Aluminium Characteristics & Applications

Origins of Aluminium

Aluminium is a metallic element that comes from the ore bauxite. Aluminium is one of about I 00 basic elements out of which the physical universe is built. In other words, it was created billions of years ago when the whirling clouds of hydrogen under constant pressure with electro-magnetic forces collided to form new elements. When Earth's mass cooled, aluminium mixed with water and oxygen to form the original matter from which bauxite is made. Bauxite is named after Les Baux, France, where it was discovered in 1821.

Converted to aluminium by modern processes, it becomes a light metal which can be given great strength by alloying with other metals. It is inherently corrosion-resistant, conducts heat and electricity, yet can be processed to reflect light and radiant energy. Aluminium is classified non-toxic. It is non-magnetic. It can be formed by all known metalworking processes. Its intrinsic properties make it able to be used in many circumstances where other materials would not be considered.

Alloy	Characteristics	Available Forms	Applications
6060	Suitable for intricate sections of light and medium strength. Forms well in T4 temper. High corrosion resistance, good surface finish, anodises well.	All shapes, tubing and rod.	Architectural extrusions such as glazing bars, windows frames and general purpose extrusions.
6082	Recommended alloy for structural purposes. Good strength and general corrosion resistance. Good weldability.	Structural shapes of all types, rod, bar and tube, offered in T6 temper.	Vehicles, bridges, roof trusses and general structural applications.
6106	Light structural alloy. Designed to provide optimum mechanical properties, complexity of shape, minimum section thickness and good surface finish. Good corrosion resistance, weldability and formability.	Thinner structural shapes, rod, bar and tubing.	Light structural applications, where surface finish is important. Marine, transport applications.
6261	Special purpose structural alloy. Good surface finish and corrosion resistance. Good formability in T4 temper. Good weldability.	Structural shapes of all types, rod, bar and tube, offered in T6 temper.	Structural applications where surface finish is important. Marine, transport applications.
T4	Medium structural alloy. Good extrusion characteristics with good surface finish.	Structural shapes of all types, rod bar and tube offered in T5 temper.	Medium structural applications, where surface finish is important. Marine, Transport applications.
T5	Special purpose structural alloy. Good surface finish and corrosion resistance. Good formability in T4 temper. Good weldability.	Structural shapes of all types, rod, bar and tube, offered inT6 temper.	Structural applications where surface finish is important. Marine, Transport applications.
T6	Recommended alloy for structural purposes. Good strength and general corrosion resistance. Good weldability.	Structural shapes of all types, rod, bar and tube, offered in T6 temper.	Vehicles, bridges, roof trusses and general structural applications.

Properties

WEIGHT

The specific gravity of aluminium is 2.7, about one-third that of iron (7.9) and copper (8.9). The weight to strength ratio of aluminium makes it an ideal construction material for the transport industry - air, sea, road and rail - where its light weight contributes to energy saving, increased load capacity and speed. Aluminium is also used in large-scale construction of high-rise buildings, power transmission cables and towers.

CORROSION RESISTANCE

When aluminium is exposed to air, a thin oxidised film forms on the surface, which helps to protect the metal from further corrosion. Anodising treatment enhances corrosion resistance, and is used in building construction, joinery, household appliances and utensils.

SURFACE ENHANCEMENT

Aluminium can be thermoset powdercoated or electrochemically anodised surface treated for enhanced protection and appearance. A wide range of colours are available. Aluminium is thus widely used for interior and exterior cladding of buildings and vehicles, and the fabrication of household and commercial appliances.

Sheet Specifications

ALUMINIUM 5005 H34

Aluminium alloy 5005 is a medium strength alloy with very good resistance to atmospheric corrosion and very good weldability that is highly suitable for decorative anodising. Whilst alloy 5005 is suitable for anodising, streaks can occur - if the finish you are seeking is critical, please specify 'special anodising quality' at time of order.

Temper Type

ALUMINIUM 5052 H32

Aluminium alloy 5052 in H32 temper has very good corrosion resistance to seawater and marine and industrial atmosphere. It also has very good weldability and good cold formability. It is a medium to high strength alloy with a strength slightly higher than 5251 and a medium to high fatigue strength.

ALUMINIUM 5083 H321/116

Aluminium 5083 is known for exceptional performance in extreme environments. 5083 is highly resistant to attack by both seawater and industrial chemical environments.

Alloy 5083 also retains exceptional strength after welding. It has the highest strength of the non-heat treatable alloys but is not recommended for use in temperatures in excess of 65ºC.

