

Emerging Applications of APC Panels as Architectural Material – An Eco-friendly Approach

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China and India are the world's biggest consumers of cement, steel and wood. Consumption of those items can be saved certainly and reduced if aluminum plastics composite (APC) sheets and allied products are used as and where it is applicable. This is an eco-friendly material, as it can be made easily from the discarded, waste or recycled items. This paper have discussed various applications, advantages and properties of APC sheets. Moreover, a comparison of APC sheet with other conventional materials is made and the uses of these materials in interior and exterior high rise buildings are also explained. Finally, the emerging applications of these materials in trains, ships, and airplane have also been mentioned.

Keywords : APC Sheet; Interior and exterior design; Emerging applications in transportation

INTRODUCTION

Each month, China needs to build an equivalent of a Houston or a Philadelphia just to keep up with population growth. Each year, Shanghai constructs or renovates 200 million square feet of building spaces, almost the same amount as all the office spaces in New Jersey. To fuel that boom, China uses more than two-fifth of the world's annual output of cement, one-third of its iron ore, one-quarter of its lead and steel, and more than one-fifth of its copper, aluminum and zinc.

Similar situation is foreseen in India too. Because, besides concrete and steel, along with China, India is the world's largest importers of wood. Together, the two countries import more than 10 million cubic meters of tropical logs per year (China: 7.3 million, India: 3 million) and still also import more timber from non-tropical countries – especially Russia¹.

Utilization of such lots of wood can not be saved but can be certainly reduced with the introduction of APC. Specially, when an image is the first priority, aluminum plastics composite panel (APC panels) provides the answer for both interior and exterior applications. Lightweight yet strong, APC is the ultimate material for today's requirements with durability to retain its sleek good looks long into the 21st century.

ADVANTAGES OF ALUMINUM PLASTIC COMPOSITE PANEL

Different advantages derived from APC panel are as

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follows²

- The design of APC conforms to the requirement of the exterior wall of high buildings, which can replace glass wall to reduce light reflection with light weight and good performance in anti-wind.
- The service life of APC is long. The surface of APC can be coated with different kind of prints, such as polyvinylidene difluoride (PVDF), the service life of which is more than 15 years.
- APC is able to meet the demand for environmental protection and fire prevention. Its principle materials include aluminum coil and PE, which can be recycled.
- APC is very easy to be given different shapes means of different tools.
- The decoration effect of APC is gorgeous and attractive with the days and better than expensive marble and other materials.

WHAT IS APC MATERIAL

An aluminum composite panel is composed by three layers. The upper layer and the bottom layer composed of high strength aluminum alloy, and the middle layer is made of a non-toxic polyethylene (PE) board. Additionally, there is a removable protective film on the surface of the aluminum composite panels for protection during transportation and assembly. The panels are available in a range of standard coil coated colors in polyethylene-terephthalete (PET) and PVDF finishes with a thickness range of 1– 8 mm. PVDF coating is made for exterior purposes, which consists of 3 layers of coating – primer, paint, and varnish. The standard thickness of panels with PVDF finishing is above 32 microns. PE coating is made

for interior purposes. This type of coating does not use the primer layer, directly applying paint on the aluminum skin. The standard thickness of PE coating is usually above 18 microns.

The raw materials being used for the production of aluminum plastic composite panel with PVDF coating are low density polyethylene, adhesive film for aluminum and PE adhesion. Aluminum coil with PVDF coating, which consists of three layers, ie, primer, paint and varnish is shown in Figure 1.

Specifications of the Various Raw Materials

- Aluminum alloy : AA1100, AA3003, AA3105, AA5005
- Thickness : 0.12-0.70mm,
- Width : 1240mm, 1270mm, 1520mm, 1570mm etc
- Maximum diameter : 1200mm
- Weight : 2.5T/ coil, 3T/coil
- Interior diameter : 505mm or 405mm
- PVDF thickness : $\geq 25\mu\text{m}$
- Gloss : meet the customer requirement
- Color standard : $E \leq 2$ or it is not obvious by eyeballing
- Pencil hardness : $\geq 2\text{HB}$
- Coating adhesive : not lower than first grade
- Impact : no crack (50kg/cm)

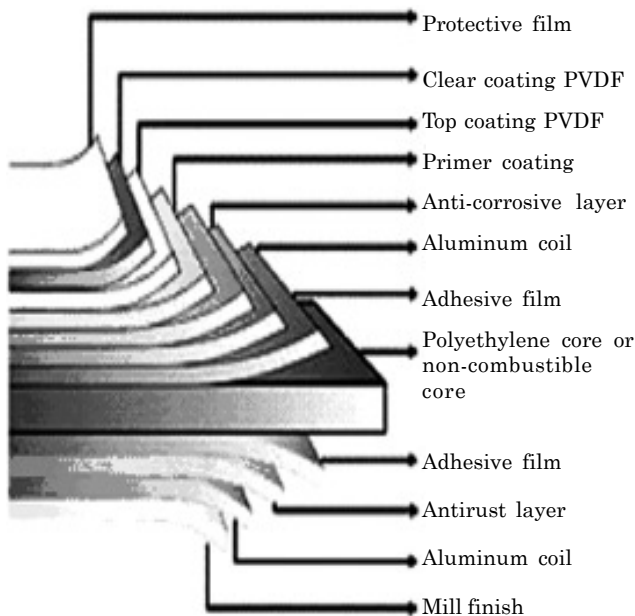


Figure 1 Raw materials used for the production of aluminun-plastics composite panel

