

ALUMINIUM IN ARCHITECTURAL APPLICATIONS

Aluminium could be described as the material that has revolutionised modern construction. It is light, strong, rigid and can be extruded in complex shapes to extremely close tolerances. It is inherently corrosion resistant and can be easily treated to enhance this resistance for adverse conditions. It can be finished in a wide variety of permanent colours. It is an abundant mineral resource which is processed with minimal environmental impact and is fully recyclable.

While aluminium can be used for exterior cladding panels, ducting, ceilings and innumerable fittings and fixtures, its most visible application on most buildings is as curtain walls, windows and door frames. With few exceptions, aluminium is the material of choice for joinery applications.

In choosing joinery material, the range is generally limited to wood, steel, PVC and aluminium. These can be classified according to strength, durability and stability, thermal transmission, finish and ease of manufacture.

Table 1 compares the tensile strengths of aluminium, wood and vinyl (PVC)

Table 1
Tensile Strength

Material	MPa	psl
Aluminium	150	21,750
Wood (across grain)	3.47	504
Vinyl (PVC)	44	6,400

The values show that aluminium is 3.4 times stronger than vinyl, and 43 times stronger than wood.

Values are in MPa (Megapascals) and in psl (pounds per square inch). Materials compared are aluminium alloy 6063 T5 temper (the alloy used for aluminium windows). Ponderosa pine in air-dry condition and vinyl profile compound Geon 87416.

Table 2 compares the rigidity and resistance to bending of aluminium, wood and vinyl (PVC)

Table 2
Modulus of Elasticity (E – value)

Material	MPa	psl
Aluminium	68,965	10,000,000
Wood (across grain)	9,517	1,380,000
Vinyl (PVC)	2,965	430,000

Values are in MPa (Megapascals) and in psl (pounds per square inch). Materials compared are aluminium alloy 6063 T5 temper (the alloy used for aluminium windows), Ponderosa pine in air-dry condition and vinyl profile compound Geon 87416.

Strength

Aluminium ranks behind steel for strength and stiffness in absolute terms but its ability to be extruded into complex shapes means that maximum advantage can be taken of its strength with the minimum use of material. Steel, by comparison, is generally restricted to simple rolled or pressed shapes, which tend to be heavy or bulky.

Wood and PVC are considerably weaker than either metal. Designs tend to be rather bulky to attain the strength necessary for even quite modest joinery elements. For large spans, such as shopfronts, curtain-wall mullions, wood and PVC sections must either be impossibly large, or combined with reinforcing members to attain the necessary strength to match all metal designs.



Use and misuse of Aluminium

Durability and Stability:

Aluminium ranks as the number one material. Stability is defined by Webster's Dictionary both as "firmness" and "resistance to chemical change or physical deterioration".

Durability is defined as "the ability to last a long time without significant deterioration". These two properties are precisely the reason why aluminium is so superior to the other two common window construction materials, vinyl (PVC) and wood.

Physical properties – In the original state, aluminium is an inorganic, homogeneous material. Vinyl (PVC) and wood are both organic materials. Under normal conditions, mill finish aluminium forms a self-healing layer of oxide which seals

the metal surface from further corrosion. Extra protection is given by anodising and powder-coat pre-treatment. Washing under a normal building maintenance programme is sufficient to remove the usual build-up of dirt and environment pollutants which might affect the metal. Good design can minimise or negate the effects of adverse climates and local hazards, such as salt-water.

Aluminium is indefinitely stable, under all foreseeable climatic conditions. It will expand and contract, in a totally predictable way but retain its integrity and strength. PVC by comparison, softens with heat and hardens with cold and ultimately is embrittled with age and exposure to UV from sunlight. Timber is subject to attack by insects and fungus unless thoroughly pre-treated and requires constant maintenance to protect it from weather and to maintain its appearance. Timber is also, subject to unpredictable movement with changes of climate. Steel is similar in stability to aluminium but requires meticulous attention to rust-proofing during fabrication and regular, often expensive maintenance to preserve its appearance and the integrity of the corrosion barriers, even under mild conditions.

Finish:

In this respect, aluminium stands head and shoulders above its competitors. Aluminium extrusions generally exhibit excellent surface characteristics, enhanced by anodic or powder-coated finishes in a very wide range of colours and in some cases, textures. With modern techniques and good quality control, surface finishes can be expected to last 30 years or more.

