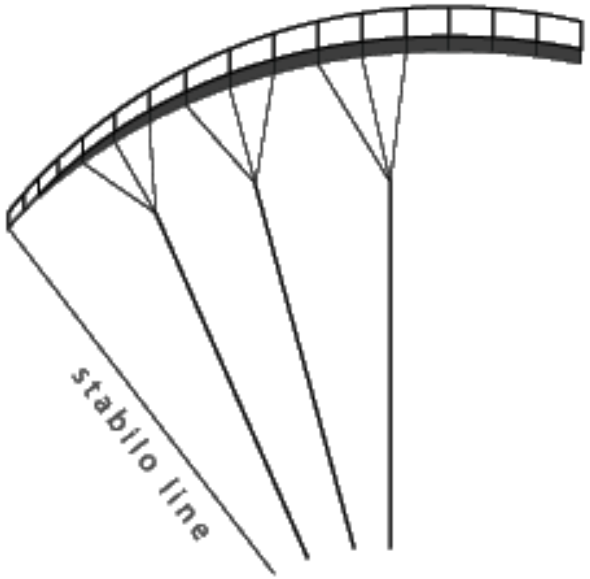
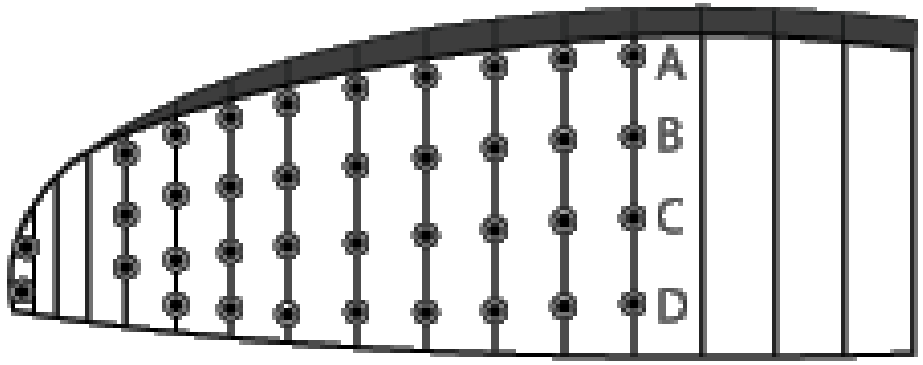
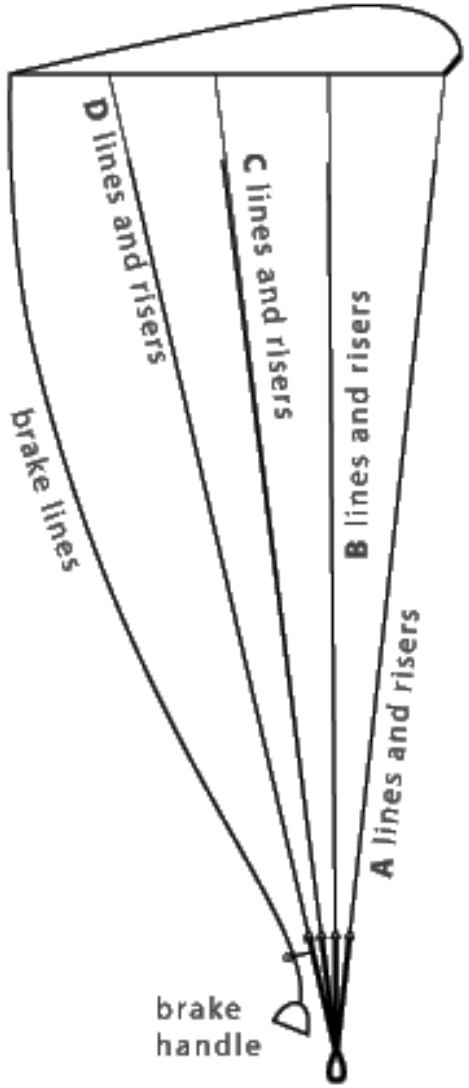
# Paraglider - lines




A, B, C и D rows of attachment points of right lines




Paraglider suspension elements

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# Paraglider - lines

REQUIREMENTS:

- Low elasticity
- High load capacity
- Minimum diameter

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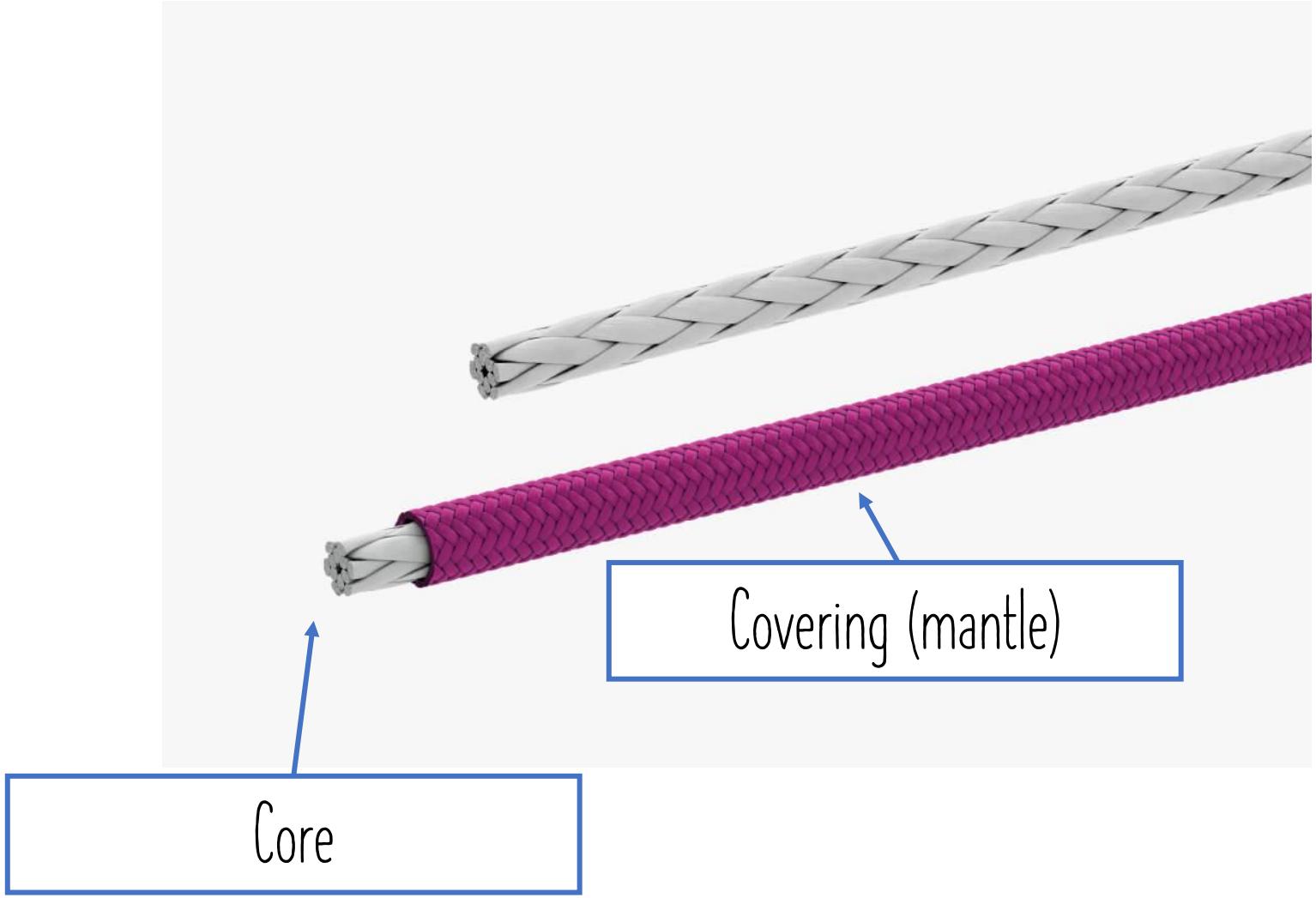
# Paraglider - lines

REQUIREMENTS:

- Low elasticity
- High load capacity
- Minimum diameter

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# Paraglider - lines

Durability ⟷ Drag

Thinner line: less drag, but higher tendency for knots

A-B lines takes more than double the load of C-D lines

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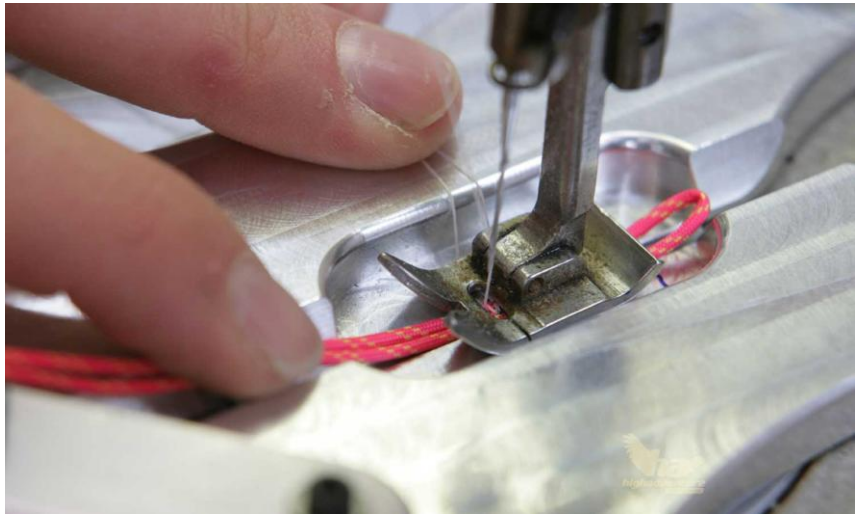
# Paraglider - lines



- Sewing
- Splicing

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# Paraglider - lines

To the glider: looped

To the riser:

Maillone (quick link)

Softlink

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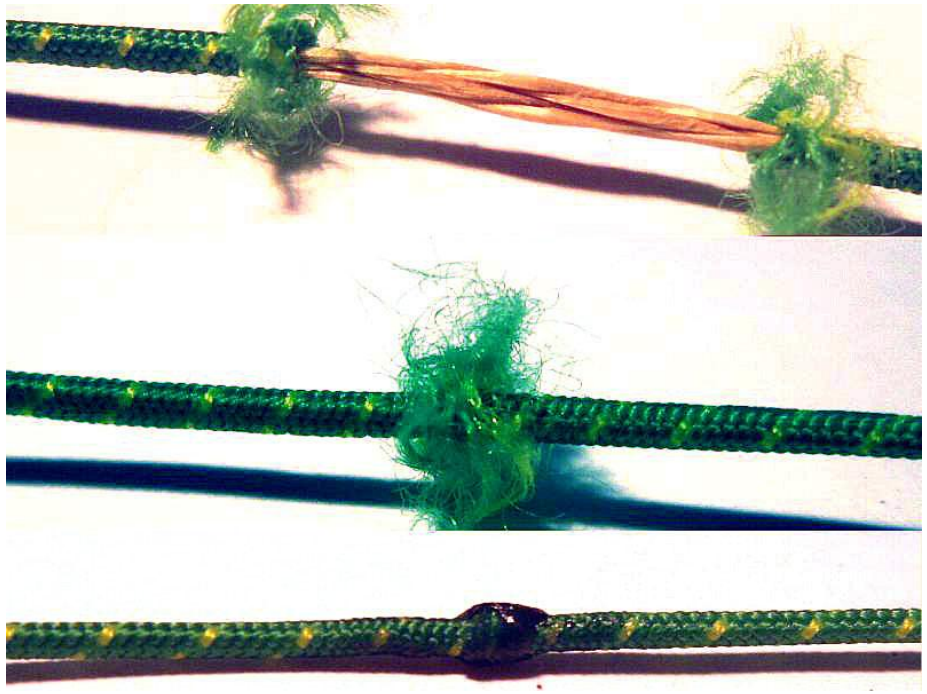
# Paraglider - lines

Damages:

- Shrinking / shortening
- Lengthening
- Damaging the cover



# Paraglider - lines

Scenarios:

- A lines (elongation, shortening)
- B lines (shortening)
- D lines (elongation, shortening)

Profile?

