Kalzip

Durability of aluminium

Technical Information

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General

All building materials are eventually degraded by weathering, corrosion, rot and decay. Aluminium's natural ability to resist these influences better than many materials is one of its most widely appreciated features. In its unprotected "mill finish" form aluminium is used very successfully for long-life everyday products such as ladders, greenhouses, lamp standards, boats, aeroplanes and hollowware.

In the building industry aluminium is now a first choice wherever durability coupled with minimal maintenance are prime considerations.

It is the natural oxide skin on aluminium that provides an ever-present barrier to atmosphere attack. Inert and hard, the oxide layer protects the underlying metal, reforming spontaneously if cut or scratched. This layer, an integral part of the metal, thickens very slowly with age and darkens in time according to the amount of atmospheric pollution. Aggressive pollutants will attack the aluminium at any weak spot in the oxide, giving rise to localised pitting. Such attacks are self-stifling and performance data collected over long periods of time show that pollutant attack effectively ceases after a number of years. This behaviour of aluminium is in complete contrast to mild steel, which must be protected to prevent rapid corrosion. Even with coated steel corrosion is a potential hazard as any penetration of the applied protective layers of zinc, aluminium, paint or plastic laminate allows corrosion to spread underneath in the steel.

Atmospheric conditions and their effect on aluminium

Industrial atmospheres

The most frequently encountered industrial pollutants are sulphur dioxide and hydrogen chloride. In the presence of moisture, these gases can form acids, which may penetrate the protective aluminium oxide layer and attack the underlying metal. Such pitting attack, generally known as weathering, has been monitored and shown to reduce in time. Other industrial pollutants include ammonia, carbon monoxide and carbon dioxide, all of which have little effect on aluminium.

Coastal and marine atmospheres

Aluminium is an excellent material to use in marine environments and coastal situations. The effect of sodium chloride, the major marine atmospheric pollutant, on aluminium, is less than that of industrial pollutants.

Suburban and rural atmospheres

The level of atmospheric pollution is generally very low. Aluminium exposed to such atmospheres can have an exceptionally long life.

Urban atmospheres

The main pollutants are carbon monoxide and carbon dioxide. These pollutants have little effect on aluminium.

Rain washing

Rainwater has a beneficial washing effect on exposed aluminium surfaces.

This dilutes any pollutants resting on the metal, and washes them away, helping to preserve the durability of the aluminium.

In some areas where the aluminium is sheltered (eg beneath a soffit), it will be necessary to clean the surface periodically to remove potentially corrosive deposits.

This can be done by hosing with water, using a neutral detergent.

Historic information

The two most commonly quoted examples to demonstrate the durability of aluminium are Eros, and San Gioacchino.

The statue of Eros was cast in high purity aluminium, and erected in Piccadilly Circus in 1893. For the first half of the 20th century, London had a very highly polluted atmosphere. Furthermore, the traffic density in Piccadilly Circus was probably as high as anywhere in the world. At the time of the Coronation celebrations in 1953, the statue was cleaned. On removal of the surface grime it was found that the metal was in excellent condition, with no evidence of pitting or corrosive attack.

The cupola of the church of San Gioacchino in Rome was clad with sheet aluminium in 1897. A detailed examination of the roof was carried out in 1949; it was found that after 52 years in an industrial/urban environment the metal remained in very good condition, maximum depth of pitting was only 0.8 mm.

Both Eros and San Gioacchino are over a hundred years old; they are still in place, and their useful life will extend far into the future.

Kalzip Alclad alloy

Although aluminium is regarded as a material that will offer a long life expectancy when used as a roofing or cladding material, the unpainted Kalzip (ie stucco embossed finish) has an additional weathering layer which will give a very significant improvement in corrosion resistance. This improvement in corrosion resistance is achieved by "cladding" the base material with a sacrificial layer. The process of cladded aluminium (Alclad), which was originally developed for aircraft construction, involves an approximate 5% thick layer of AlZn1 (aluminium zinc alloy) being rolled onto the base material under high pressure and at a temperature of approximately 500°C.

Both materials are welded in the process, ie their structural components become so diffused into one another that no separating layer exists any more. The improved protection against corrosion comes from the negative potential of AlZn1 of 150 mV towards the base material of AlMn1Mg1.

In the event of damage to the oxide film of the outer skin, or at cut edges, or drilled holes, the "cladding" protects the purer base material electrochemically.

