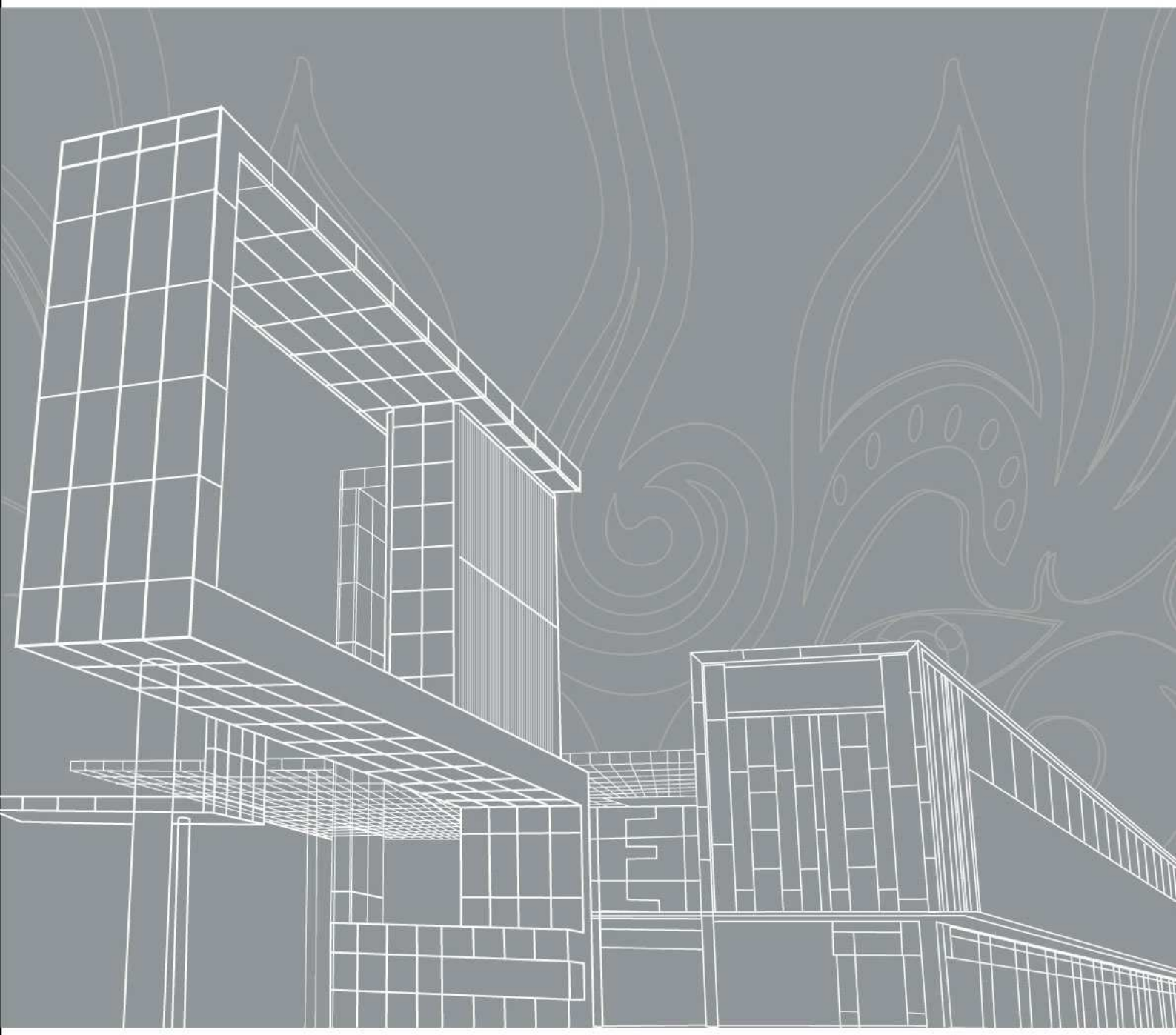
i-BOND

Aluminum Composite Panel

PIVOT

About ACP



PIVOT DECORATIVE MATERIALS CO., LTD.

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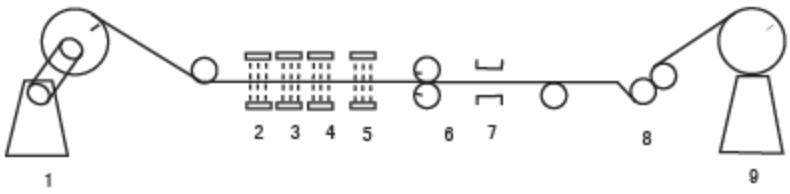
- Definition: Aluminum composite panel refers to the composite panel made of aluminum and plastic. To be specific, it is a kind of composite panel that aluminum panel and plastic core material were bonded together by special adhesive under certain process conditions. The face of aluminum composite panel was coated with ornamental coating and the back coated with protective one.