Angle of attack?
Inflation?
Speed?
Stall tendendy?
Frontal tendency?

# Paraglider - lines

## 5 m lines

- Higher center of gravity
- Smaller magnitude of oscillation

## 7 m lines

- Lower center of gravity
- Bigger pendulum with sudden direction changes

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# Paraglider

- Canopy
- Lines
- Risers
- (Speed system)
- (Harness)

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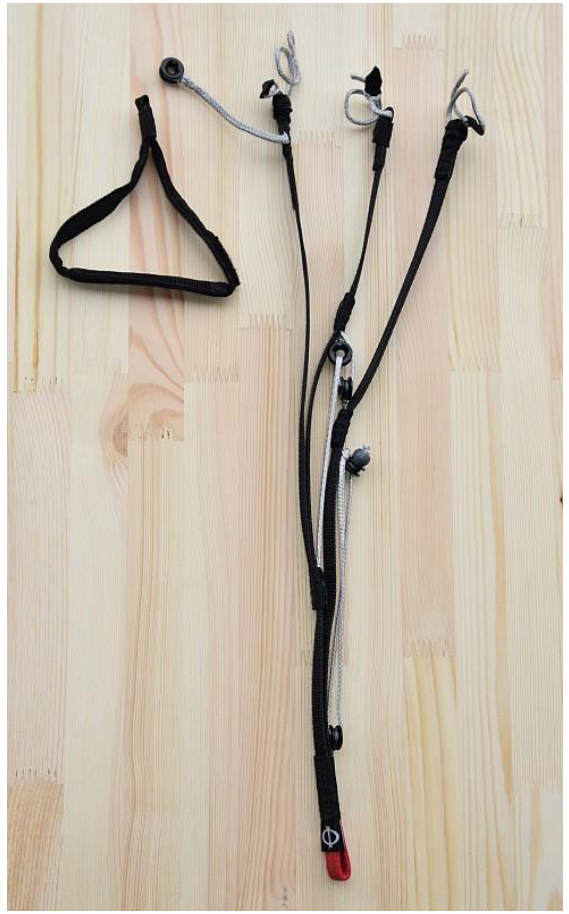
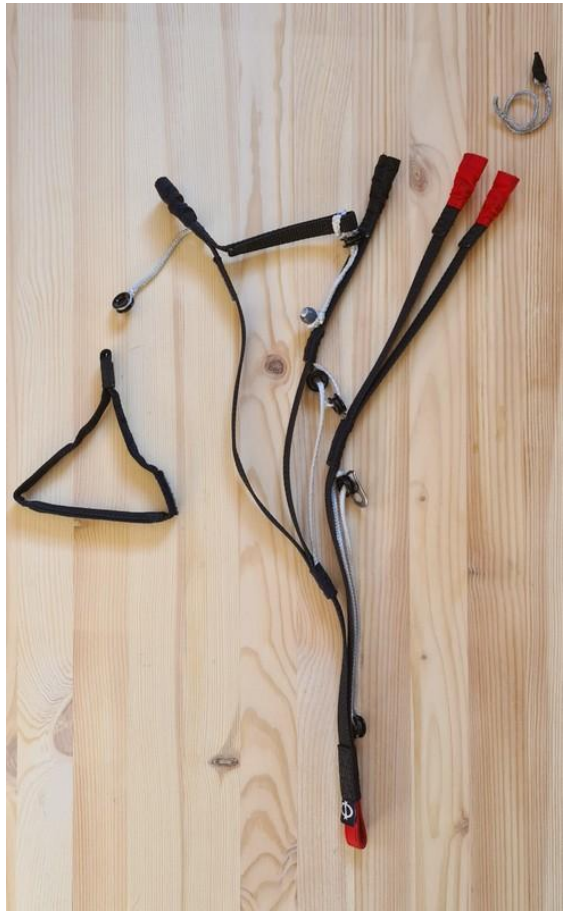
# Paraglider – risers & speed system





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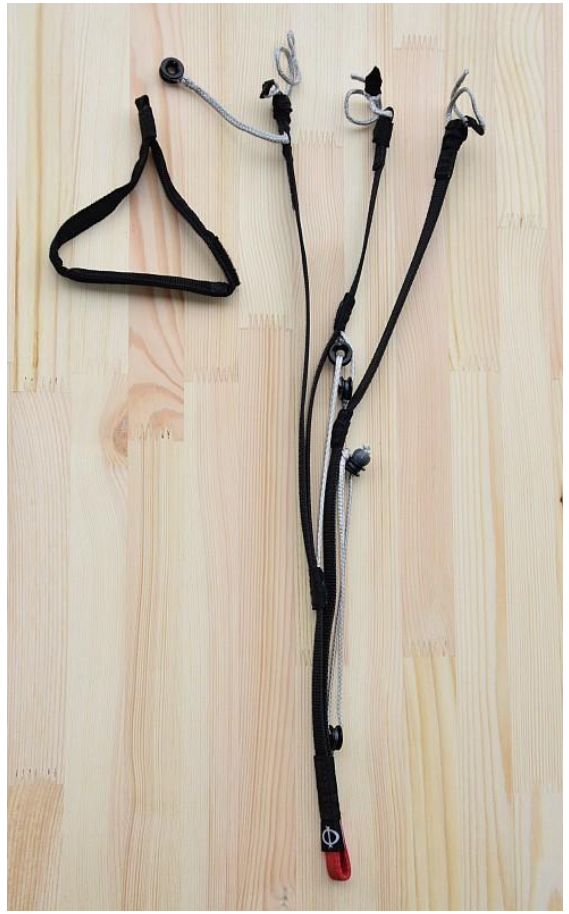
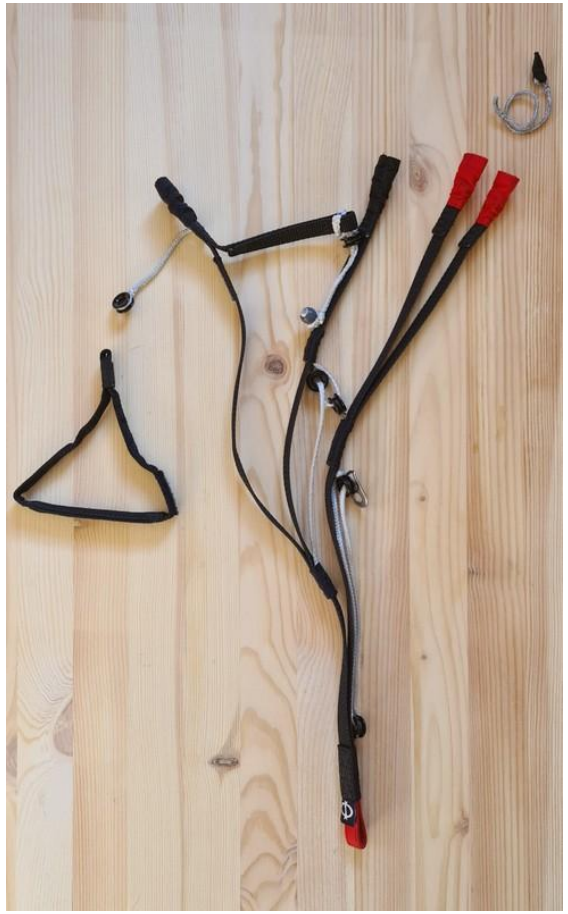
# Paraglider – risers & speed system





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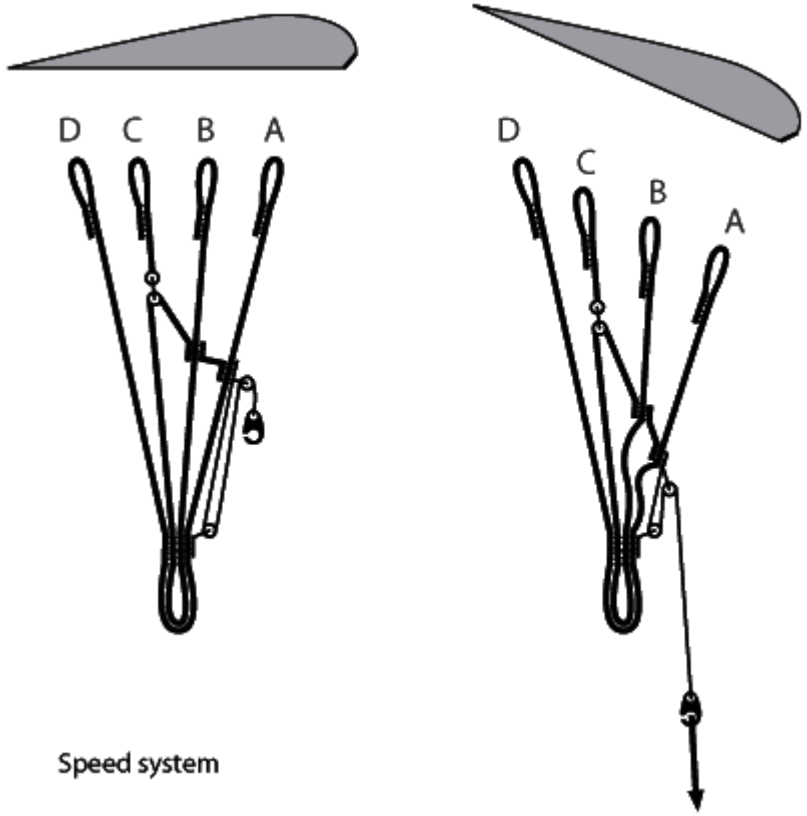
# Paraglider – risers & speed system



