Airframe

- A drone frame/airframe is the structural backbone of a drone.
- It is the skeleton on which all other components are mounted and protects all the electronics inside the drone.
- It supports motors and other electronics and prevents them from vibrations.
- They need to be designed to be strong but also lightweight.

Airframe

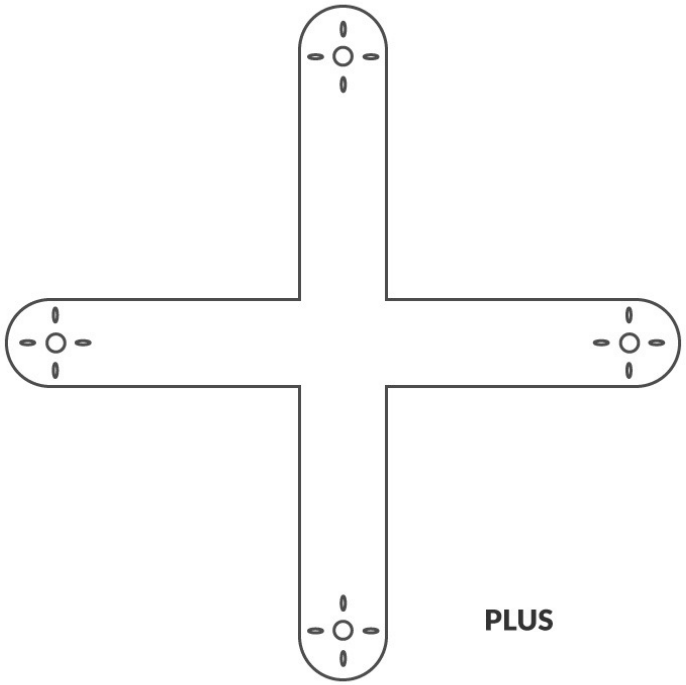
Airframe – Key Considerations

- Here is a list of things that need to be considered when choosing a quadcopter frame
  - Layout
  - Size
  - Weight

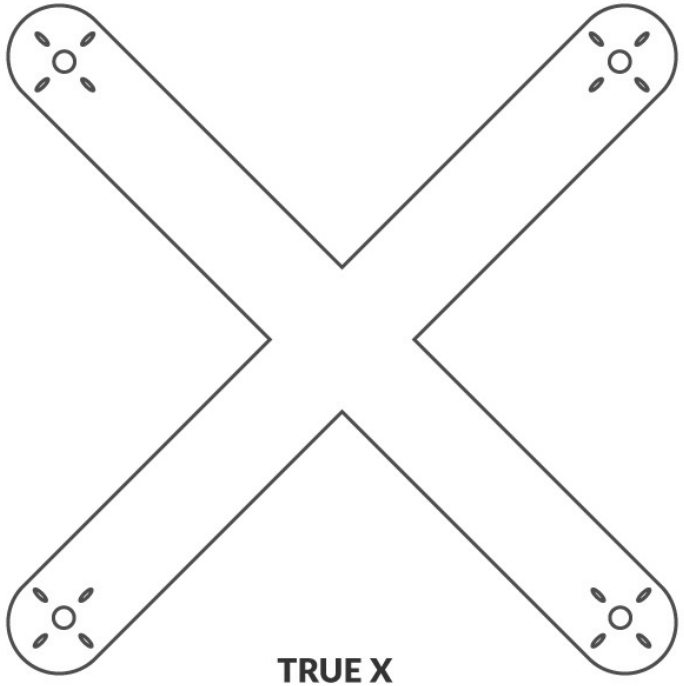
Airframe – Layout

- Some of the most critical performance characteristics of the drone depend on the frame's cosmetic design; these not only affect how the drone looks but also give the drone specific aerodynamic features.
- The more noticeable design characteristic is the types of frames available.
- The commonly used drone airframe layouts are H frame, X Frame and Stretch, Although there are a lot of other less common frame types.

