

## BMX Materials Part I

This month we will take a look at materials commonly used in BMX components. Many times I find in talking to fellow BMXers that there are some common misconceptions that these consumers have about the materials manufacturers use in their products. I will show you the facts about these materials and explain the differences.

I am going to show you the details behind 3 commonly used BMX Materials:

Aluminum  
Steel  
Titanium

Here are some definitions to explain what we are talking about.

**Density** is a measure of how heavy a material is within a certain size (volume). This is expressed as (grams/cubic centimeter, g/cc) or (pounds/cubic inch, lb/in<sup>3</sup>). It does not change for material grade or heat treat.

**Yield Strength** is a measure of a point of material failure. It is expressed in units of pressure (Pascal Pa) or (pounds/square inch, psi). Yield strength is very dependant on the material grade and heat treat.

**Modulus of Elasticity** is a measure of how springy (Flex) the material is. It is also expressed in units of pressure (Pascal Pa) or (pounds/square inch, psi). It does not change for material grade or heat treat.

**Strength to Weight Ratio (STWR)** Yield strength divided by the density.

### Aluminum:

Density = 2.81g/cc (0.102 lb/in<sup>3</sup>)

Modulus of Elasticity = 71,700,000,000 Pa (10,400,000 psi)

7075-T6 Yield Strength = 503,000,000 Pa (73,000 psi)

6061-T6 Yield Strength = 255,000,000 Pa (37,000 psi)

7075-T6 STWR = 715,686

6061-T6 STWR = 362,745

Aluminum is a commonly used material due to its ease of machining, cost and moderate strength. The grade makes a big difference in strength. This is the main reason why we at Rennen use 7075-T6 in our chainrings, gears and cogs. One drawback to 7075 is that it is roughly twice the price of 6061, this should not be a surprise as it is superior in strength.

**Steel (grade 4130):**

Density = 7.85 g/cc (0.284 lb/in<sup>3</sup>)

Modulus of Elasticity = 205,000,000,000 Pa (29,700,000 psi)

Yield Strength = 779,000,000 Pa (113,000 psi)

4130 STWR = 397,887

4130 is a commonly used material for BMX frames due to its, low cost and high strength. Yield strength numbers for 4130 steel vary greatly due to many different heat treatments available. Numbers that I have presented above are for a relatively high strength heat treat, although density and modulus do not change.

**Titanium (grade 6AL4V):**

Density = 4.43 g/cc (0.160 lb/in<sup>3</sup>)

Modulus of Elasticity = 113,800,000,000 Pa (16,510,000 psi)

Yield Strength = 880,000,000 Pa (128,000 psi)

6AL4V STWR = 800,000

Titanium is usually a high cost upgrade for BMX components, but as you can see it has many benefits. It is lighter than steel but about the same strength. It will also flex more than steel for the same geometry. In addition it is heavier and a lot stronger than aluminum. The biggest drawback to titanium is cost. On average, it is 4 times more expensive than aluminum and 10 times more expensive than steel.

What can we learn from this?

1. From the data presented we can see that Aluminum (6061) and Steel have the same STWR . This explains why so many BMX frames have been floating around the same general weight whether it be steel or aluminum.
2. Titanium is twice the STWR of steel or aluminum (6061), but again the problem is price, are we ready to pay 4-10 times more?
3. 7075-T6 Aluminum also has twice the STWR of steel. Problem here for frame manufacturers is that 7075 cannot be welded.
4. Titanium is lighter than steel but about the same strength. It will also flex more than steel for the same geometry of the part.

I hope you enjoyed the article, next month I will show you an experiment in which we will visually see the differences between these materials.