Foot accelerator

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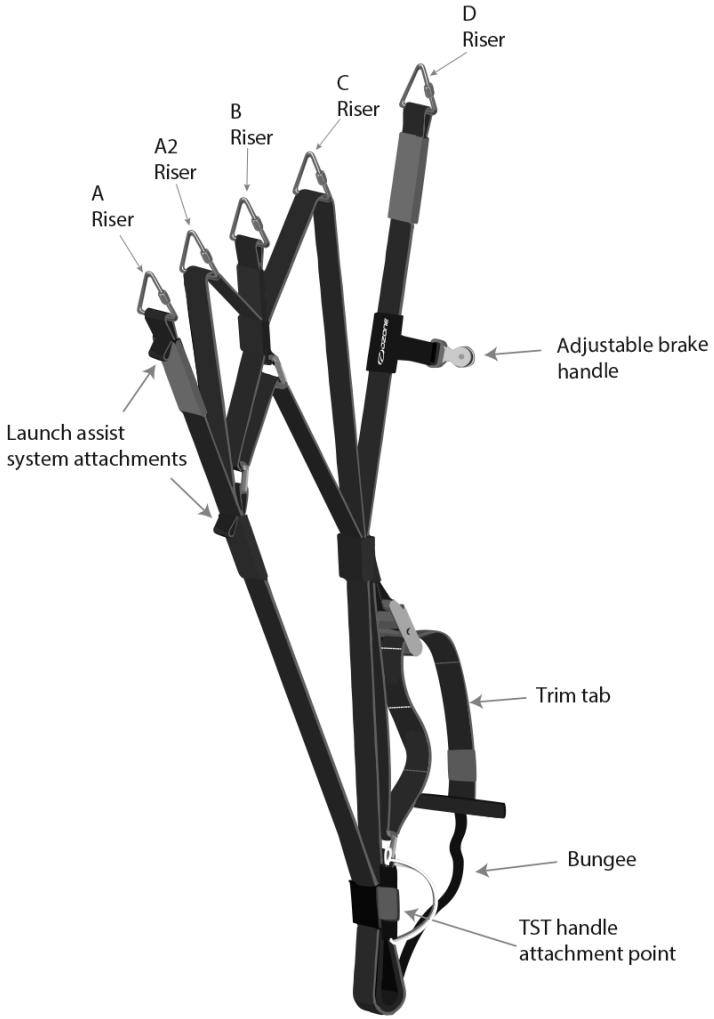
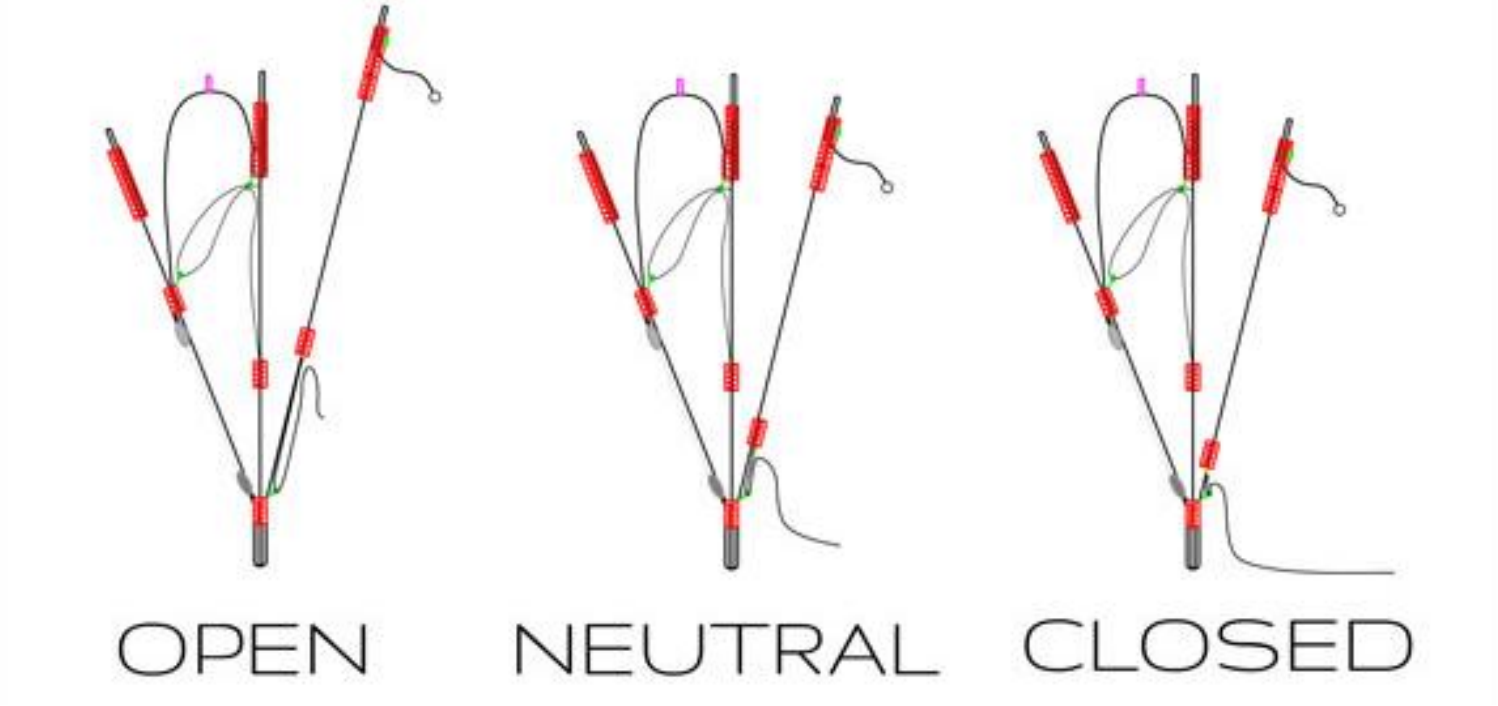
# Paraglider – risers & speed system




Trim tab

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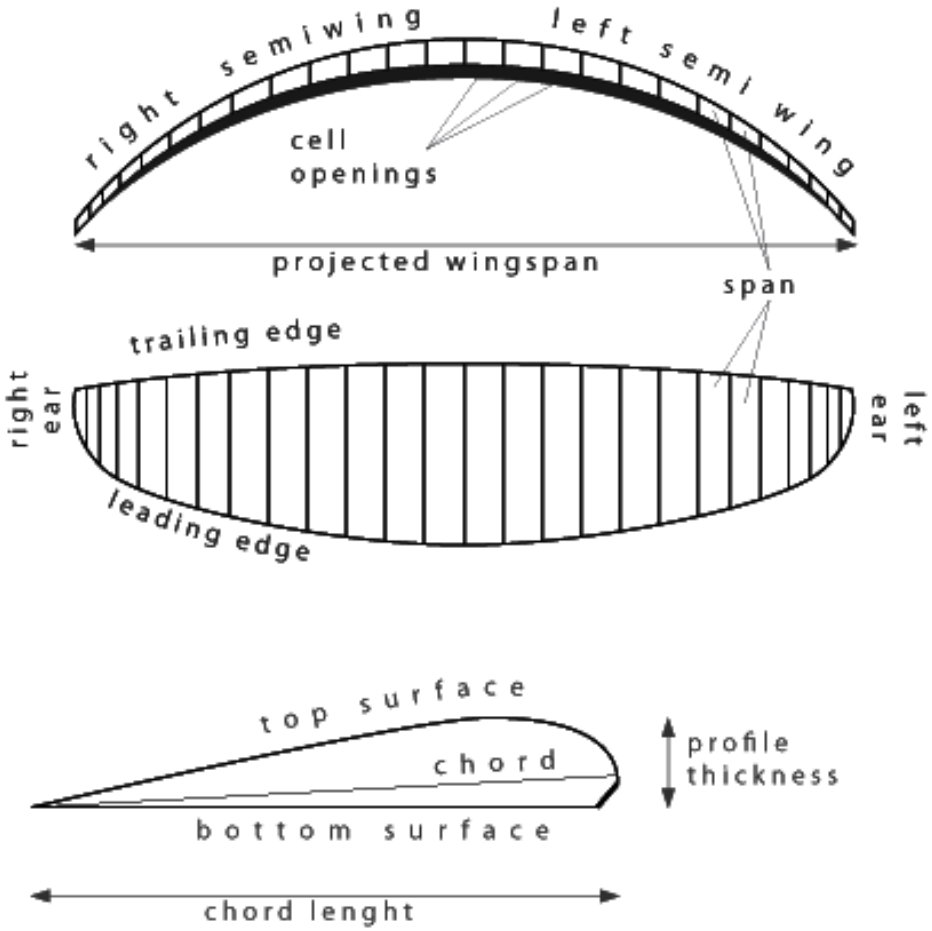
# Paraglider - geometry




Wing elements viewed from in front, above and a profile section

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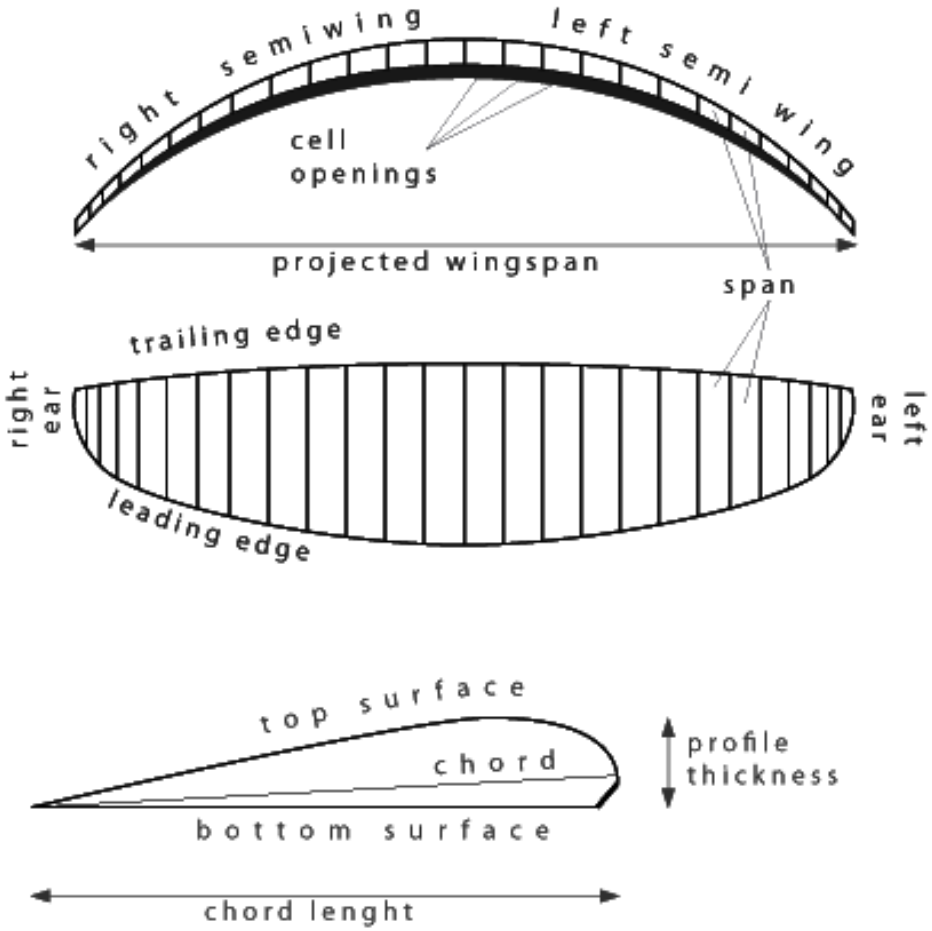
# Paraglider - geometry

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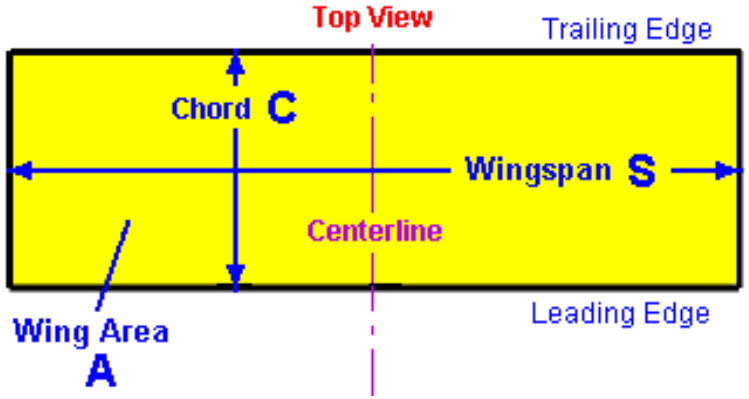