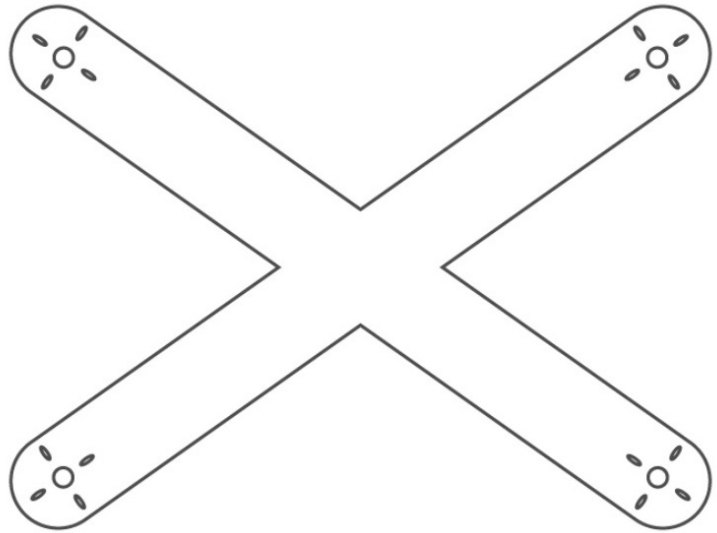
Airframe – Layout



PLUS

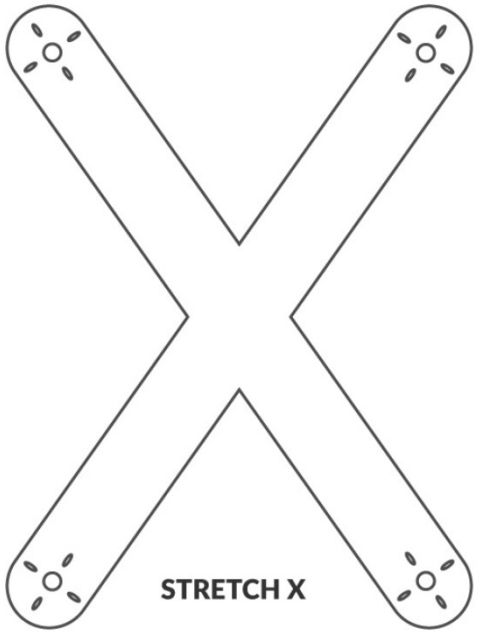


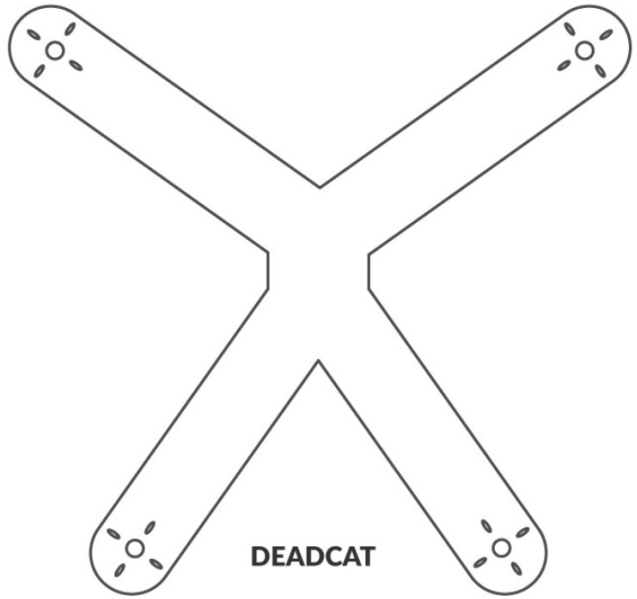
TRUE X

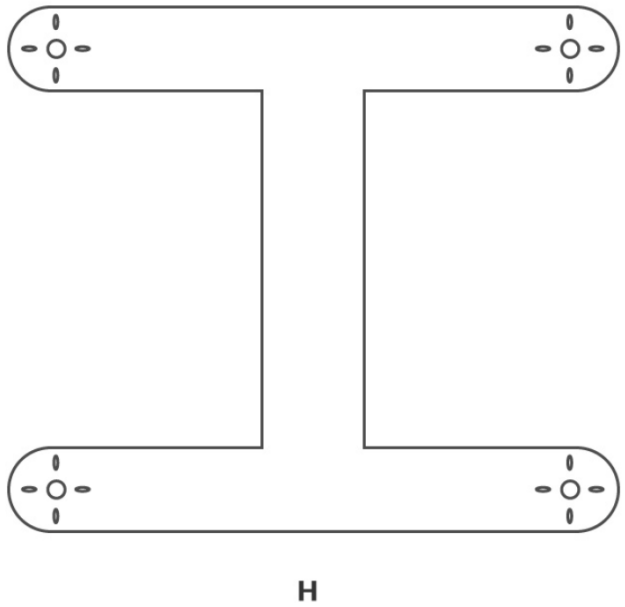


WIDE X

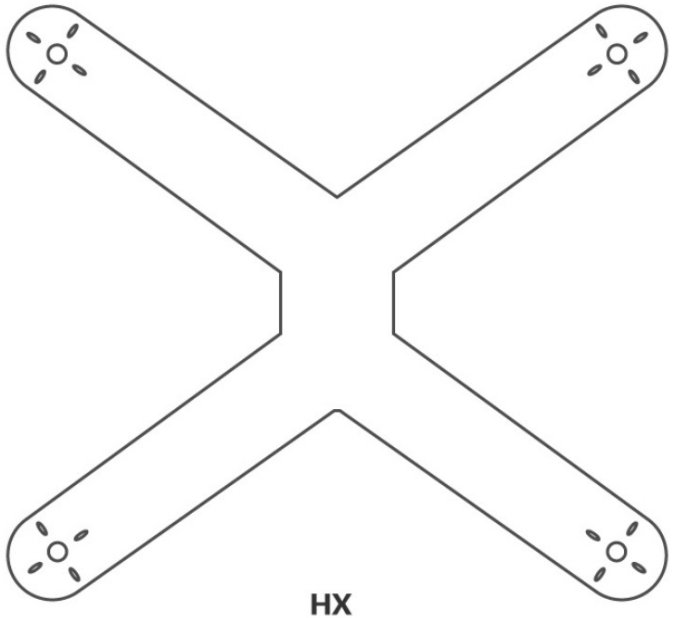
Airframe – Layout



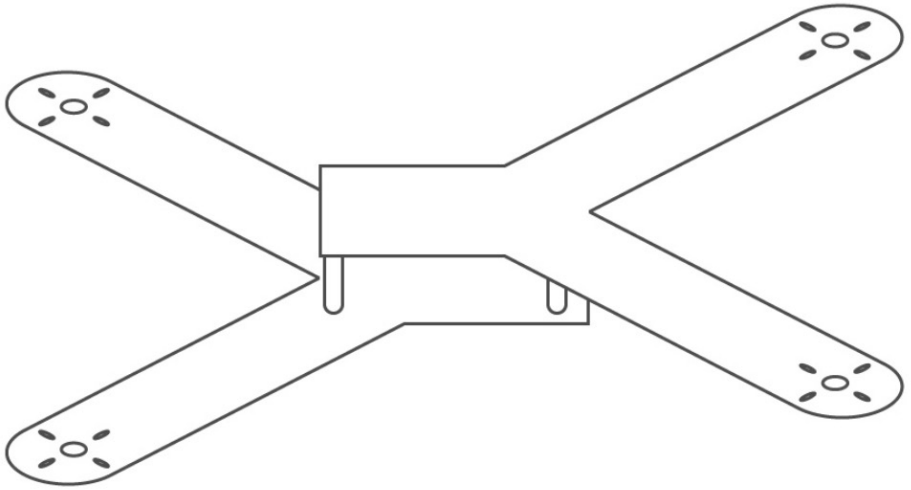




Airframe – Layout



HX



Z

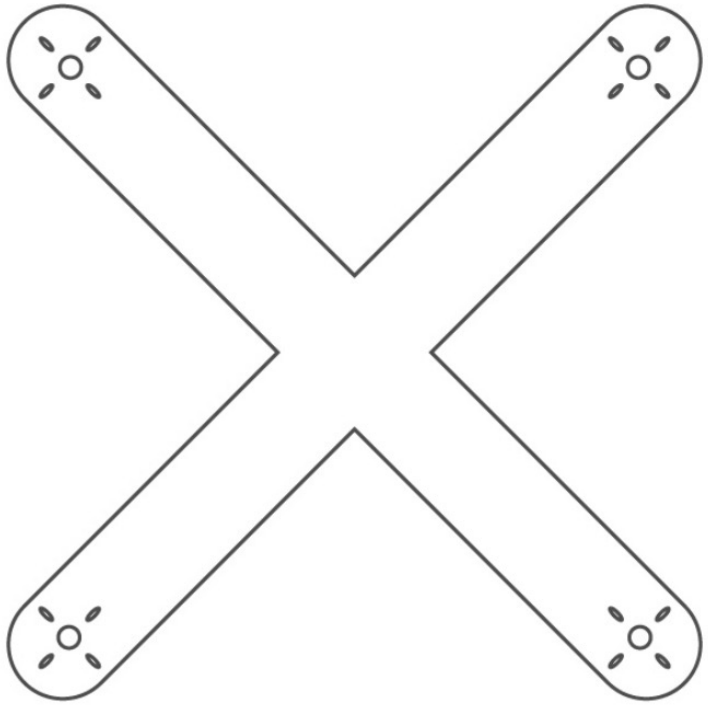
Airframe – Layout

- **True X:** The perpendicular distance between each motor's centre is equal, giving the quadcopter the same level of stability on all axes.
- **Wide X:** freestyle frame - this is because more central space is often required to mount an action camera and battery on top of the frame.