- Name: Aluminum composite panel is the name specified in national standard. It is also called aluminum composite panel, aluminum composite material, aluminum plastic panel and plastic aluminum panel etc.

Structure: As a ply of plastic core material was sandwiched between two layers of aluminum panels, aluminum composite panel can be regarded as sandwich structure. In fact, its actual structure is much more complex. The following drawing shows the typical Aluminum composite panel structure.
Aluminum panel usually adopts pure aluminum or corrosion-resisting aluminum alloy with a thickness of about 0.1-0.5mm. Panel brand and thickness is different in variety. Plastic core material adopts PVC previously and now uses PE in general. PE thickness is about 1.6-5.0mm. Chemical treatment layer is also called invert film, which is formed in pretreatment process before painting. Its function is to improve anticorrosion property of aluminum panel and to enhance adhesive force between aluminum and coating. Bonding material is made from high molecular material. Its function is to bond aluminum panel and plastic composite material. The upper surface coating is to protect top panel and for decoration. Coating brand varies according to different Aluminum composite panel brand and purpose. Transparent coating protects surface coat. Back protective coating mainly protects back aluminum panel.

Degreasing line production process drawing



1、letkff
2、paint degreasing
3、paint degreasing
4、paint washing
5、paint washing
6、roller coating formation
7、drying
8、drive
9、wrapup

Aluminum Composite Panel Introduction

Basic concept of aluminum composite panel

- 1. Acid degreasing cleaning agent is extensively used at present. This agent is prepared by mixed acid and aluminic acid degreaser. Mixed acid can't remove oil itself. It only takes increment effect on specific surface area where aluminum panel and painting contacts with each other (in favor of enhancing coating anti-adhesive force). In the mean time, the gas it generates helps mix the solution. Aluminic acid degreaser is a kind of high efficiency active agent, producing an amount of foam in stirring. The foam takes wetting, filtration and solving effects on oil stain and hence achieving cleaning and degreasing. It is to control aluminum panel degreasing and oil removal effects mainly by controlling solution concentration.
- 2、The main purpose of washing after degreasing is mainly to avoid relic oil on aluminum panel being brought to the next work order. Otherwise, it not only affects the next work order but also affects painting adhesive force (it is not easy to control formation membrane in chemical reaction in the next work order).
- 3、Use pure water for cleaning after washing. Pure water is also called deionized water, which guarantees coating quality.
- 4、Conduct invert film treatment process after pure water cleaning. Invert film treatment can improve wet ability of organic coating so as to increase special surface area, which improves aluminum panel anticorrosion property and coating adhesive property. It adopts mixed coating method in this process to ensure that invert film uniformly adheres to both upper and lower surface of aluminum panel. Invert film shall not be too thick or too thin. Both may affect coating adhesive force.
- 5、Conduct drying procedure after invert film treatment. Control drying temperature to ensure that aluminum panel surface temperature is under 100℃. If the temperature is too high, crystal water of the invert film will decompose and cracks and micropores on surface will increase, which will directly affect aluminum panel anticorrosion property and increase surface roughness. This is in favor of coating adhesive force, i.e. increasing coating adhesive force.
- 6、Cool it after drying and drive it for inspection. If qualified, wrap it up as formation final product.

Aluminum Composite Panel Introduction

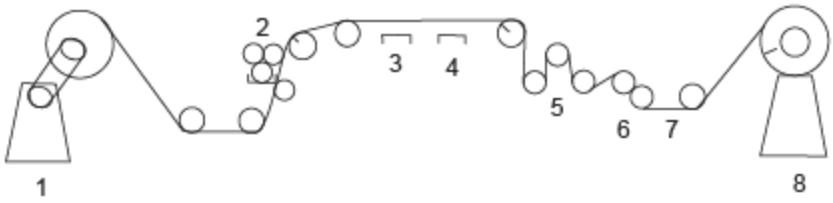
Basic concept of aluminum composite panel

Major quality problems usually occurred in formation process:

- 1. Degreasing concentration is too low to clean up oil stain on aluminum panel surface and to affect coating quality. It may easily occur depainting in regular inspection by boiling water after coating.