Aspect Ratio = AR

$$AR = \frac{S^2}{A} = \frac{S}{C}$$

Aspect ratio

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# Paraglider - geometry

## Glide Angle

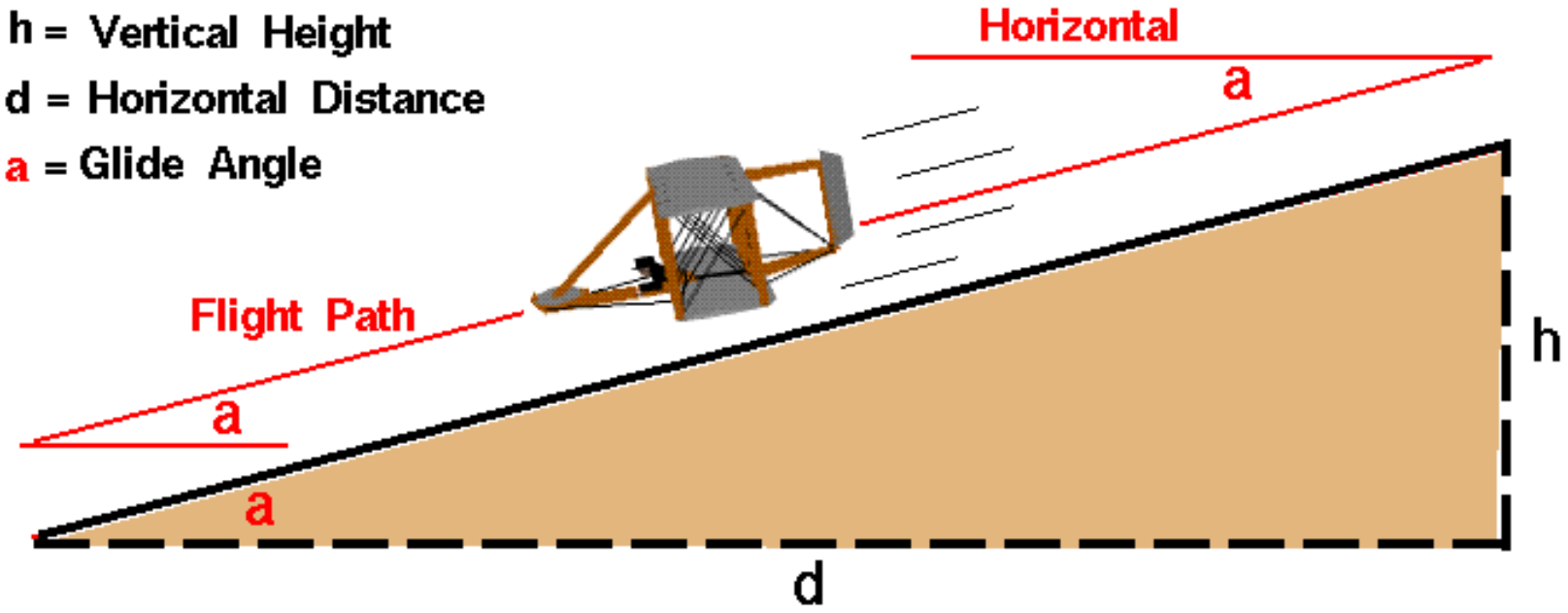
### Glide Ratio

Glenn Research Center

h = Vertical Height

d = Horizontal Distance

a = Glide Angle




From trigonometry : $\tan(a) = \frac{h}{d}$

ratio = $\frac{\text{Vertical Height}}{\text{Horizontal Distance}}$

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# Paraglider

Wing loading = Total weight / Surface area

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# Paraglider

Total weight???

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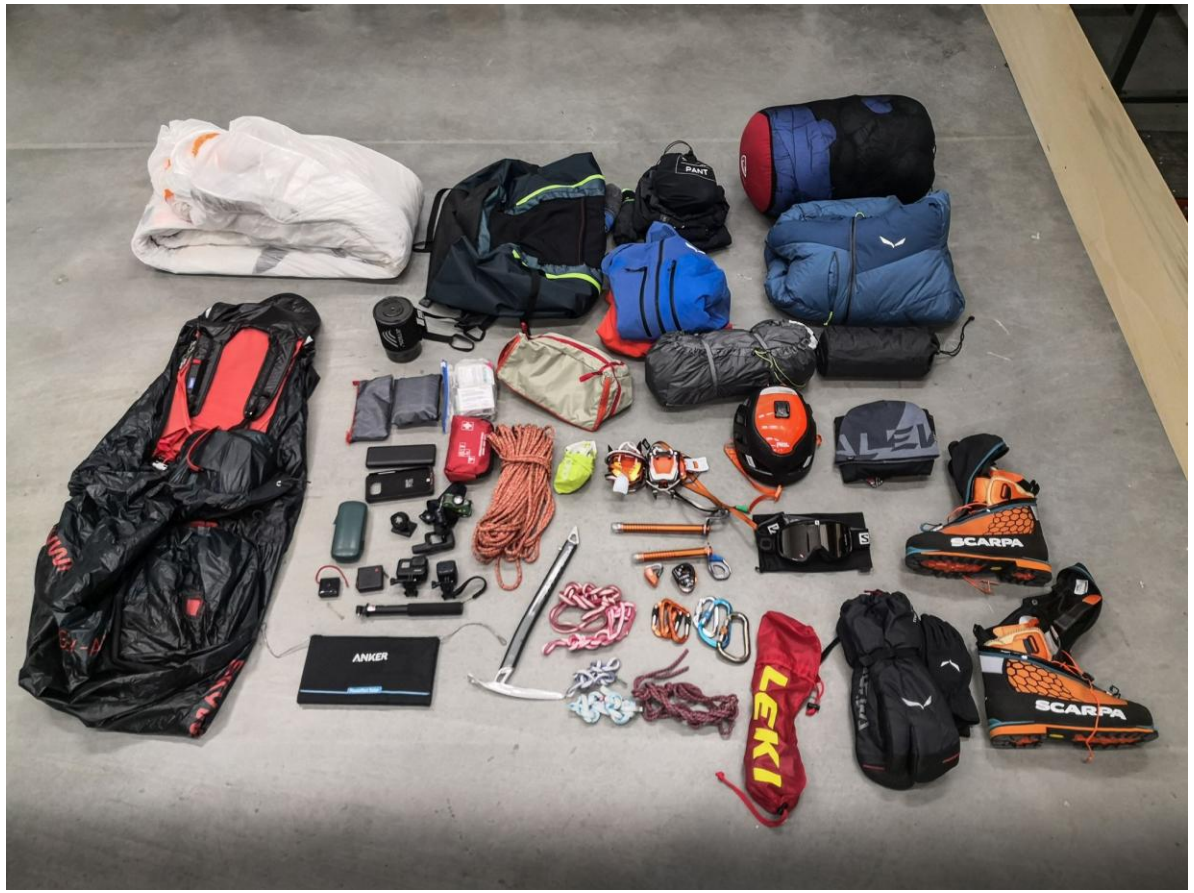
# Paraglider

Total weight:

- Pilot
- Glider
- Harness
- Rescue
- Packing (container, backpack, etc)
- Helmet
- Instruments
- Clothes

...

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# Paraglider

Wing loading = Total weight / Surface area

3-4 $kg/m^2$

Effect on the flying characteristic???

# Paraglider

„Yearly" check

# Paraglider

Lifetime
Handling
Water landing
Repairing

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# Paraglider – Maintenance

„Yearly" check

- Visual

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# Glider – Maintenance

„Yearly" check

- Visual
- Measure the porosity

# Glider – Maintenance

„Yearly" check

- Visual
- Measure the porosity
- Measure the lines (trimm)

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# Glider – Maintenance

„Yearly" check

- Visual
- Measure the porosity
- Measure the lines (trimm)
- Betsometer

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# Glider – Maintenance

„Yearly" check

- Visual
- Measure the porosity
- Measure the lines (trimm)
- Betsometer

- REPORT

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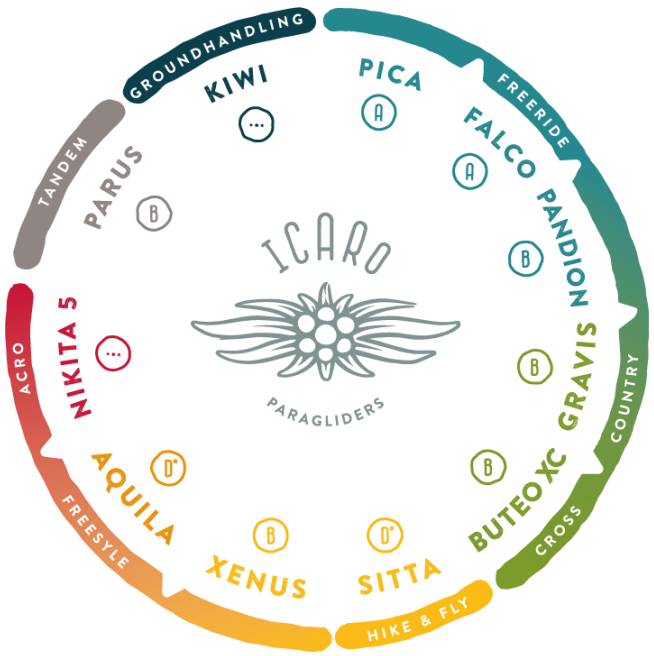
# Glider – How to choose

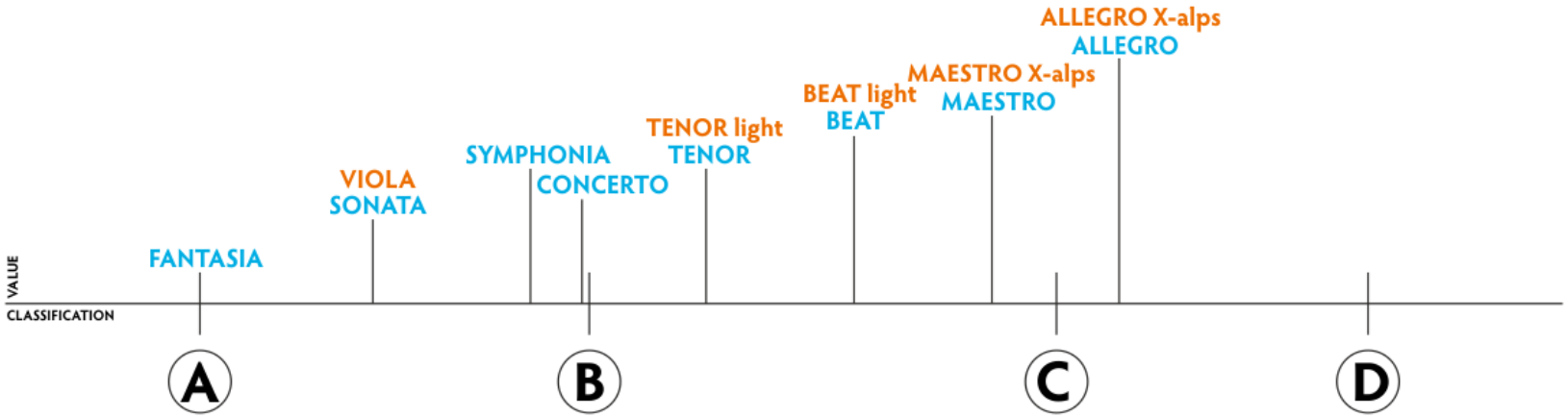
TYPE (A, B, C, D, CCC)

# Glider – How to choose




TYPE (pilot knowledge, requirements)

SIZE!!!

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# Glider – How to choose

Test report

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# Glider – How to choose

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# Glider – How to choose

Safety class

# Glider – How to choose?

TYPE (pilot knowledge, requirements)

SIZE!!!

Brand (no importance, test it!)