- **Stretch X**: typically favoured by racers who are seeking more stability on the pitch axis, which can improve control when the quadcopter is racing at high speed.
- **Dead Cat:** Its purpose is to remove the propellers from the sight of the on-board HD camera; this is achieved by increasing the perpendicular distance between the two frontal motors.

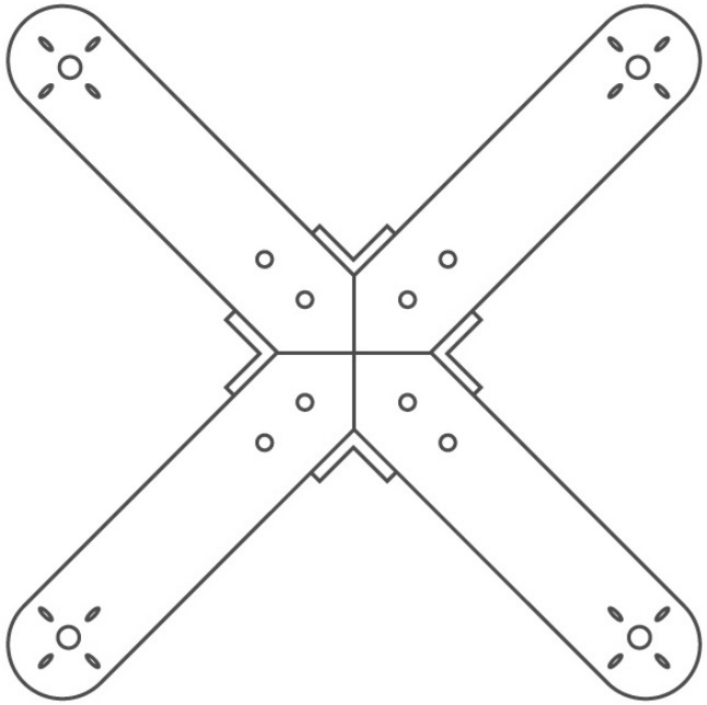
Airframe – Layout

- **H:** the H quad has lost favour due to its bulky size and awkward configuration.
- **HX:** HX is a newer variant of the H. Instead of placing the arms at the tip and tail of the carriage, a true X, wide X or stretch X configuration is applied, most often wide or true X.
- **Z**: Mounting the motors on different planes improves the prop wash handling of the quadcopter, as less turbulent air is directed towards the rear motors during forward flight.
- **Plus Frame:** A plus frame can be seen as advantageous in that each motor is responsible for rotational movement in only one axis, theoretically meaning finer control is possible.
- Although, plus frames are more prone to breakage due to most impacts involving a forceful strike to the front arm only.