- Boiling point : no distortion and color change (boiling in $99 \pm 1^\circ\text{C}$ water, then cooling for 2 h). Corrosive surface deeping in 5% muriatic acid and 5% NaCL, interior deeding in the 2% muriatic acid and 2% NaCL, after 48 hours, no change
- Package standard : PE plastic in interior, same width hardboard out of surface

Specification of Adhesive Film

- Thickness : 0.03mm, 0.05mm
- Content : 60%
- Composition : PE, macromolecule material
- Melting point : 90 degree
- Composite temperature : 120 degree
- Hot pressing method : heating at both sides
- Bonding working temperature : $200 \sim 210^\circ\text{C}$
- Bonding pressure : $4\text{kg}/\text{cm}^2$
- Bonding pressing time : above 30 ~ 60 s

Metal Surface Condition

- Phosphorus or Chrome metalized and degreasing handled in advance, keeping it clean from dust, moisture and impurity.

Main Characteristics

- Possesses powerful and stable adhesive property.
- Easy process and application.
- Resists boiling water.
- Temperature difference under diverse environment.

Features

- No requirements for molds and sealing tools, as it closely conforms to the product.
- Protection from rust and oxidation.
- Availability in small quantity and large variety.
- Low cost.
- Lower coefficient of friction that can protect the product.
- Easy to calculate and count.
- Capable to reduce waste.

- Tough enough, even though the needle, which stand up, can be easily packed without piercing the film.
- High speed package;
- High gloss, clarity, sparkles.

PRODUCT SPECIFICATION AND ITS PROPERTIES

- Panel thickness : 2mm to 6mm
- Standard panel size
 - Panel Width : 1220mm to 1550 mm
 - Panel Length : 2440mm to 4880 mm

Shades and Colours

Different colours and shades used in APC sheets have described in tabulated form in Table 1.

Table 1 Major colours used in general

Bright silver	Metallic gold	Champagne gold	Copper
Metallic silver	Champagne silver	Dark silver	Brown stone
Metallic bronze	Copper metallic	Pale copper metallic	Black shine
Bronze metallic	Medium bronze	Metallic	Red stone
Metallic blue	Green	Saffron yellow	Green stone
Metallic gray	Brushed aluminum	Coral red	HP blue
Orange	Pure white	Gray white	Cream stone
Broken white	Sand spark	Red stone	White stone
Lagoon blue	Sea blue	Green	Black

Table 2 Comparison of APC sheet with aluminum and steel

Al-P1 Composite Panel		Aluminum		Steel	
Thickness, mm	Weight, kg/m ²	Thickness, mm	Weight, kg/m ²	Thickness, mm	Weight, kg/m ²
3	4.5	2.7	7.3	1.9	14.8
4	5.6	3.3	8.8	2.4	18.7
6	7.3	4.5	12.2	3.2	25.0

Table 3 Properties of APC sheet

APC Sheet	Properties
Temperature resistance	From -50°C to +80°C
Temperature expansion of aluminum cover sheets	2.3 mm per linear meter for temperature difference of 100°C
Thermal expansion of the aluminum sheets	2.3 mm per 100°C
Thermal insulation	0.29W/m ² K
Dimensional tolerances	Thickness ±0.2mm, width -0, +2mm, Length -0, +4mm.
Maximum difference between diagonals	3 mm.
Operating temperature	Range -50°C to +80°C.
Sound insulation	thickness sound insulation
	3 mm 23dB
	4 mm 24dB
	6 mm 25dB

COMPARISON AND PROPERTIES OF APC SHEET

A brief comparison between APC, aluminum and steel sheet are shown in Table 2 and the major properties of the APC sheet are shown in Table 3.

APPLICATIONS OF APC PANEL IN INTERIOR

The various applications of APC sheet in interior are listed below

- Curtain wall
- Internal and external wall
- Ceiling
- Eaves
- Balcony-galleries

- Exhibitions
- Partitions
- Advertise fascia
- Showing
- Display platforms

The exterior and interior applications of APC panels are shown in Figure 2 and Figure 3.

DETAILS OF APC PANEL APPLICATIONS

The uses and applications of aluminum composite panels are manifolded, some of which are listed below³.