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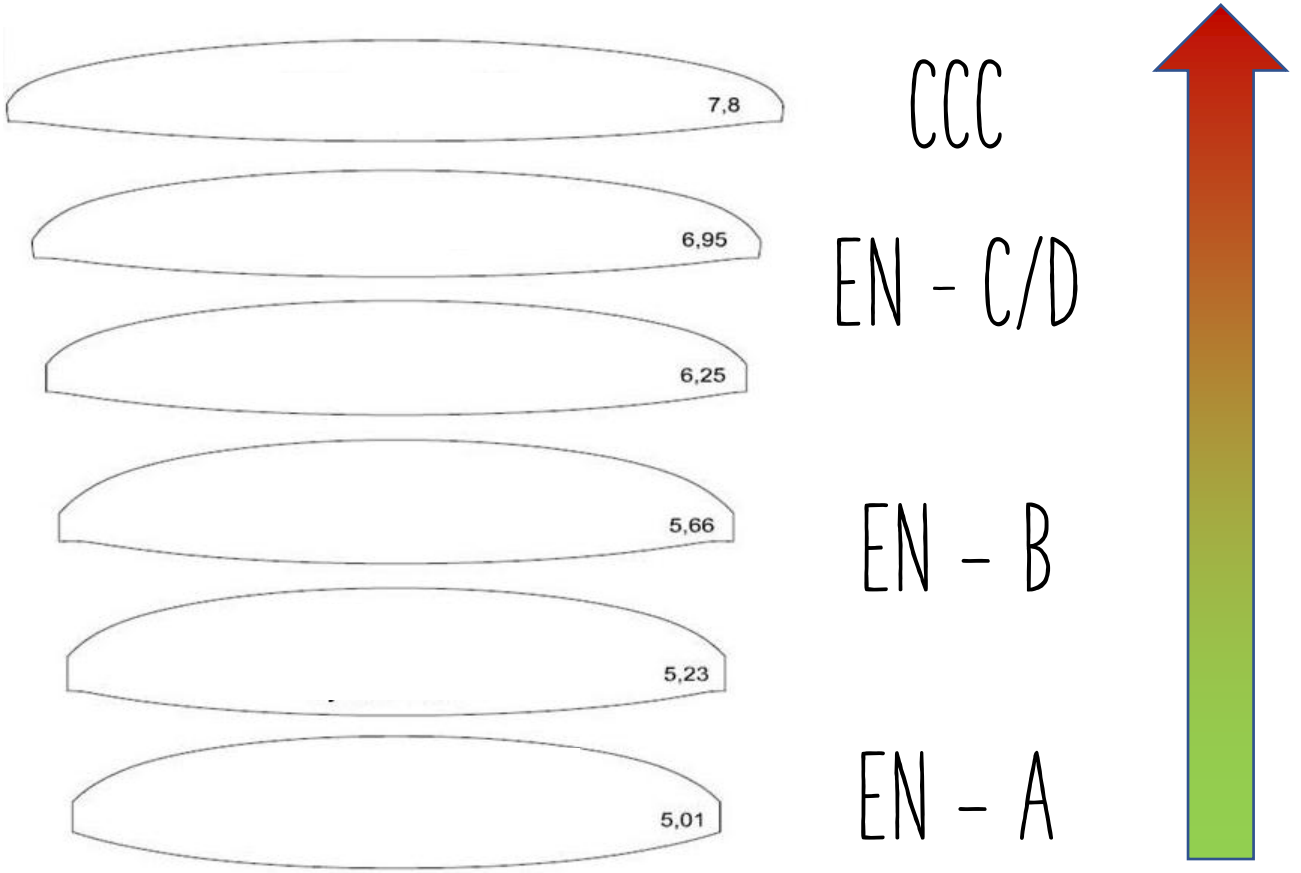
# Paraglider - categories

Competition? Acro?

Cross country?

Hike & Fly?

Relaxed weekend flights / soaring?




Performance ↔ Passive safety

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# Equipment

- Paraglider
- Harness
- Rescue
- Other equipment

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# Harness - types

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# Harness - protection

Hike & Fly harness

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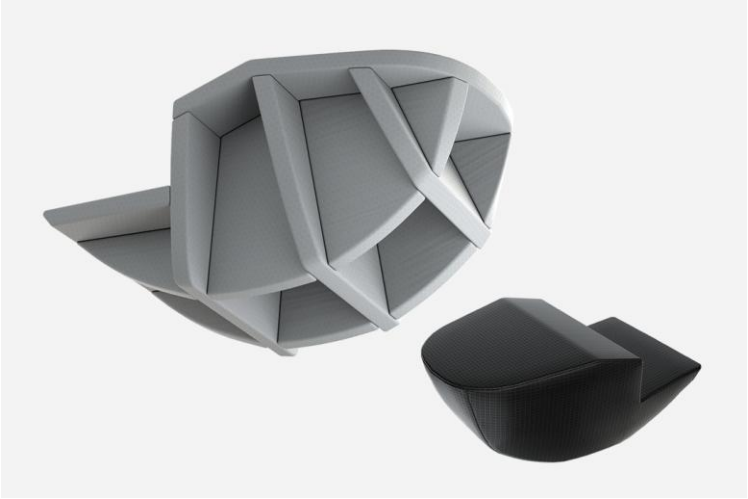
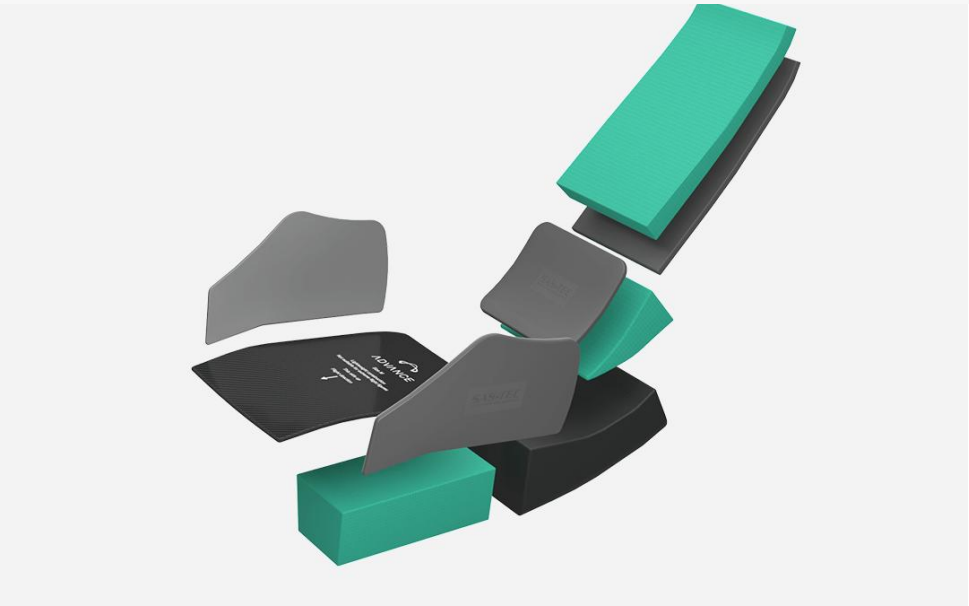
# Harness - protection

- Airbag
- Hybrid (Airbag-Foam)
- Foam





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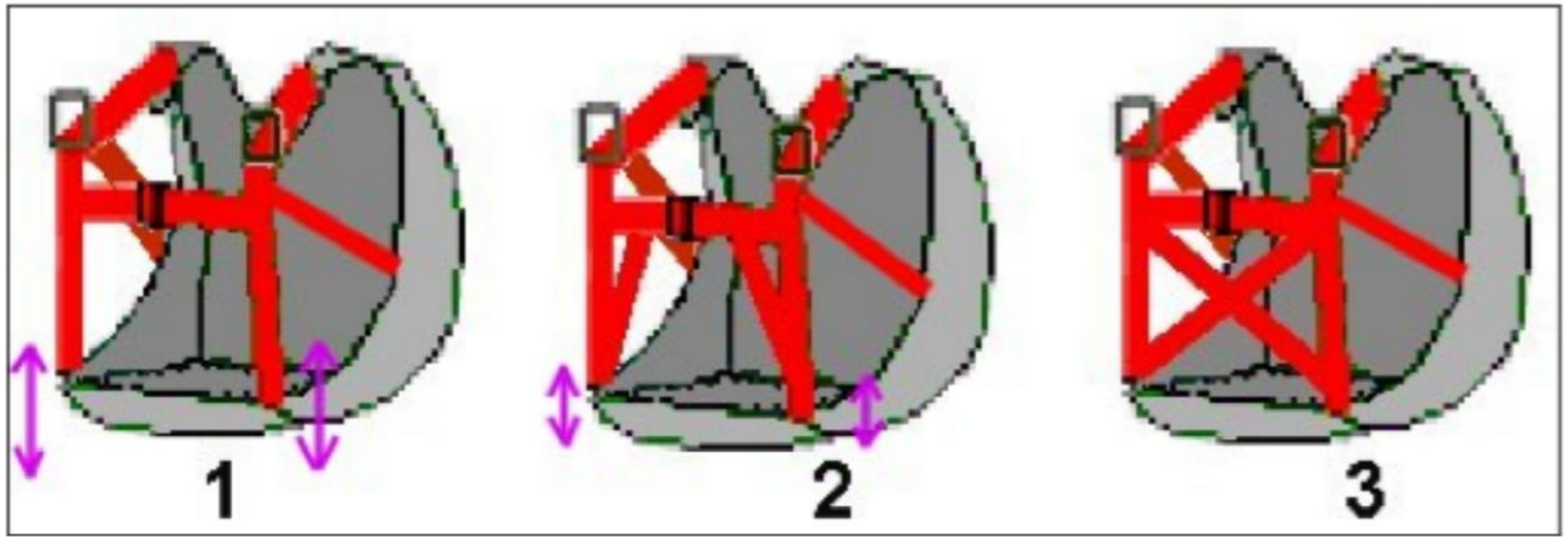
# Harness - bracing




| | |
|---|---|
| Easy to weightshift | Difficult to weightshift |
| Feel of Turbulence | Less feel of turbulence |

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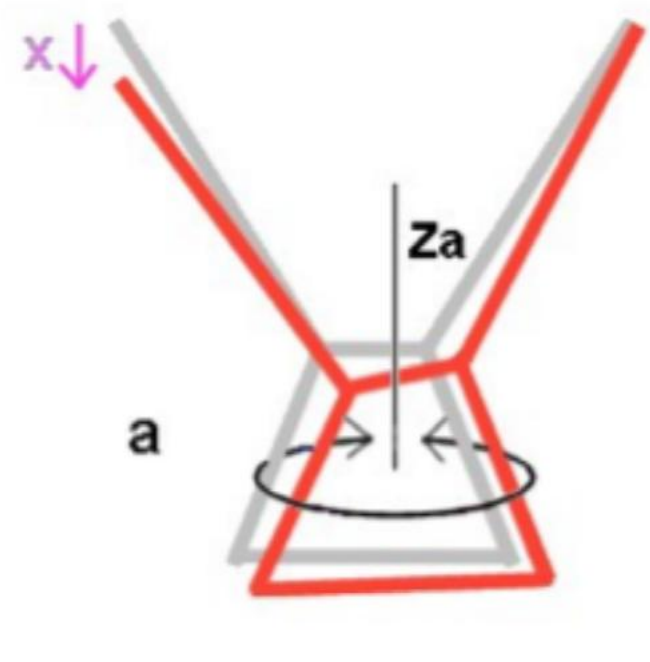
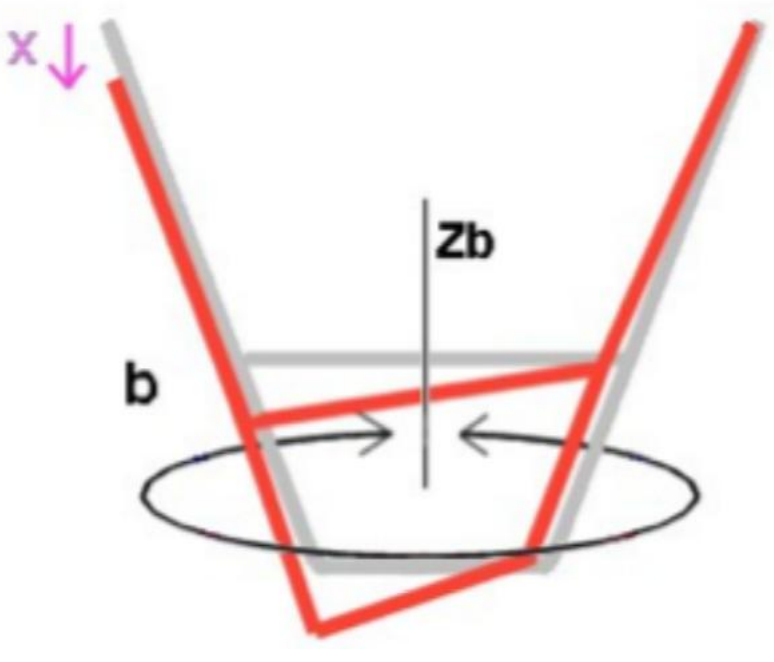
# Harness – Carabiner position