Alloy	Properties	Application	
5005-H34		• Buildings – roofing, cladding, corrugated sheet, signage, road signs & name plates • Food & chemical equipment	• Furniture • Anodised parts • HVAC equipment • Packaging • Pipe & tube • Can bodies
5052-H32	• Decorative finish • Hard-wearing • Non-slip • Corrosion-resistant • Low maintenance • Anti-static • Lightweight	• Treadplate • Boiler making • Containers • Name plates • Road signs • Architectural Paneling	• Welded tubes • Chemical industry • Irrigation • Desalination units • Pressure vessels • Rivets
	• Very good corrosion resistance to seawater, marine, & industrial atmosphere • Excellent weldability • Good cold formability • Medium to high strength/fatigue strength • Decorative finish • Hard-wearing • Non-slip • Corrosion-resistant	• Treadplate • Boiler making • Containers • Nameplates • Road signs • Architectural panelling • Welded tubes	• Chemical industry • Irrigation • Desalination units • Pressure vessels • Rivets
5083		• Shipbuilding • Rail cars • Vehicle bodies • Tip truck bodies • Mine skips and cages • Pressure vessels	

Tolerances & Mechanical Property Limits

Applicable manufacturing tolerances are those set out by the Aluminium Development Council of Australia Ltd (ADCA) in Aluminium Standards, Data and Design: Wrought Products (First Edition 1994). Invariably, tolerances for an individual geometric shape are subject to negotiation and agreement between extruder and customer. Under this provision, the function of the shape in its specific application is given priority consideration. All manufacturing tolerances are subject to review from time to time.

DIMENSION TOLERENCES[1]

Cross-sectional metal dimension[2] (mm)	ADCA Tolerance (mm)
Up to 3	0.15
3 to 6	0.18
6 to 12	0.20
12 to 20	0.23
20 to 25	0.25
25 to 40	0.31
40 to 50	0.36
50 to 100	0.61
100 to 150	0.86
150 to 200	1.12
200 to 20	1.37

I. Dimensional tolerances are rounded down to the nearest 0.05mm because all calipers used to measure metal dimensions are almost universally graduated at intervals of 0.05mm
2. Metal dimensions refer to solid metal dimensions or any measurement unbroken by a gap or void. For tolerances across gaps or voids refer to ADCA Standards.

USEFUL FORMULAE

Nominal mass (kg/m²) of extruded aluminium:

Calculate cross-section area (mm²) and multiply by 0.00271

Factor

Difficulty of Extrusion Factor:

Calculate the perimeter of the section (for hollow sections, both outside and inside perimeters) and divide the result by the nominal mass (kg/m) of the section.

Weight of Billet

Billet, 178mm diameter - Imm = 0.0666 Kg

Billet, 202mm diameter - Imm = 0.0875 Kg

MECHANICAL PROPERTY LIMITS - EXTRUDED PRODUCTS

Cross-sectional metal dimension[2] (mm)	Thickness (mm)[3]		Tensile Strength (MPa) (mm)		
	Over	Up to	Ultmate minimun	Yield minimun	Elongation[4,5] % min in 50mm or 5.65√-A
1350 - H112		All	60	-	23
6060 - T5		12.0	150	110	8
	12.0	25.0	145	105	6
6106 - T6		10.0	235	210	8
	10.0	25.0	205	170	8
	25.0	150.0	185	160	10
6005A - T5		All	260	240	8
6261 - T6		All	295	255	7
6082 - T6		20.0	295	255	7
	20.0	150.0	310	270	7

3. The thickness of the cross-section or wall thickness from which the tension specimen is taken determines the applicable mechanical properties.
4. For material of such dimensions that a standard test specimen cannot be taken, or for material thinner than 1.6mm the test for elongation is not required.
5. A = specimen cross-sectional area.
6. These yield strengths are not determined nor guaranteed unless specifically requested.

Source: Aluminium Standards, Data and Design: Wrought Products (ADCA First Edition 1994).

Cleaning Aluminium Surfaces

Aluminium has natural beauty and lustre of its own, yet its surface can be treated in various ways to protect and enhance its appearance, which can be maintained with regular, low-maintenance attention.

The surface of fabricated aluminium, whether untreated, anodised or coated, can be spoiled by improper care. Here, we briefly summarise the methods of maintaining good appearance of aluminium surfaces after installation. Usually this care is no more than periodic cleaning, as in e.g. : window glass. Anodising treatment will substantially enhance appearance, render the surface more resistant to various forms of attack and facilitate cleaning and maintenance.