Upon appearance of an aggressive medium the AlZn1 layer "sacrifices" itself as anodes thereby allowing the functioning of the cathode material AlMn1Mg1 to remain intact.

Tests carried out by the Federal Material Testing Institute (BAM), Berlin, shows that any pitting corrosion that takes place is restricted to the cladded layer thereby extending the life expectancy of base material far beyond normal expectations.

Effect of various exposure conditions on the durability of aluminium and organic coated aluminium profiled sheeting[(1)]

Detrimental action		Aluminium, plain (mill finish) and stucco embossed	Aluminium, organic coated
1	Rain, sleet, etc	Gradual change to dull metallic grey in rural areas, dark grey in industrial	Weathering varies with type of coating (see "organic coating on aluminium")
2	External attack by polluted and coastal atmospheres	Freely exposed surfaces as for "rain, sleet etc." Sheltered areas will become darker and may suffer only superficial attack	Weathering varies with type of coating and environment (see "organic coating on aluminium")
3	Ultraviolet radiation	No effect	Some colour change and chalking depending on type of coating (see "organic coating on aluminium")
4	Combustion	Only a problem when the local environment contains corrosive influences, eg combustion products. Generally paint coating the affected area gives adequate protection.	Normally no effect.
5	Temperature ranges	- 80°C to + 100°C	- 50°C to + 100°C
6	Suitable cleaning agents	Mild, neutral dilute detergents and soft brush. Wash down with clear water. Avoid strong alkaline and acidic cleaners.	As for plain aluminium.
7	Chemical attack	Certain chemicals attack aluminium under specific conditions. Design to avoid deposits remaining on sheeting and to ensure ventilation and/or protection on inside surfaces.	Avoid cement or plaster splashes during erection.
8	Abrasion	Scratched metal is not less durable than unscratched metal.	Resistance to abrasion depends on coating (Some colour change and chalking depending on type of coating (see "organic coating on aluminium")
9	Attack by bird droppings, rodents, insects, soil etc.	Generally no more than staining. Avoid the formation of wet poultices. Cinders and ash may be aggressive	As for plain aluminium

Organic coatings on aluminium[2]

Surface finish	General characteristics	Period (years) to repaint decision		
		Type of external environment		
		Coastal	Industrial and urban	Suburban and rural
Polyester **SP**	Good resistance to staining, scratching and fading in aggressive environments	5	5	10
Abrasion resistant polyester **ARS**	Surface gives good abrasion resistance. Other properties mid-way between SP and PVF_2	15	15	20
Polyvinylidene fluoride **PVF_2** **PVDF**	Very durable, good resistance to chemicals. Best gloss and colour retention, poor abrasion resistance, should be handled with care	20	20	30
NOTE: For organic coatings on aluminium, the period stated is the time elapsed until a discernible deterioration of the aesthetic appearance. Re-coating will restore the appearance. Failure to re-coat will allow continued deterioration of the appearance but will not significantly affect the ultimate life of the product/system				

Period to first maintenance[3]

Maintenance is deemed necessary when the original protective/decorative coating would otherwise breakdown and provide inadequate protection to the aluminium, or when the appearance becomes unacceptable.

Indications of the need for maintenance[4]

Organic Coatings

The breakdown of the protective or decorative paint film, in order of increasing seriousness, takes the form of chalking, cracking and blistering.

If left without maintenance at this last stage, flaking of the paint may occur and, the appearance may be unacceptable. Paints are considered to have reached the end of their expected life when maintenance painting has to be undertaken to prevent this further breakdown or to maintain appearance.

Plain Aluminium

Plain mill finish, including stucco embossed aluminium, is normally expected to last the design life of the building without maintenance. In certain exceptional conditions pitting and/or the formation of a loose deposit, particularly on the internal surface, can occur. Evidence of this normally appears shortly after commissioning, when the manufacturer should be consulted about remedial action.

References

Extracts taken from **BS 5427 Part 1 : 1996** - ***Code of Practice for the Use of Profiled Sheet for Roofing and Cladding of Buildings Part 1 : Design:***

1 Table 8 - The Effects of Various Exposure Conditions on the Durability of Profiled Sheeting Materials

2 Table D1 and D3 - Organic Coatings on Aluminium

3 Clause 3.17.3.1

4 Clause 3.17.3.2