Higher twist tendency

Less feel of turbulence

Smaller twist tendency

Feel of Turbulence

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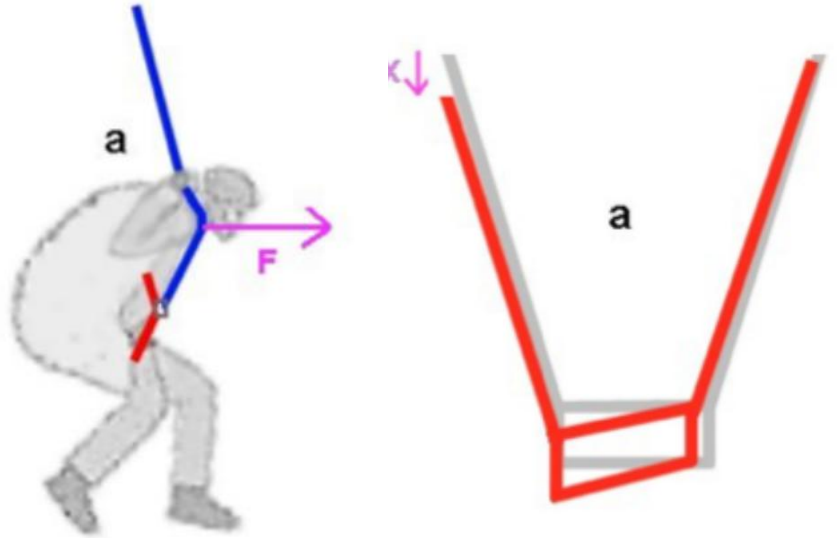
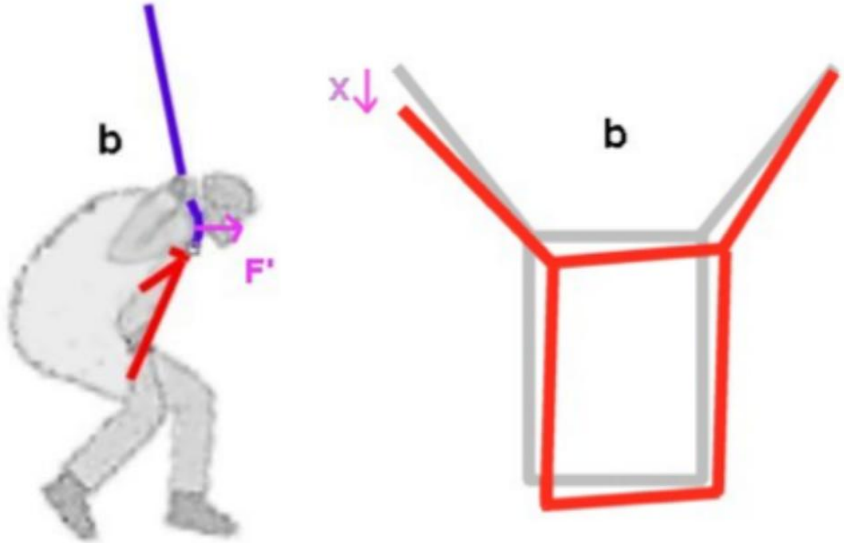
# Harness – Carabiner position




Easier to takeoff

Bigger feel of turbulence




More difficult to takeoff

Less obvious turbulence

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# Harness – how to choose

TYPE (pilot knowledge, requirements)

SIZE!!!

Brand (no importance, test it!)

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# Equipment

- Paraglider
- Harness
- Rescue
- Other equipment

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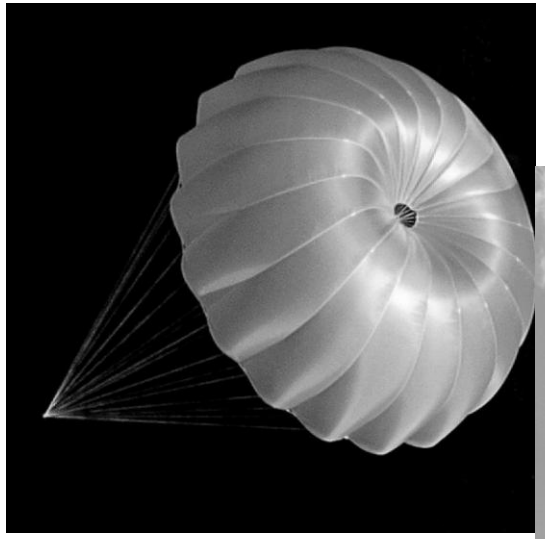
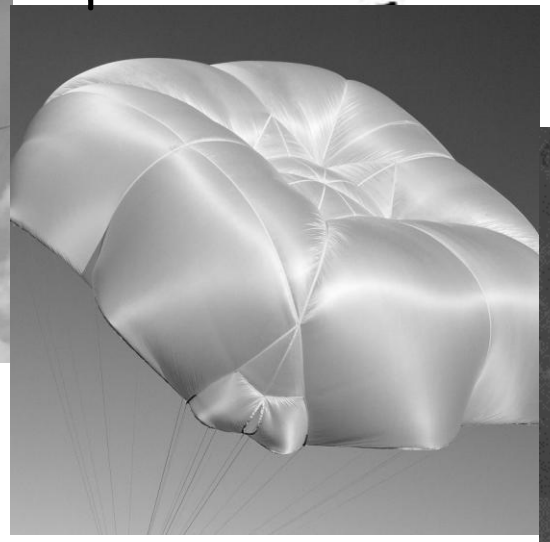
# Rescue

