Aluminum 7075: The Peak of Static Strength

Aluminum 7075 represents the pinnacle of strength in commercially available aluminum alloys. Belonging to the 7xxx series, its primary alloying element is Zinc (Zn), supplemented by Magnesium (Mg) and Copper (Cu). This combination facilitates the formation of η' ($MgZn_2$) precipitates, which create immense lattice strain and blockage of dislocation movement, resulting in tensile strengths comparable to many structural steels.[7]

Originally developed for the Imperial Japanese Navy (as Type Extra Super Duralumin) and later standardized in the US, 7075 remains the material of choice for "maximum strength" applications.[14]

Chemical Composition Analysis

The chemistry of 7075 is aggressive, with high solute content leading to its strength but also contributing to its limitations in corrosion resistance.

Element	Weight Percentage (%)	Comparison to 6061
Zinc (Zn)	5.10 – 6.10	Primary strengthener; significantly higher than 6061.
Magnesium (Mg)	2.10 – 2.90	Higher than 6061; works with Zn for age hardening.
Copper (Cu)	1.20 – 2.00	Improves strength/machinability; reduces corrosion resistance.
Chromium (Cr)	0.18 – 0.28	Grain structure control; aids in SCC resistance.
Iron (Fe)	Max 0.50	Impurity.
Silicon (Si)	Max 0.40	Impurity in 7xxx series.
Titanium (Ti)	Max 0.20	Grain refiner.
Manganese (Mn)	Max 0.30	Minor strengthener.
Aluminum (Al)	Remainder (87.1 – 91.4)	Lower percentage than 6061 due to high alloying

Mechanical Properties

The **T6** (or **T651**) temper provides the maximum static strength. 7075-T6 is renowned for having a strength-to-weight ratio that eclipses almost all other engineering metals.

Property	7075-T6 / T651	Comparison to 6061-T6	Unit
Ultimate Tensile Strength	**572 (83)**	~1.85x Stronger	MPa (ksi) [5]
Yield Strength	**503 (73)**	~1.82x Stronger	MPa (ksi) [10]
Shear Strength	**331 (48)**	~1.60x Stronger	MPa (ksi) [10]
Elongation at Break	11%	Less Ductile	% [5]
Hardness (Brinell)	**150 HB**	~1.6x Harder	HB [5]
Fatigue Strength	**159 (23)**	~1.65x Higher	MPa (ksi) [10]
Modulus of Elasticity	71.7	Slightly Stiffer	GPa [10]

Insight: While 7075-T6 offers immense strength, it comes with reduced ductility (11% elongation) and fracture toughness compared to 2024 or 7050. This makes it more notch-sensitive. In applications involving shock loading or thick sections where quench sensitivity is an issue, 7075 may be inferior to 7050.

Processing Characteristics

- **Machinability:** Rated "Fair" to "Good." Despite being harder (150 HB), 7075 machines beautifully because it is brittle enough to break chips cleanly. It allows for high-speed machining with excellent surface finishes, although tool wear will be accelerated compared to 6061.
- **Weldability:** Poor. 7075 is generally considered unweldable by fusion methods (TIG/MIG) due to severe hot cracking and micro-segregation of the Zn-Mg phases. Welding significantly degrades its mechanical properties.
- **Corrosion Resistance:** Average to Poor. It is susceptible to exfoliation and stress corrosion cracking (SCC). It is often specified with an anodic coating or as "Alclad" (though less common than Alclad 2024) to prevent environmental degradation.

Applications

- **Aerospace:** Upper wing skins (compressive loads), fuse parts, gears, and shafts.
- **Recreational:** Rock climbing carabiners, high-end bicycle sprockets, tent poles.
- **Defense:** M16 rifle receivers, missile components.
- **Tooling:** Injection molds and blow molds (due to high thermal conductivity relative to steel and high hardness).