Materials

Learn about all the different materials you will encounter in FRC.

Aluminum Types (6061, 5052)

FRC teams commonly use two types of aluminum: **6061** and **5052**. They look similar but are used for very different purposes in robot construction.

6061-T6 Aluminum

6061-T6 is the most common **structural aluminum extrusion** used in FRC.

Properties:

- High strength and stiffness
- Excellent for machining and tapping
- Holds threads well
- Common in standardized extrusions (like 1x1, 2x1, 2x2 tubing)

Best uses:

- Robot frames and drivetrains
- Structural extrusion systems
- Tapped holes for mounting mechanisms
- Load-bearing assemblies

5052 Aluminum

5052 is most commonly used for **custom cut sheet metal plates**, often provided by sponsors or local suppliers.

Properties:

- More flexible and bendable than 6061
- Excellent for sheet metal forming
- Not ideal for tapped threads
- Resistant to cracking when bent

Best uses:

- Custom gussets and brackets
- Sponsor-cut plates

- Panels, covers, and guards
- Lightweight structural sheet parts

6061 vs 5052 (Quick Comparison)

- **6061-T6 → extrusion, rigid, machinable, structural**
- **5052 → sheet metal, bendable, laser/waterjet cut plates**

Key Idea

6061-T6 is primarily used for **extruded structural tubing**, while 5052 is used for **custom sheet metal plates**, often cut by sponsors. Choosing the correct material improves both strength and manufacturability in FRC designs.

Steel

Steel is a strong, heavy metal sometimes used in FRC for high-strength or wear-resistant applications. While aluminum is more common, steel is chosen when extra strength or durability is required.

Why FRC Teams Use Steel

Steel is used because it:

- Has very high strength
- Resists bending and deformation
- Handles high loads and impacts well
- Works well for shafts and fasteners

Common Types of Steel in FRC

Mild Steel

- Easy to machine and cut
- Used for simple brackets or mounts
- Heavier than aluminum

Hardened Steel

- Very strong and wear-resistant
- Used for shafts, axles, and gears
- Difficult to machine without proper tools

Common Applications

- Drive shafts and axles
- Bearings and wear surfaces
- High-load mounting hardware
- Gearboxes and transmission components

Limitations

- Much heavier than aluminum
- Harder to machine and drill
- Can slow down robot performance if overused
- Requires stronger tools and more effort to modify

Key Idea

Steel is used in FRC when strength and durability matter more than weight. It is most commonly found in shafts, fasteners, and high-load components rather than full structural frames.

Polycarbonate

Polycarbonate (often called “polycarb”) is a tough, transparent plastic widely used in FRC for protective and structural sheet applications.

Why FRC Teams Use Polycarbonate

Polycarbonate is used because it:

- Is very impact resistant (won’t easily shatter)
- Is lightweight compared to metal
- Can be cut, drilled, and bent easily with heat
- Provides visibility through clear panels

Common Applications

- Robot bumpers backing plates
- Protective guards over mechanisms
- Electrical covers and shields
- Intake guards and anti-interference panels
- Field-safe transparent barriers on mechanisms

Properties to Know

- Flexible: can bend without cracking
- Durable: absorbs impacts without breaking
- Machinable: can be drilled and cut with proper tools
- Sensitive to heat: can melt or deform if overheated

Important Handling Notes

- Use sharp drill bits to prevent cracking
- Avoid high drill speed and excessive pressure
- Support the material when drilling near edges
- Do not overtighten fasteners (can cause cracking over time)

Key Idea

Polycarbonate is a strong, impact-resistant plastic that is ideal for protective and lightweight structures in FRC. Proper drilling and fastening techniques are important to prevent cracking and extend part life.

SRPP (Glass-Filled Polypropylene)

SRPP is a **glass-filled polypropylene sheet material** commonly used in FRC, often supplied or popularized through vendors like West Coast Products.

What It Is

SRPP is a reinforced plastic made from:

- Polypropylene base material
- Glass fiber reinforcement

This combination makes it significantly stronger and stiffer than standard plastic sheet.

Why FRC Teams Use SRPP

SRPP is used because it:

- Is lightweight compared to aluminum
- Has good stiffness for a plastic material
- Is impact resistant and durable
- Does not crack as easily as brittle plastics
- Is easy to cut and machine

Common Applications

- Robot structural plates
- Mounting plates and brackets
- Intake side plates
- Lightweight gearbox or mechanism plates
- Non-metal structural components

Manufacturing Notes

- Don't cut it with the CNC, use the laser cutter instead.

- Drills cleanly with proper speed and sharp bits if you heat up the edges with the flamethrower afterwards.
- Works well with bolts and rivets if you use large washers

Limitations

- Not as strong as aluminum in high-load structural areas
- Can flex under heavy drivetrain loads
- Edge quality matters for strength (avoid rough cuts)

Key Idea

SRPP is a lightweight, glass-filled plastic sheet material used in FRC as a strong alternative to aluminum plates in lower-to-medium load applications, especially where weight savings matter.