# Rescue - types

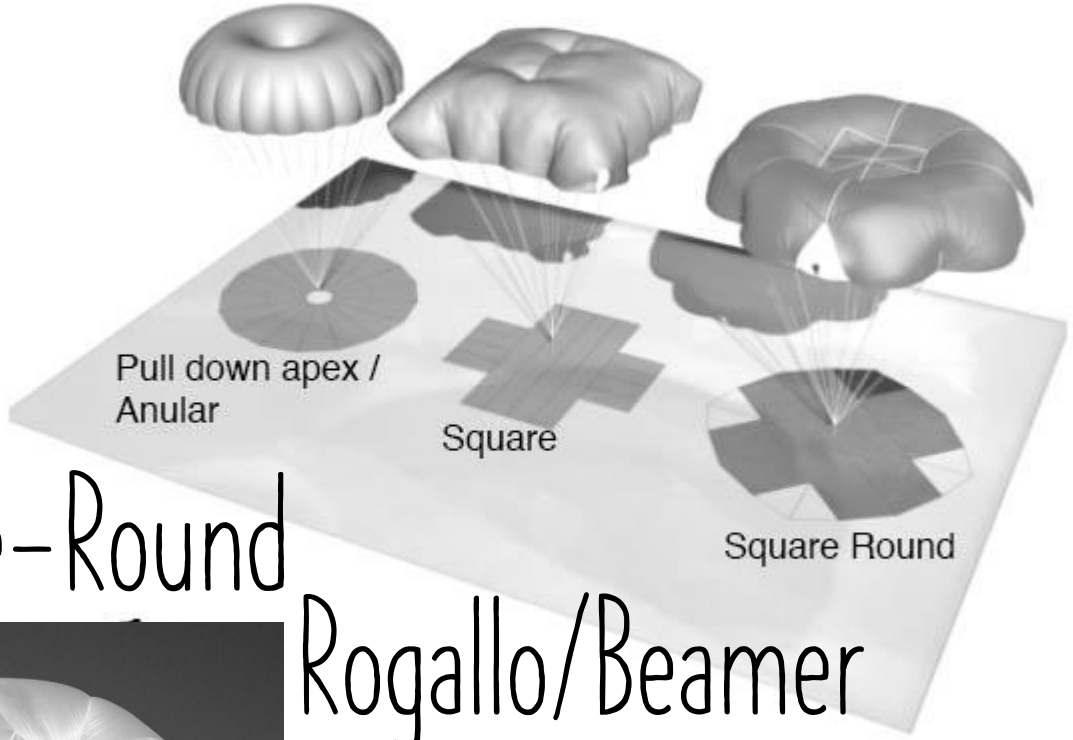


Round

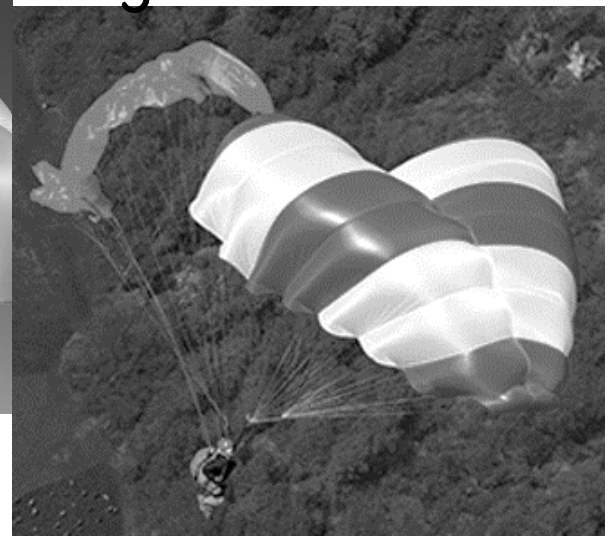
Square



Square-Round




Rogallo/Beamer



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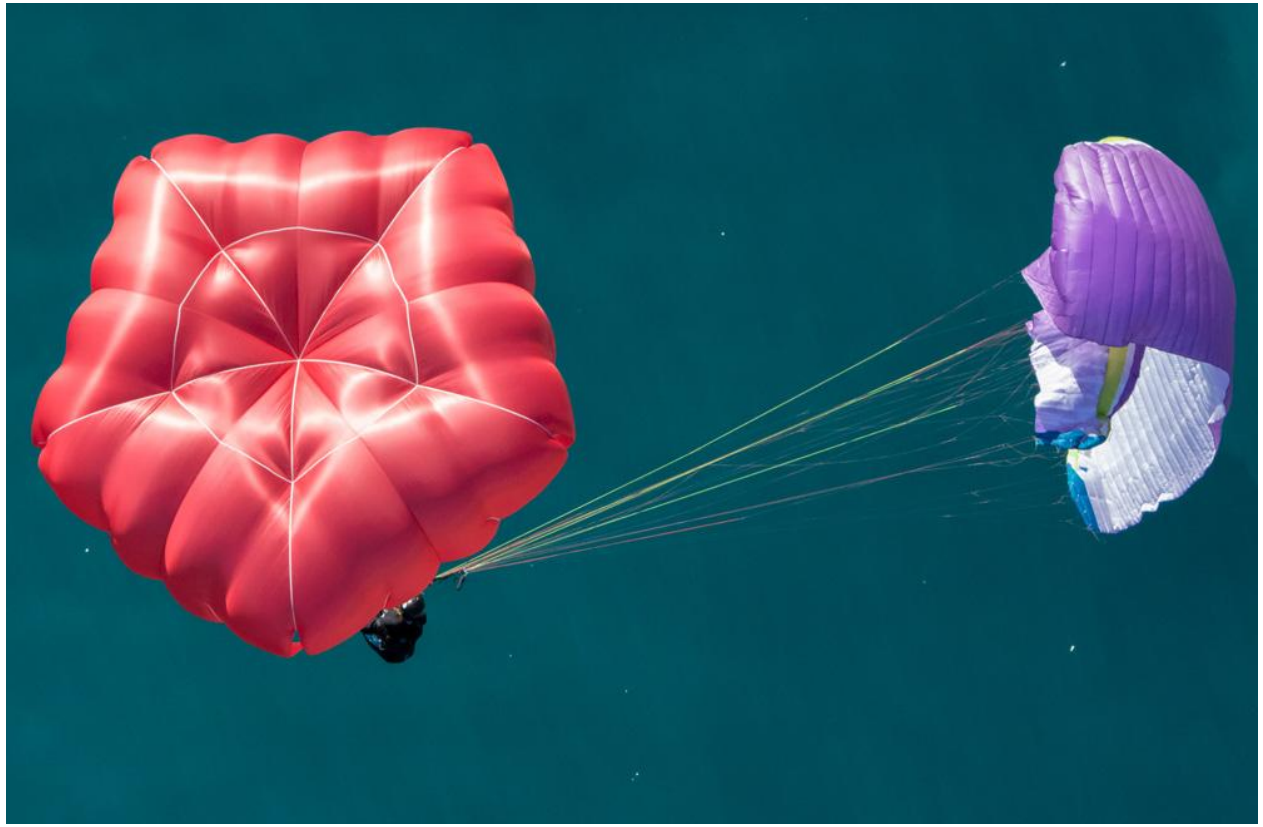
# Rescue - types



Pentagon

Octagon

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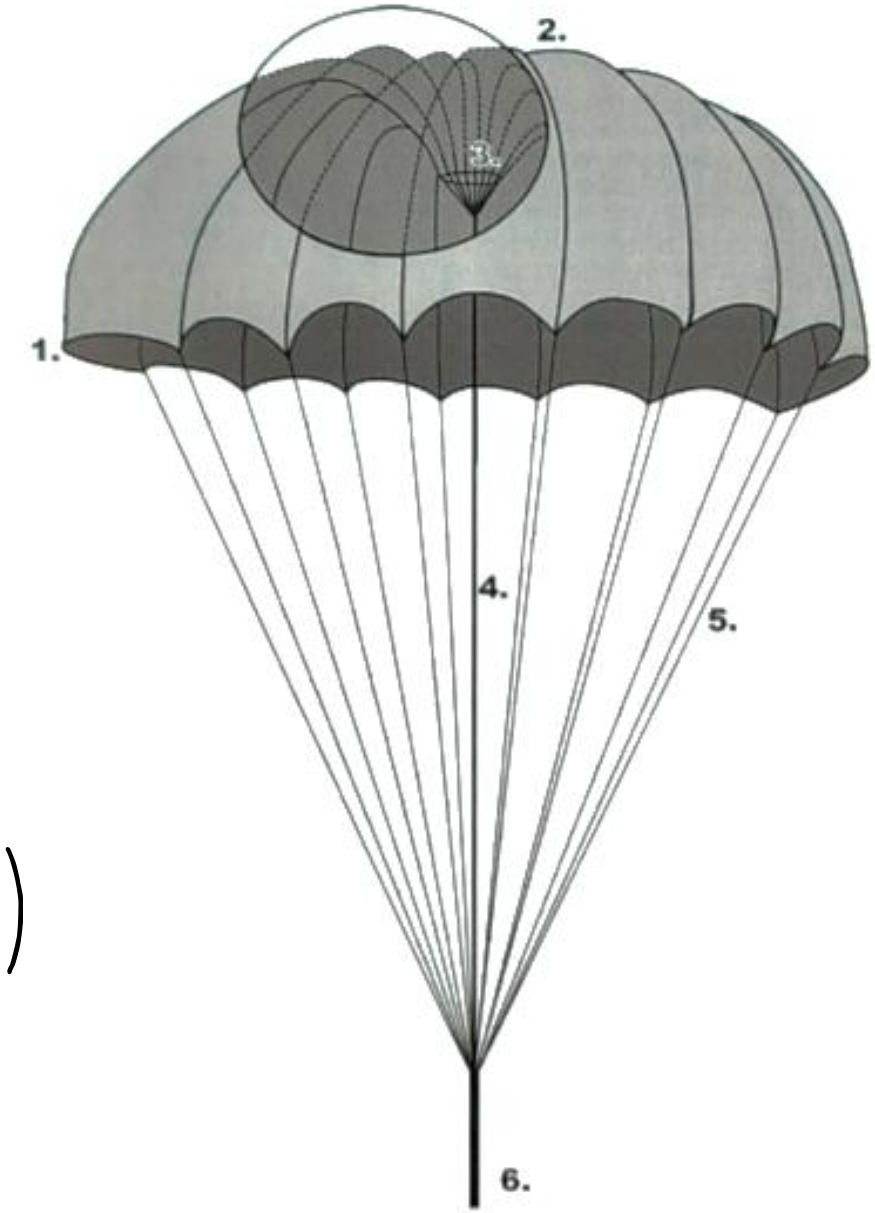
# Rescue - material

1. Basis / leading edge
2. Canopy
3. Apex
4. Central line(s)
5. Lines
6. Connecting strap / Bridle




Canopy: Rip-stop Polyamide (Nylon)

Lines: Polyester / Polyamide

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# Rescue - position

Side container

Front container

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# Rescue – attachment point

High

Low

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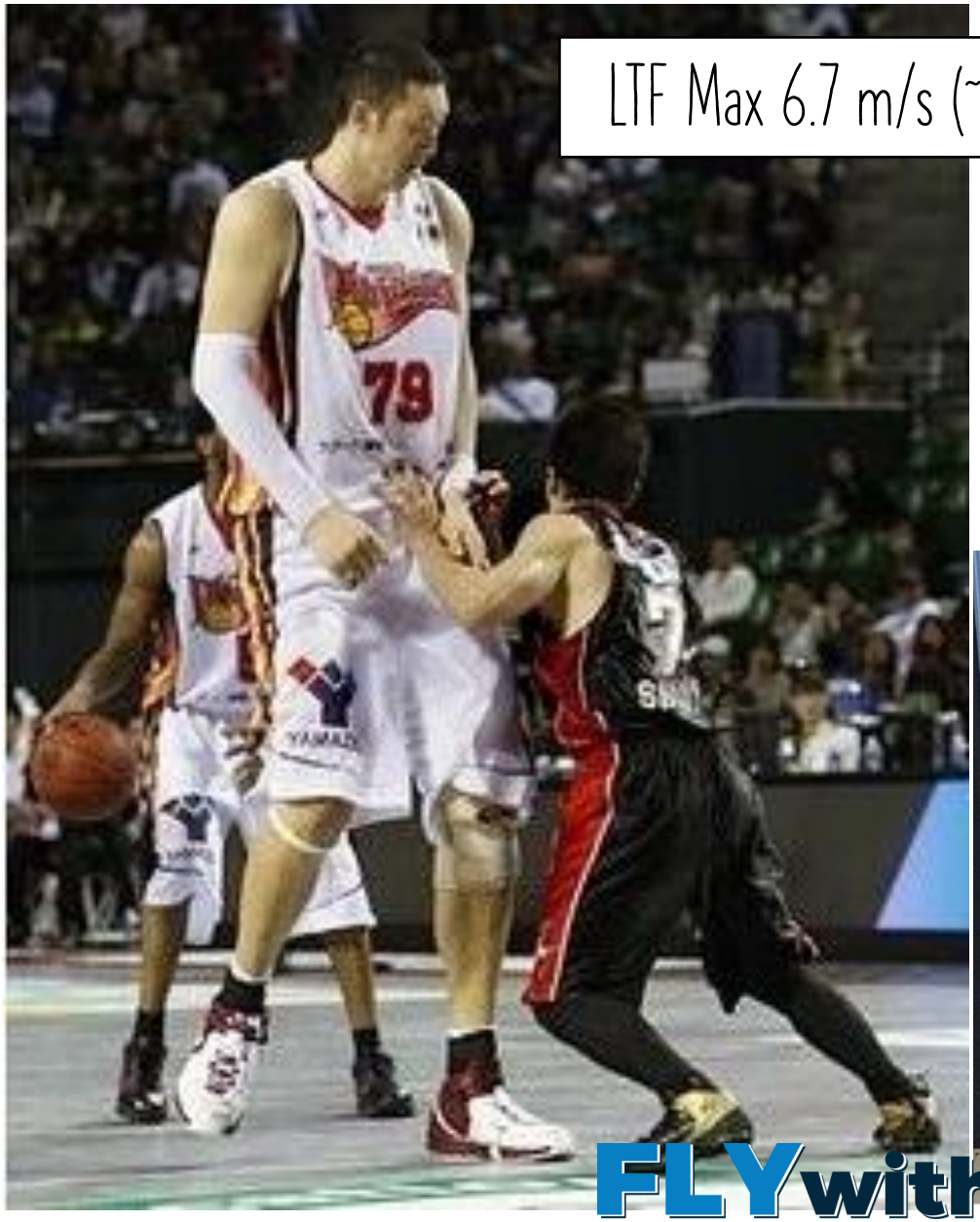
# Rescue – sink rate