2 Formation invert film is too low and coating anticorrosion property poor or coating too thick, which may easily end up in painting crack.

Painting production process drawing



1、letoff、tension adjustment
2、three-wheel precise coating
3、high temperature baking finish
4、air cooling、water coolingv
5、water cooling cycle
6、drive
7、quality cceptance
8、wrapup

- 1. Roller coating is using roller as coating carrier. As coating forms a layer of wet film of certain thickness on roller surface, coating overlays on subject surface when roller is in contact with the subject in rotation process. Our company adopts steel roller coating that is not apt to wear and distort. Compared with rubber roller, the surface of steel roller is smoother and coating surface is relatively fine. Small impurities will not cause roller deformation. As the surface presents rigidity, deformation caused by small impurities will spread to aluminum panel backing material and cause surface quality defect of Aluminum composite panel. On the contrary, rubber roller will appear deformation and absorb partial energy. Its deformation possibility is bigger than that of Aluminum composite panel. Therefore, small impurities will not affect surface quality of rubber roller coating. Only when impurity is relative big, deformation will spread to aluminum panel backing material and affect coating surface quality.
- 2. There are two kinds of baking method at present. One is strip lamp heating (infra-red lamp heating) and the other is heated air circulation hardening heating method. The former is rapid and no secondary pollution appears on panel surface. The latter uses heated air as heat carrier and transfer heat to aluminum panel coating by convection to harden the

Aluminum Composite Panel Introduction

Basic concept of aluminum composite panel

coating. Its characteristics include uniform heating, high precision of temperature control and easy control. It is also agreeable for solution volatilization and coating resin fusion or hardening rate of poly reaction film. It is an ideal hardening method for high coating quality requirements.

- 3. Cool it after baking and drive for inspection. Wrap it up as coating final product.

Major quality problems usually occurred in coating process:

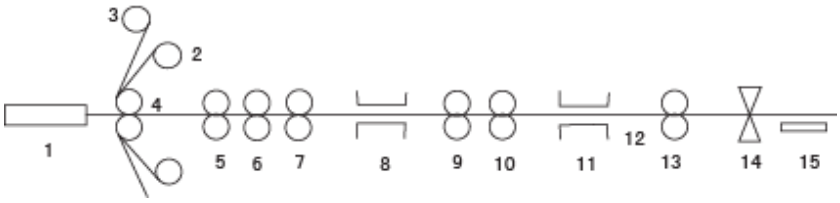
- 1. Color difference: coating mix misproportion, too high or too low oven temperature setup, improper panel temperature affected by incorrect air intake and draft system control, excessive deviation of oven control temperature, coating sensitivity to baking temperature, excessive deviation of coating temperature.
- 2. Slivering: too long service time of rubber roller, time exceeds of solvent resistance agent, poor roller lapping finish, too high coating viscosity, too high pressure of coating roller and supporting roller.
- 3. Cross stripe: too long service time of coating roller, roller axle seat loose or excessive offcenter, improper coating viscosity, or too slow roller speed or poor coating levelling property at constant coating linear speed.
- 4. Vertical stripe: coating roller mechanical damage, for instance impurity, burr, impurity in coating, or too fast roller speed or improper coating viscosity at constant coating linear speed.
- 5. Linear scratch: impurity in coating, impurity in basis material or environment dust brought to coating roller, impurity and burr etc. on live roller in production line.
- 6. Shothole: too much bubble in coating brought to coating roller, coating or water source contaminated.
- 7. Circular stain on film coating: stain left over on coated coiled material after chemical pretreatment or residual water due to inadequate drying, film coating surface dried too fast, excessive film thickness, coating circulation stir too fast, bubble generated in coating process.
- 8. Granule spot: unclean oven interior, coating unclean or polluted.
- 9. Dent: rough basis material surface, impurity on live roller when basis material in transmission.
- 10. Uneven luster: coating mix misproportion, nonuniform heat air convection and quality in oven.
- 11. Accumulation at edge or bubble at edge: coating viscosity too low, coating wet film too thick, coating roller damage, uneven basis material edge.

Aluminum Composite Panel Introduction

Major quality problems usually occurred in coating process:

- 12. Surface blur: coating leveling uneven, nonuniform cooling usually for PVDF FI-carbon coating.
- 13.Poor adhesive force: oil left over after pretreatment, invert film too thick or uneven etc., inadequate baking, coating problem.