Surface cleaning is achieved with water and detergent: regular cleaning will maintain the "as new" appearance for decades.

PVC is "self-colour"; the colour is fully through the material. The colour is very limited, and due to the nature of the pigments used, darker colours will continue to degrade with age and exposure to UV radiation in sunlight. Wood continues to be difficult to finish: paints need regular renewal, which is a time-consuming and expensive process outside of the factory environment. Steel finishes similarly need periodic replacement: the process is made more difficult if the primary corrosion barrier (usually zinc) is damaged and rusting has begun.

Thermal Transmission:

This factor has become increasingly important as energy costs continue to rise and climate-controlled buildings become the standard. Heat loss (or gain) can be a substantial cost over the working life of a building but can be largely controlled through careful design. In this respect, metals perform badly, with the thermal conductivity of aluminium being the highest of the four basic materials. However, design techniques exist to thermally break window systems with plastic or resin barriers within the sections, without loss of structural strength. It is worth noting that all materials conduct heat to some extent and that heat transference through glass is vastly more significant than that through frames. With the use of high-performance insulation double-

glazing, thermal breaking of frame members become more important, however.

In summary, We can say that no single material is ideal for all purposes, but on balance, the positive features of aluminium make it the material of choice for almost all joinery applications. It is made from an abundant mineral resource and is recyclable. It gives the designer wide scope for mechanical innovation and can be finished in a very large range of longlasting colours. In short, it provides cost-effective and aesthetically pleasing solutions in architectural applications.

Powder-coated or anodised

If the question is asked, what surface finish is best-anodising/powder-coating, the answer will be "it depends". The factors which contribute to this non-committal answer and which you need to think about before making your choices are:

- What colour do you want ?
- How glossy do you want the surface to be ?
- How much is the surface going to be exposed to the sun and will colour change matter ? and
- What chemicals are in the air in the particular environment ?

As far as colour is concerned, the anodising range is typically light bronze-medium, bronze-mark, bronze-black and natural silver. Other colours are generally only used for internal work and are not recommended.

So if a blue, red or yellow finish, for example, is required, you will be more likely to choose a powder-coated window and if you want a high-gloss finish in any colour you almost certainly want a powder-coat.

Powder-coatings however are like any other paint coating – given strong exposure to the sun they will 'chalk' and can fade slightly. The manufacturers recommend regular maintenance procedures to counter this.

It is impossible to simply tell an enquirer which finish is best – it comes down to the designer or building owner making a choice, based on aesthetics and maintenance considerations rather than on the performance of the window itself.

Sea-salt deposited by the wind and not washed off by rain or through routine maintenance washing can be very damaging to aluminium windows. Examples of attack on anodising – especially along the sharp edges of extrusions have been seen – on parts of window sheltered by overhanging eaves. Provided they are applied properly, powder-coatings are less troubled by this, although even they are not completely free of degradation along sharp edges. Both powder-coating and anodising can be high-performing finishes. Both require factory application and the critical step is the surface preparation before the coating is applied. Purchasers should insist that the product has been prepared to one standard or a recognised equivalent.

Regular Maintenance:

Powder-coated surfaces – should be cleaned as frequently as necessary to prevent dirt building up. Usually this will only require clean water but more severe contamination can be removed with warm water, detergent and a soft brush.

Anodised surfaces – can be cleaned with a dry soft cloth, or a soft brush and clean warm water. Solvent cleaner (such as kerosene and white spirits) can be used to remove paint, joint sealant or roofing compounds and very heavy deposits can be removed with an abrasive wax or stainless steel wool. A wire brush should never be used.

Reasonable minimum cleaning frequencies for anodising aluminium have been suggested as:-

Environment	frequency
Rural and Unpolluted Urban	6 monthly
Polluted Urban	3 monthly
Industrial, Heavily-polluted Urban and Marine	Monthly

L. R. Goonatilake

Gordon Frazer and Co. Ltd.

*"The 'environment' does not lend itself to simple right-or-wrong selection criteria of materials."
Stuart Johnson (1993)*

*"Where space is restricted the design of that space becomes all important ... where materials are limited, use of proper and appropriate materials become all important."
John Browns (1985)*