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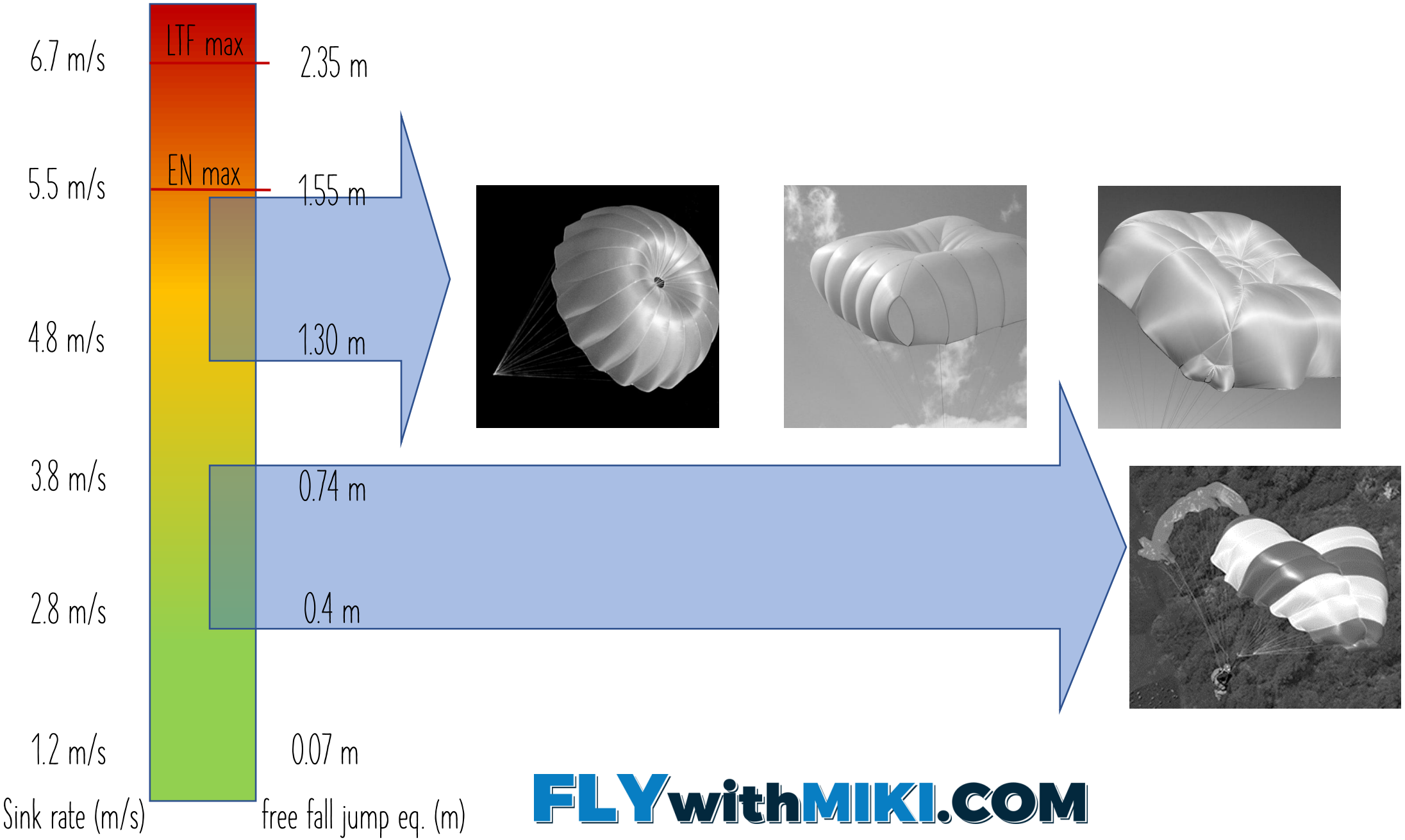
# Rescue – sink rate

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# Rescue – Opening time

Factors:

- Porosity
- Packing intervall
- Airflow speed
- Handle position

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# Rescue - Maintenance

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# Rescue - Maintenance

Lifetime
Handling
Water landing
Repairing

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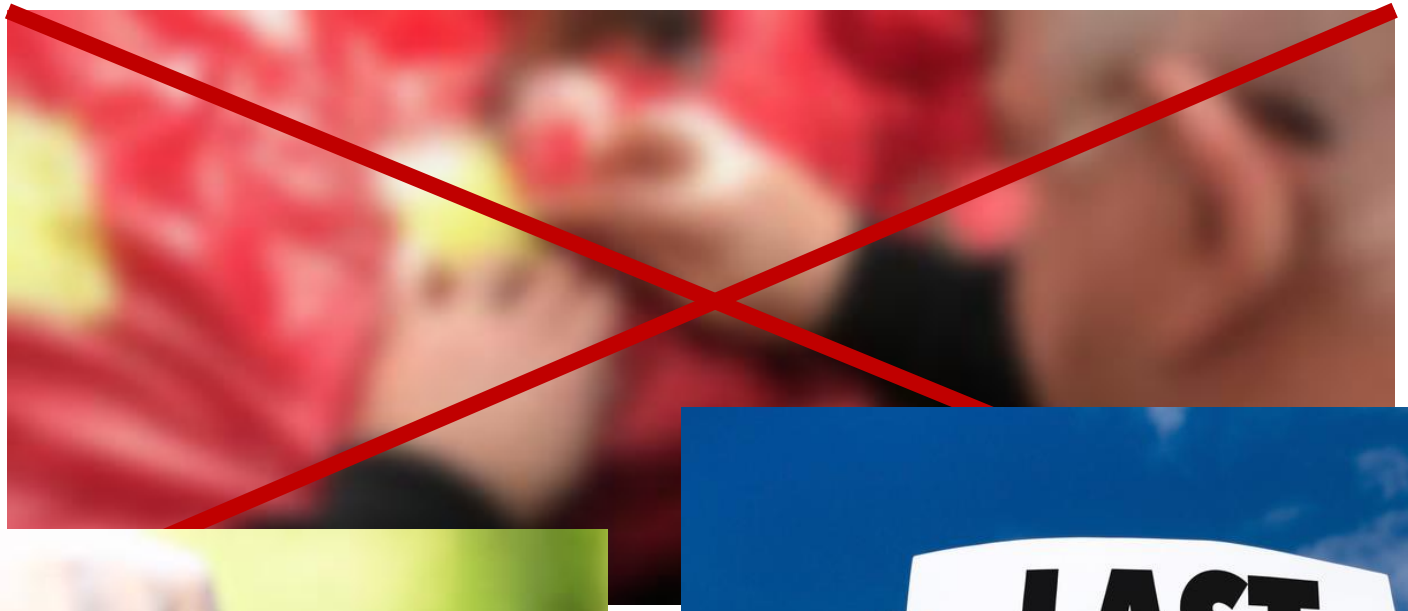
# Rescue - Maintenance

Lifetime

Handling

Water landing

Repairing



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# Rescue – How to choose

TYPE (pilot knowledge, circumstances)

SIZE!!!

Brand - no importance

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# Equipment

- Paraglider
- Harness
- Rescue
- Other equipment

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# Equipment - Instruments

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# Equipment – Instruments

## Variometer – GPS

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# Equipment – Instruments

## Anemometer

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# Equipment - Other

Radio

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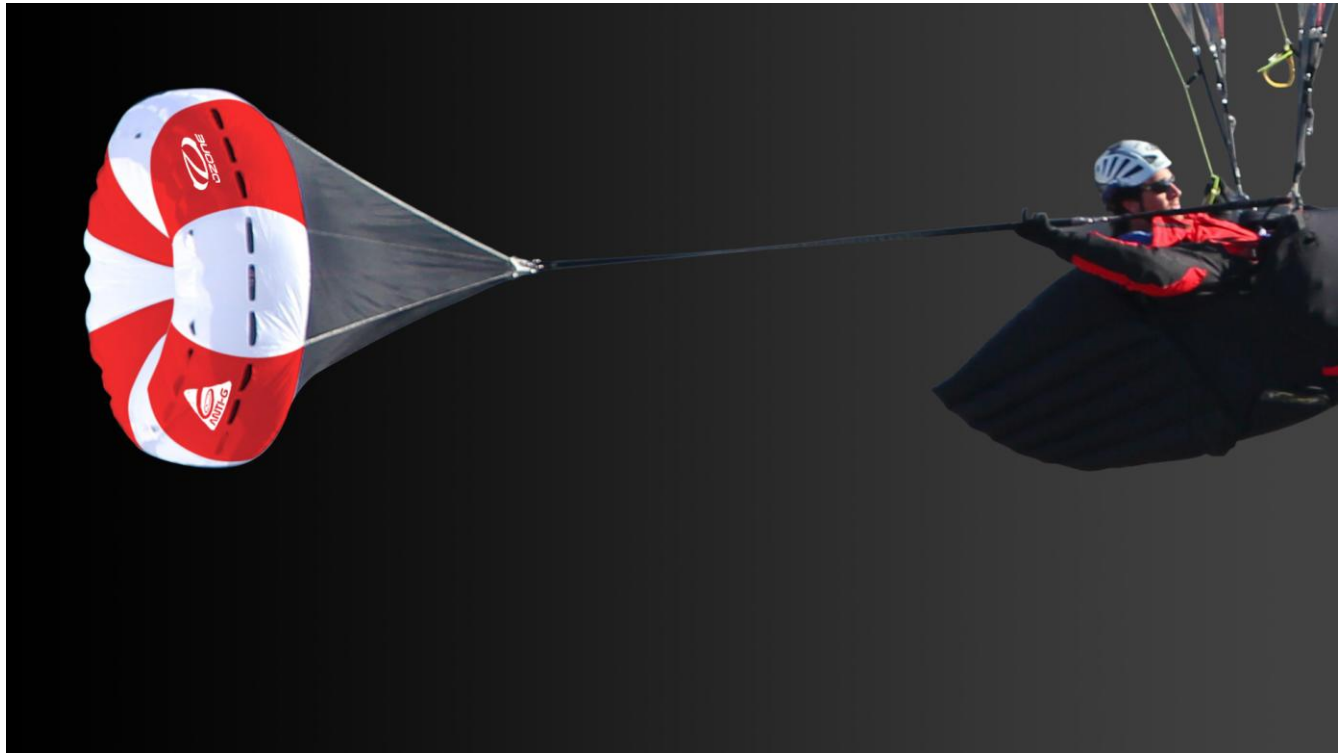
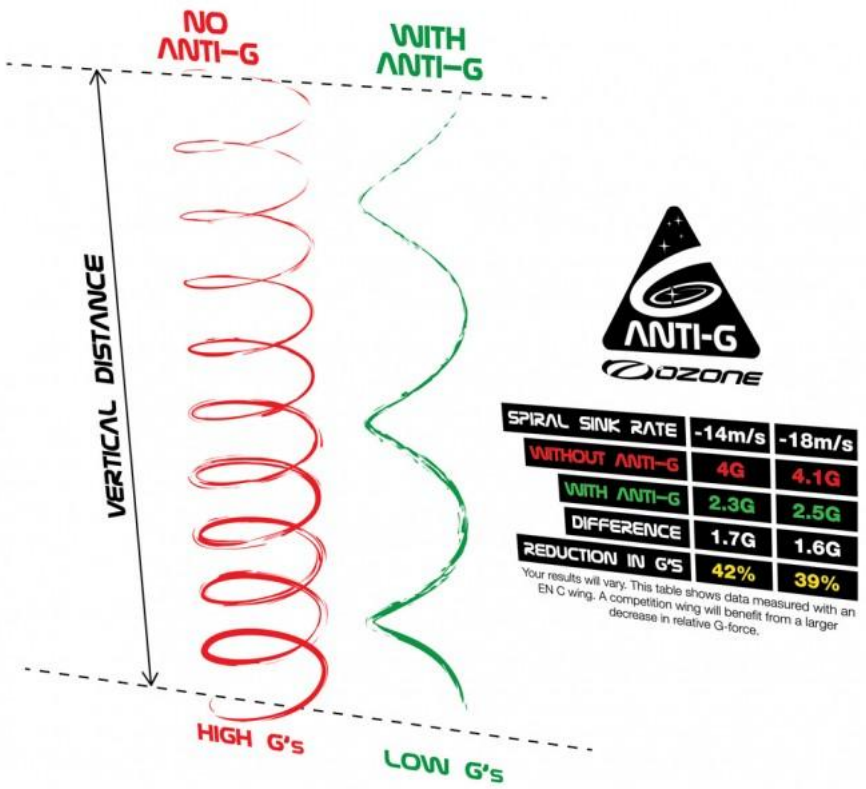
# Equipment - Other

## Anti G Parachute






| SPIRAL SINK RATE | -14m/s | -18m/s |
|---|---|---|
| WITHOUT ANTI-G | 4G | 4.1G |
| WITH ANTI-G | 2.3G | 2.5G |
| DIFFERENCE | 1.7G | 1.6G |
| REDUCTION IN G'S | 42% | 39% |

Your results will vary. This table shows data measured with an EN C wing. A competition wing will benefit from a larger decrease in relative G-force.

# Equipment - Other

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# Equipment - Clothing

EN-966

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# Equipment - Clothing

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# Equipment - Clothing

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# Equipment - Clothing

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# Equipment - Clothing

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# Additional equipment

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# Additional equipment

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# Additional equipment

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# Thanks for your attention

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