Compounding process drawing



1、PEmelting and extrusion
2、coated aluminum coil letoff
3、polvmer film letoff
4、large diameter compounding roller 1
5、large diameter compounding roller 2
6、large diameter hot-press roller 1
7、large diameter hot-press roller 2
8、heat treatment furnace
9、large diameter cold-press roller 1
10、large diameter cold-press roller 2
12、quality inspection
13、drive and transporation
14、scale and cut
15、automatic unloader

- 1. Plastic extruding machine is mainly composed of adjustable-speed motor, reduction gear, screw, heating board and electrical apparatus control part. Its function is to heat and melt plastic particle, which is extruded by threaded rod and forms panel primarily. The panel is then cooled and molded to plastic core panel as required by special three roller evener. It includes material blender, particle feeding and drying system, feed port chilled water system, threaded rod air cooling system and Gas-axis system etc. (ratio of rod length to diameter shall be better ≧32).
- 2. Screw temperature control: screw is mainly divided into three sections, feeding section, compressing section and plasticizing section. Temperature control range shall usually be within 40-200℃.
- 3. Evacuating equipment: As PE particle itself contains water or may be exposed to water in transportation and as water will absorb enough amount of heat in threaded rod extrusion process, if there is no vacuum evacuating equipment to boil off and to evacuate water, the water will not get vaporized under high pressure inside the screw and will be extruded together with plastic. As a result that the pressure of extruded plastic rapidly drops from high pressure inside the screw to normal pressure in air, water contained will immediately vaporize. At feeding port of model and

Compounding process drawing

three rollers, vapor will pile up with water vapor continuously entering to form larger bubble and then break up, which will leave many small pits on trimmed core board surface. This will end up in failure of normal compounding.

- 4．Three rollers: Based on preset clearance among three rollers, grind, roll, cool and mold the molten plastic extruded out of forming die to form panel of certain thickness. Core panel surface shall be bright, flat without bubble and stripe. Panel thickness shall be uniform and in close tolerance.
- 5．Polymer film: Polymer is directly used to bond plastic core board and aluminum coil. It shall be flat when unwrapped. Tension control shall be proper (it is required that rough side is in contact with aluminum material).
- 6．Hot pressing compounding roller: Aluminum composite panel is compounded in rolling process conducted by 1-3 group pressing-heating roller. Heating roller transfers heat to aluminum panel by close contact with two sides of aluminum panel. Aluminum panel temperature rises and transfers heat to bonding material and core board so that the latter both temperature rises rapidly to achieve bonding of aluminum panel and core board. If roller temperature is too high, the temperature on aluminum panel surface will also be too high to affect coating quality. As FI-carbon coating is thermoplastic resin and sensitive to temperature, it will be “scalded” and generate blackspot on panel surface. That is the reason to choose roller of larger diameter, which has enough heat capacity to ensure small temperature variation and uniform heat exposure on panel surface. Panel thickness shall be primarily formed at the first group of compounding roller. Default clearance is generally 0.1-0.5mm larger than panel thickness. Too big clearance will result in obvious panel waveness, which is adverse to evenness in cold pressing and lowers peel strength. Too small clearance will result in great elastic deformation of core material. In this case, residual stress will also affect panel shape and lower local peel strength.
- 7．Heating furnace: It is mainly used to remove residual stress and adjust panel shape. The temperature shall be 20-50℃ higher than panel temperature.
- 8．Cooling and forming roller group: It is mainly used to adjust panel shape. The panel just compounded is at high temperature. At this moment, glue between each layer is not cold set yet and bond strength is still low. The glue need slow cooling. Otherwise, upper and lower aluminum panel will shrink too fast to form lengthwise wave.

Aluminum Composite Panel Introduction

Compounding process drawing

- 9．Cooling section: The section uses several groups of cooling fans up and down, which not only guarantees cooling effects but also satisfies arc scale requirement. Final panel temperature shall be controlled at 50 c lower (included) than surface temperature.
- 10．Multiple groups of straightening machine: i.e. evener, which is composed of three rollers. Panel shape can be adjusted by adjusting clearance between upper and lower roller.
- 11．Quality inspection: Check and control product quality according to national and enterprise standard.
- 12．Cut aluminum panel after driving. Size can be determined according to order requirements.
- 13．Final product of Aluminum composite panel: Final product of Aluminum composite panel, compounded and bonded with protective film on the surface, can be warehoused for delivery after acceptance.