Airframe – Layout



UNIBODY



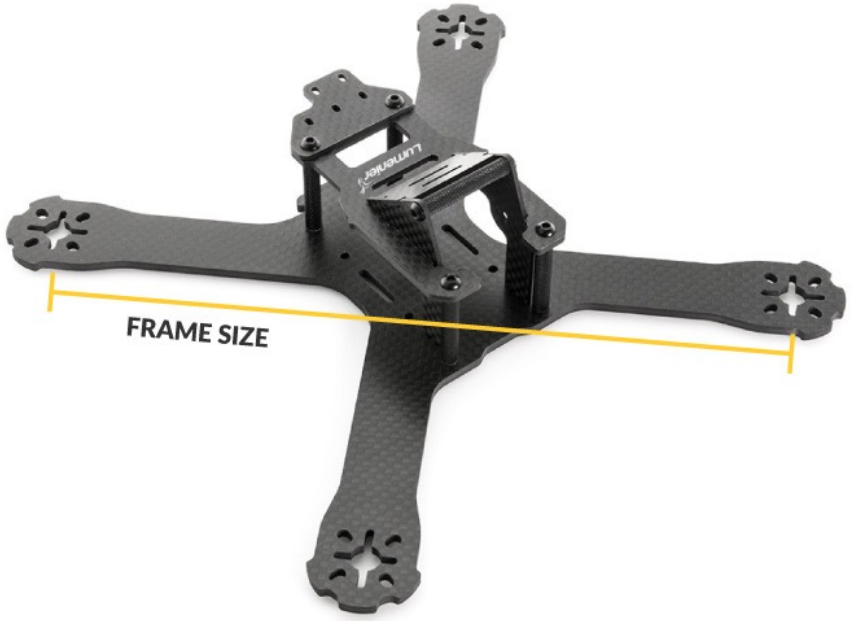
SEPARATE ARMS

Airframe – Layout

- Deciding between a unibody or a replaceable arm frame can be difficult.
- The advantage of a unibody frame is the ease of use due to not having the need to assemble a collection of carbon plates.
- Separate arm designs are typically favoured because of their cheaper cost and ease of repair.
- Separate arm designs are typically cheaper than unibody frames as they do not require as much of the carbon sheet they are cut from to be wasted.
- The replaceable nature of the arms also allows the quad to be designed lighter weight, because the arms may be made to a narrower width.
- If an arm breaks it can simply be quickly replaced for a low cost.

Airframe – Size (a.k.a. wheelbase)

- Quadcopter frame size is the diagonal motor-to-motor distance measured in millimetres.
- It dictates the size of the propeller you can run on it.
- Therefore, the frame size often refers to the maximum propeller size it can support, instead of its wheelbase.
- For example, for a five-inch frame, the frame is sized for 5 inch propellor
- A frame measuring less than 150mm motor-to-motor is categorized as a micro. A frame larger than 150mm motor-to-motor is considered a mini.
- When measuring an unconventional multicopter frame, such as a hexacopter or tricopter, the size will always be given by the greatest motor-to-motor distance.



Airframe – Size (a.k.a. wheelbase)

- Here is a table showing roughly what maximum prop size different mini quad frame sizes can support

Frame Size	Prop Size
280mm+	7″
220-250mm	6″
180-220mm	5″
150-180mm	4″
120-150mm	3″
90-120mm	2″

Airframe – Weight

- Frame weight depends on the choice of materials.
- The most common materials are carbon fiber, plastic, and aluminum.
- Carbon fiber is the strongest and lightest material, but also the most expensive and brittle.
- Plastic is the cheapest, most flexible material, but also the heaviest and weakest.
- Aluminum is a good compromise between carbon fiber and plastic, offering moderate strength, weight, and cost, but also prone to bending and corrosion.

Airframe – Weight

- **Aluminum** is a popular choice due to its strength-to-weight ratio. It's lightweight, durable, and relatively easy to work with. It provides a good balance between strength and cost.
- **Carbon fiber** is lightweight and incredibly strong. It's often used in high-performance quadcopters because it offers excellent strength-to-weight properties. However, carbon fiber frames can be more expensive compared to other materials.
- **Fiberglass** is another lightweight material that is commonly used for quadcopter frames. It is less expensive than carbon fiber but still provides decent strength.