The Architectural Aluminium Fabricators' Association of New Zealand has published a guide which deals with all aspects of design and use, care and maintenance. Here we only briefly highlight the cleaning aspect since it applies to so many users of architectural aluminium products.

Grime which causes deterioration cannot be prevented from settling on exposed surfaces. If cleaned reasonably frequently then the mildest methods of washing will produce satisfactory results. There are many ways to clean aluminium, from using plain water to harsh abrasives. The type of cleaning that should be used is governed by the finish, degree of soiling, and the size, shape and location of the surface to be cleaned. The mildest method possible should be used, particularly for aluminium which has been anodised.

With anodised aluminium, surface deterioration occurs as a result of grime deposition and contaminated moisture attack. In coastal environments it is caused by airborne chlorides, in industrial or urban environments by sulphur compounds. Grime deposits absorb contaminated moisture like a sponge, assisting attack on the film, which cannot be restored without removal. Cleaning frequency depends on accessibility and environmental severity. In rural areas, cleaning may be needed only every six months. In industrial and marine environments, cleaning is recommended at least every three months, preferably monthly.

The following cleaning materials and procedures are listed in order from mild to harsh. The mildest treatment should be tried on a small area and if not satisfactory only then should the next be examined:

1. Plain water
2. Water with mild soap or detergent
3. Solvents, eg: kerosene, turpentine, white spirit.
4. Non-etching chemical cleaner
5. Wax-based polish
6. Abrasive wax
7. Abrasives

After applying cleaning agents, the surface should be washed down thoroughly and dried with a clean cloth to prevent streaking. There should be no concentration of cleaning agents at the bottom edges of the aluminium. If using proprietary cleaning solutions, manufacturers' recommendations should be obtained and followed carefully.

If abrasives are used, the appearance of the aluminium finish may be altered. If there is a grain in the finish, cleaning action should always be with the grain. If the condition of the surface indicates the use of abrasive or etching materials, it is advisable to consult a cleaning specialist. If all other methods fail it may be necessary to resort to heavy-duty cleaning. This involves cleaning methods using strong etching chemicals or coarser abrasives.

Handling & Storage

MACHINABILITY

Aluminium can be easily fabricated into cast or forged shapes, foil, sheet, rod, tube and wire. Considered to be the best material for complex-sectioned hollow extrusion, it also displays excellent machinability and plasticity in bending, cutting and drawing.

STRENGTH

The tensile strength of pure aluminium is not high, but depending upon the alloy or temper, a strength of up to 60 kg/mm2 can be achieved. You can choose the alloy with the most suitable strength characteristics you need according to your application. Some alloys are stronger than ordinary steel or even equal to special (alloy and treated) steels in tensile strength. While steel becomes brittle at low temperatures, aluminium increases in tensile strength. Because of its low modulus of elasticity, aluminium absorbs impact and is used in potentially high-impact applications such as automobile bumpers.

EXPANSION

Aluminium extrusions have a comparatively high coefficient of expansion which is 0.000023mm per mm length of extrusion per °C. A length of aluminium extrusion 6m long will expand over 4mm when the temperature rises 30° C. When designing, especially building design, provision should be made for expansion and contraction caused by temperature changes. Thermal expansion is particularly important where aluminium extrusions are used with other materials having different expansion rates.

ELECTRICAL CONDUCTION

The electrical conductivity of aluminium is approximately 60% of copper yet about one-third the weight. Aluminium is a very economical material as an electrical conductor and is widely used in power-transmission cables, bases of electric bulbs and other electrical applications.

HEAT CONDUCTION

Aluminium is about three times as thermo-conductive as steel. It is used for cooking utensils, air-conditioners, industrial heat exchangers, automobile engine parts and solar energy collectors.

MAGNETIC SENSITIVITY

Aluminium is non-magnetic and is used where the use of magnetic metals would be detrimental to equipment performance, such as compasses, parabolic antennae, computer disks and other magnetically driven applications.

REFLECTIVITY

The surface of uncoated aluminium is highly reflective of light, radiant heat and electronic waves - the purer the metal, the more so. This feature is utilised in mirrors and reflectors for stoves, infrared dryers, lighting equipment, light-wave-guides and in building temperature control.

RECYCLABILITY

Owing to its low melting temperature, aluminium is economically recyclable, requiring only about 3.5% of the energy required for smelting. Use of recycled aluminium has benefits for all concerned with conservation of energy and natural resources.