Plywood

Plywood is a layered wood composite made by pressing thin sheets of wood veneer together with alternating grain directions. This structure gives it strength and resistance to cracking compared to solid wood.

Why FRC Teams Use It

Plywood is used because it:

- Is strong and relatively stiff for its weight
- Is easy to cut, drill, and shape with basic tools
- Holds fasteners reasonably well
- Is inexpensive and widely available

Common Use in FRC

Plywood is primarily used as **bumper backing**, where it:

- Provides a rigid structure for bumper assemblies
- Helps maintain bumper shape during impacts
- Supports mounting hardware that attaches bumpers to the robot frame

---

Material Notes

- Typically 3/4" thick in FRC applications
- Grain layers are oriented for strength in multiple directions
- Works best when edges are sealed or protected

Limitations

- Can crack or splinter if overloaded or poorly drilled
- Heavier than many modern composite materials
- Sensitive to moisture if left unsealed

Key Idea

Plywood is a strong, low-cost composite material used in FRC for structural support in bumper systems, where rigidity and durability are more important than weight savings.

When to use which material

Each material used in FRC has distinct mechanical and manufacturing properties that determine how it behaves under load, during machining, and in real-world robot use.

6061-T6 Aluminum

- High strength and stiffness
- Excellent machinability
- Holds tapped threads well
- Maintains shape under load with minimal flex
- Can be anodized for corrosion resistance

5052 Aluminum

- High ductility (bends without cracking easily)
- Lower strength than 6061-T6 in rigid structures
- Very good fatigue resistance in sheet form
- Poor thread-holding capability compared to 6061
- Excellent for forming and sheet fabrication

Polycarbonate

- Extremely high impact resistance (does not shatter)
- Flexible and can bend significantly before failure
- Transparent, allowing visibility through panels
- Sensitive to heat during machining
- Crack-resistant compared to brittle plastics like acrylic

SRPP (Glass-Filled Polypropylene)

- Lightweight with moderate stiffness
- High vibration damping compared to metals
- More rigid than standard plastics due to glass fill
- Low density relative to aluminum
- Good fatigue resistance in sheet applications

Steel

- Very high strength and hardness
- Excellent wear resistance
- High density (heavy compared to aluminum)
- Maintains shape under extreme loads
- Can be heat-treated for increased hardness

Plywood

- Cross-laminated structure resists splitting
- Good stiffness for its weight
- Anisotropic (strength depends on grain direction)
- Absorbs impact energy without immediate fracture
- Sensitive to moisture and environmental conditions

Key Idea

Each material behaves differently under stress, machining, and impact. Understanding these unique properties allows FRC teams to choose the right material for strength, weight, flexibility, and durability requirements.

Sheet Thickness

Sheet materials in FRC come in standard thickness increments. These increments strongly affect stiffness, weight, and how parts behave under load.

Common Sheet Thickness Increments

Most sheet materials (aluminum, polycarbonate, plastics) are typically available in:

- 1/16"
- 1/8"
- 3/16"
- 1/4"
- 3/8"
- 1/2"

These standard sizes are what most FRC designs are based on.

How Thickness Affects Strength

1/16"

- Very lightweight
- Low stiffness
- Easily flexes under load
- Best for light covers or non-structural panels

1/8"

- Common general-purpose thickness
- Balanced stiffness and weight
- Good for gussets and light structural plates

3/16"

- Noticeably stiffer than 1/8"
- Better resistance to bending and vibration

- Heavier, used for more loaded structures

1/4"

- High stiffness and strength
- Strong resistance to impact and bending
- Significant weight increase
- Used for structural or high-load plates

3/8"

- Very rigid
- Used in rare high-load or specialized applications
- Often heavier than necessary for most FRC robots

1/2"

- Extremely stiff and strong
- Minimal flex even under high load
- Very heavy for robotics use
- Typically only used for specialty mounts or extreme-load components

---

Key Strength Idea

Thickness has a non-linear effect on stiffness:

- Small increases in thickness produce large increases in rigidity
- A 1/4" plate is significantly more resistant to bending than a 1/8" plate

This is why most FRC designs stay at:

- 1/8" for light structures
- 3/16" for stronger plates
- Only going thicker when absolutely necessary

Material Interaction

Thickness also depends on material type:

- Aluminum → efficient strength-to-weight
- Polycarbonate → remains flexible even when thick
- Plastics → stiffness depends heavily on reinforcement
- Steel → very strong even at thin sections

Key Idea

Sheet thickness increments determine structural behavior more than most other design choices. In FRC, teams minimize thickness whenever possible and only increase it when load or rigidity demands it.