Architecture

Aluminum composite panel is the most versatile building material for exterior and interior uses. Examples of exterior (curtain walling and wall paneling) usages include high rise commercial, industrial, residential buildings, shopping malls, etc. Specific functions are for store canopies, shop fronts, dealer sign boards, display units, innovative furniture, partition, etc. Many developers now suffer from stained concrete, cracked masonry, falling render and other time related problems.



Figure 2 Exterior application of APC sheets

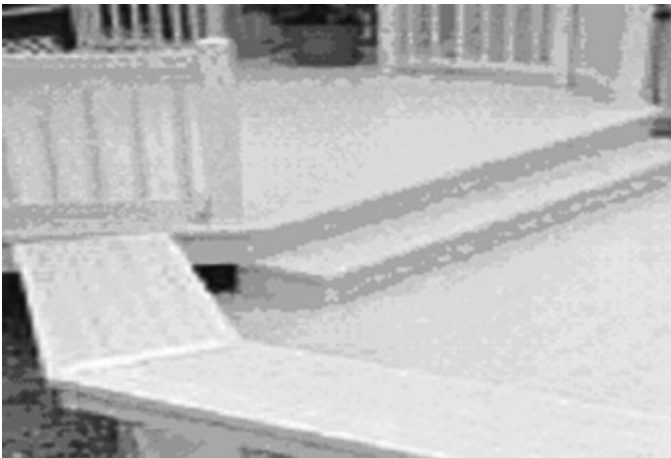


Figure 3 Interior application of APC sheets

Inevitably, this results in an unattractive appearance and a fall in commercial value. Aluminum composite panel applied over cladding system will provide a new 'skin' for the building and will improve dramatically the visual effect of an old building and restore the property's value. APC offers outstanding protection from weather and withstand the effects of industrial pollution and save energy. It is lightweight, quick to install and easy to maintain. APC is available in a range of colors and sizes.

Transport/Vehicles

These products are ideal for all types of transport cladding application because of their distinct outstanding features, namely, lightweight, strength and rigidity, sound and vibration dampening characteristics, capacity to remain flat in adverse climatic conditions, smooth pre-finished surface and easiness to fabricate. Application of APC sheets for five principle means of transport are given below and also shown in Figure 4.

Buses : Manufacturers use these products for exterior cladding, sidewalls, roof panels and air conditioning ducts.

Trucks : Bodybuilding applications include sideboards, floors, swing boards, doors and advertising sign panels.

Ships : Shipbuilders utilize the fire rating characteristics of APC for all types of interior cladding such as walls, doors, ceilings, bulkheads and floors.

Rail : Locomotive and rolling stock manufacturers take advantage of all the features of these products for ceiling panels, interior linings, floors and bulkheads.

Airports and railway stations : World-over, all modern airports are using APC for exterior and interior use. In railway stations also, the use of APC is increasing widely.

Corporate Entities

To secure and expand the market share, different commercial establishments like modern shopping centres, famous corporations, banks, supermarkets, petrol pumps, car showrooms require good infrastructure,



Figure 4 Application of APC sheets in transportations items

which also represents an identifiable and memorable architectural statement. This can be achieved with aluminum composite panel (ACP). There are tangible images, which successfully catch the customer's eye as well as his long-term attention. ACP offers a tailor made solution for every image, be it with exclusive colors or innovative surface contours.

Signs/Boards

Easy and light assembly, as well as durable weathering resistance, represents crucial advantages in the area of sign making. ACP's characteristics have no creative limits. Excellent flatness and smooth surface ensure accurate register alignment in small and large format, high-resolution half tone screen-printing without pre-treatment. Exemplary even ink coverage and adhesion is achieved whether spraying or lacquering. ACP allows fast and reliable application of vinyl with the advantage that replacement does not even leave a mark on the lacquer finish.

Display

Even when displays start to move, ACP is able to retain its shape due to outstanding rigidity. A multiplicity of three-dimensional form can be achieved by means of folding and bending of the material, which provide flexibility with additional structural strength on ACP material. Be it system stand panels, cover elements, picture backing or 3D product presenters, the dimensional stability, durability and easy processing of ACP make it mandatory for displays and exhibitions. Excellent flatness and

flawless surface finish of the material facilitate problem free lamination with adhesive foil or sprayed adhesives.

Apart from the above uses, ACP is widely used in office and decorative furniture, in the exterior decoration of equipment and machine tunnels and subway interiors, and in outdoor billboards and plates.

MANUFACTURING PROCESS

The ACP panel is composed of two of pre-finished thin sheets with and coil-coated aluminum, continuously bonded to either side of a polyethylene core, under tension at the point of bonding. The sheets are restricted by the core, retaining residual tension. The result is a superior flat, rigid, strong surface that is stable under ever-changing thermal conditions.

During manufacturing of ACP, the two materials (PE and aluminum coil) are stick together and heat is applied by means of compound roller in unique technique to attain the effect of hard separation for decoration.

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