Major quality problems usually occurred in compounding line:

- 1．Inadequate peel strength: The major reasons include inadequate technique temperature and heating time, improper clearance among rollers, poor or polluted aluminum surface quality and poor polymer film quality.
- 2．Bubbling: The major reasons include poor partial aluminum panel surface quality, poor polymer film quality, infusible particle on core board surface, inadequate temperature or air in material layers.
- a．Press mark: The major reasons include that roller surface is unclean and PE surplus material is carried to compounding rollers.
- 3．Scratch: The major reasons include unclean roller surface or improper transportation.
- 4．Press pit and uneven panel surface: The major reasons include impurities in PE material or inadequate temperature of roller of roller trio machine.
- 5．Shell tuck: The major reasons include shell tuck on raw aluminum coil, tension out of control or difference on both sides.

Aluminum Composite Panel Introduction

Aluminum composite panel class and specification:

It is usually classified according to its purpose, product function and surface decorative effect.

(1) Classified by purpose

a) Aluminum composite panel for building curtain wall

Minimum thickness of upper and lower aluminum panel shall be no less than 0.50mm and total thickness no less than 4mm. Aluminum material shall conform to requirements of GB/T3880. It usually adopts 3000 and 5000 series of aluminum alloy panel and FI-carbon resin coating. Thickness of the second coating layer shall be greater than or equal to 25um and that of the third layer 30um.

b) Aluminum composite panel for external wall decoration and ad.

Upper and lower aluminum panel shall be anticorrosive. Each thickness no less than 0.50mm and total thickness no less than 4mm. It usually adopts FI-carbon or polyester coating. Thickness of polyester coating film shall be greater than or equal to 16um.

c) Aluminum composite panel for indoor decoration

Thickness of upper and lower aluminum panel is usually 0.50mm and minimum thickness no less than 0.10mm and total thickness usually 3mm. It usually adopts polyester or crylic acid coating.

(2) Classified by product function

a) Common panel

- This kind of panel has no special functional requirement and is used for decoration in general cases. Performance index conforms to Aluminum composite panel technical indicators other than special indicators.

b) Fireproof panel

Fire panel uses low smoke halogen-free inflaming retarding polyethylene as core material. According to GB8624-1997, Building Material Performance Classification Method, its fire safety performance grade shall reach flame resisting grade (B1 grade) or non-inflammable grade (A grade). Other performance indicators shall also conform to Aluminum composite panel technical indicators. A grade refers to non-inflammable material. B1 refers to flame resisting material. B2 refers to flammable material. And B3 combustible material.

c) Antistatic panel

Antistatic panel uses antistatic coating to coat Aluminum composite panel. Surface resistivity is under 109Ω, which is lower than that of common aluminum panel. Accumulation of static electricity and dust accumulation is

Aluminum Composite Panel Introduction

Aluminum composite panel class and specification:

hard to appear on its surface. It has the effect of antistatic, dust proof and self-cleaning and can avoid electric shock and fire due to static electricity.

d) Antibiotic and mould proof Aluminum composite panel

This kind of panel uses antibiotic and mould proof coating to coat Aluminum composite panel, which can control microbial activity and growth and finally kill bacteria. It can restrain microbial activity and growth and kill microbe to create a clean environment.

e) Chameleon Aluminum composite panel

Chameleon Aluminum composite panel has three layers of coating, primer, top coat and clear lacquer. It is provided with all kinds of superior physical mechanics performance of FI-carbon Aluminum composite panel and ensures that no obvious chalking and color fading appears on coating surface in 15 years. It adopts hi-tech coating technology in baking to add imported flash pearly luster aluminum powder in clear lacquer, which forms into a layer of film after high temperature hardening. Post-coating surface has special decorative effects. This product makes use of natural optical interference principle. In the same illuminant and from different angles, Aluminum composite panel surface will present different flash effect with multi colors and high brightness. It is extensively used in indoor and exterior locations to be specially represented in recreation places and marketplaces. The surface effect cambered chameleon panel is more impressive.

f) Nanometer FI carbon Aluminum composite panel

At the same time of bearing all superior performance of FI carbon Aluminum composite panel, the hi-tech nanometer coating technology enables the product to have advantages of multiple performances over traditional FI carbon Aluminum composite panel, like pollution resistance, self cleaning and acid-alkali proof. It is a new type of building material replacing the older generation. Compared with traditional FI carbon Aluminum composite panel, the coating surface of this product has perfect self-cleaning performance. Usually, external wall of Aluminum composite panel is seriously polluted by dust and rain in half a year later. Especially, the silicone sealant used in project, sometimes without strict quality assurance, creates lots of black stain at seam location, which is not only hard to be cleaned but also affects wall appearance. Now nanometer FI carbon Alumi

Aluminum Composite Panel Introduction

Aluminum composite panel class and specification:

num composite panel resolves this problem. Because of the low tensile force of coating itself, worm mark is hard to adhere to its surface. Slight worm mark can be washed by rain to achieve self cleaning. A large sum of cleaning and maintenance cost will be save every year. The simplest identification method is to use oily marking chalk to scribble on the surface. No marks shall be left on real product. Marks on common panel will be hard to be wiped out. The product can be extensively used in top grade building curtain wall, and indoor and exterior decoration at star hotel, conference center, airport and public utilities etc.