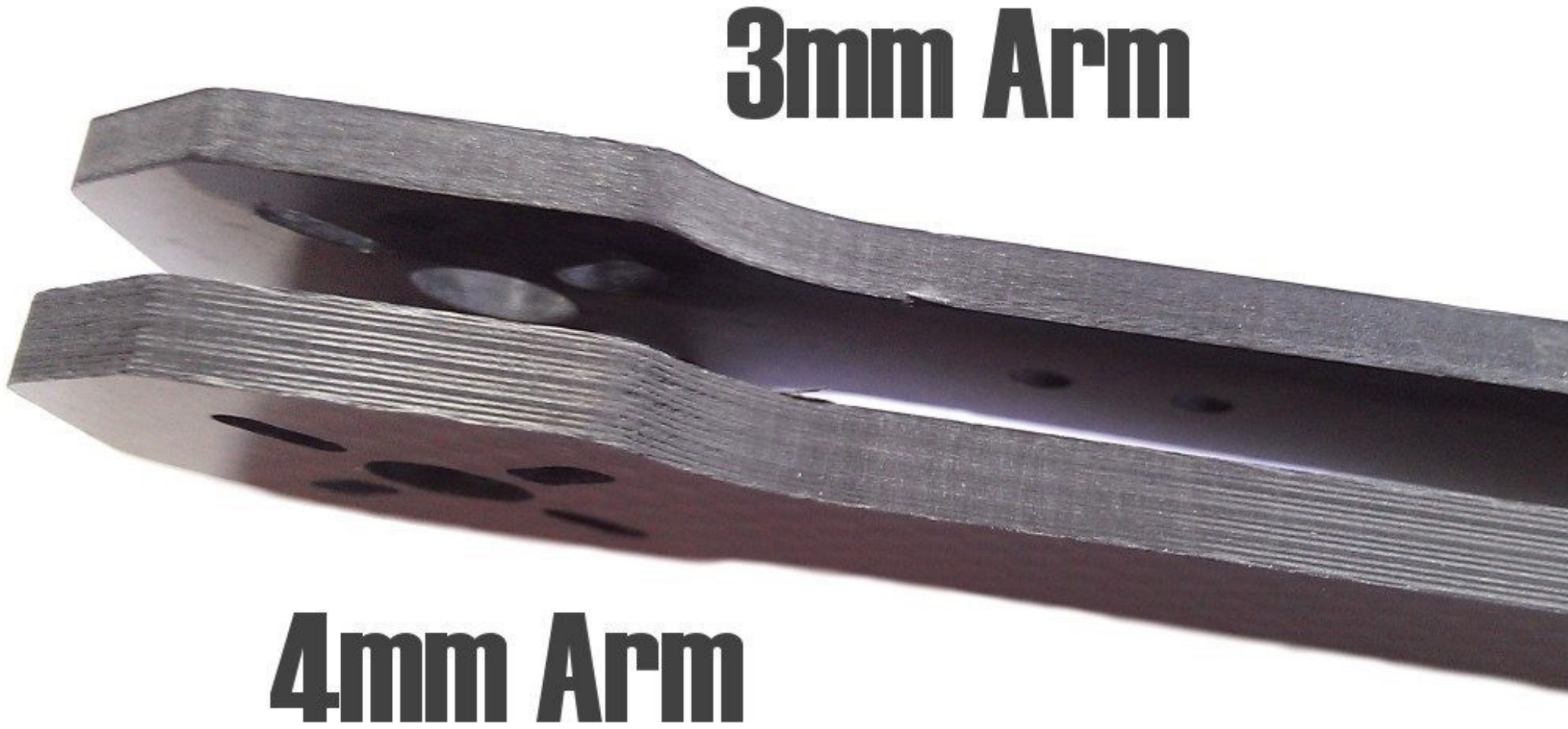
Airframe – Weight

- **Plastics** are used in some entry-level and toy-grade quadcopters frames. While not as strong as aluminium or carbon fibre, plastic is cost-effective and suitable for lighter applications.
- **Wood** is occasionally used for DIY or hobbyist quadcopter frames. It's readily available, easy to work with, and can provide a rustic or unique appearance. However, wood is generally heavier than other materials.
- **Titanium** may be used for its excellent strength and corrosion resistance in high-end applications. However, it's relatively expensive, making it less common in consumer-grade quadcopters.

Airframe – Weight

- **Composite materials,** a combination of materials that may include a mix of carbon fibre, fibreglass, and other reinforcing elements, are used in some quadcopter frames. These combinations are designed to balance strength, weight, and cost.

Airframe – Carbon Fibre Thickness



Airframe – Carbon Fibre Thickness

- Thicker carbon fiber means better strength, rigidity and sturdiness, but it also gets heavier.
- Durability matters most on the arms, as they take most of the strain in a crash. This makes it common to see top, centre and bottom plates cut from thinner 3mm or even 2mm CF