(3) Classified by surface decorative effect

a) Coating decorating board

It covers all kinds of decorative coating on aluminum panel surface, usually FI-carbon, polyester and crylic acid coating etc.

b) Oxidation colored Aluminum composite panel

It uses anodic oxidation technology to treat aluminum alloy panel. Color includes rose red and bronze etc.

c) Film decorating board

It is to adhere color stripe film to aluminum panel painted with primer or directly to degreasing treated aluminum panel by bond under certain process conditions. Major brands include hill stripe board and wooden stripe board etc.

d) Drawing block

The surface of aluminum alloy panel is wire drawing treated, usually including golden wire drawing and silver wire drawing.

e) Mirror board

The surface of aluminum alloy panel is polished as it were a mirror.

Specification:

Common specifications of Aluminum composite panel are:

Total thickness	Width	Length
2mm	800mm	1000mm
3mm	1220mm	2440mm
4mm	1250mm	3000mm
5mm	1500mm	4000mm
6mm	1570mm	6000mm

Other specifications and sizes can be arranged.

Aluminum composite panel of 1220mm×2440mm is called standard panel in the trade.

Characteristics of Aluminum composite panel

1) Light mass

Compared with aluminum (or other metals) of same rigidity or thickness, Aluminum composite panel has lighter mass, thus greatly lowering architecture load.

Compare of rigidity, thickness and area density of different materials

Aluminum Composite Panel Introduction

Aluminum composite panel class and specification:

RigidityEJ./ KN.m2/m	Aluminum composite panel		Aluminum panel		Steel panel	
	Thick ness /mm	Area density Kg/m2	Thicknes s/mm	Area density Kg/m2	Thickne ss/mm	Area density Kg/m2
0.125	3	4.5	2.7	7.3	1.9	14.8
0.24	4	5.5	3.3	8.9	2.4	18.7
0.59	6	7.3	4.5	12.2	3.2	25.0
1.11	8	9.1	5.5	14.9	4.0	31.2

- 2) Perfect rigidity

  Aluminum composite panel skillfully makes use of the principle of double T-iron structure. Technological process guarantees panel has stable internal stress and hence has excellent mechanical property.

- 3) Abundant colors and good ornamental effect

  Aluminum composite panel can be coated in a variety of colors to fit for pattern design for all kinds of purposes.

- 4) High surface smoothness

  Surface smoothness of Aluminum composite panel bears comparison with single metal panel.

- 5) Perfect durability

  Test shows its service life is longer than 20 years in outdoor environmental extremes.

- 6) Perfect processing performance

  Process like cutting, punching, slotting and bending etc. with simple wood processing equipment or special equipment in factory or at job site is available.

- 7) Perfect cost behavior

  Aluminum composite panel production adopts continuous coating and continuous compounding processing technology. Compared with metal single panel, it has high production efficiency and low cost.

- 8) Broad purpose

  Aluminum composite panel has excellent cost performance ratio and broad purpose. Other than decoration in curtain wall, inner and external wall, hall, restaurant, shop and conference room etc., it can also be used in rebuilding of old constructions or used as counter, furniture surface layer and inner and external wall of vehicles etc.

Aluminum Composite Panel Introduction

Raw material and technical requirements

Aluminum material

Aluminum composite panel band choice

(1) Aluminum band brand

Surface aluminum material greatly affects quality of Aluminum composite panel. National standard requires that aluminum material used in exterior wall shall choose anticorrosion aluminum in accordance with GB/T 3880, i.e. 3003 aluminum alloy coil. Aluminum material used in inner wall can choose 1100 industrial pure aluminum coil. German ALUCOBOND uses 5005 Aludur coil. Choose different brands of aluminum band according to its variety, purpose and client requirements etc.

According to national standard GB/T 16474-1996, aluminum and its alloy numbering shall comply with international 4 digit number system denomination method recommended by international trademark registration agreement organization. The first number means group, as follows:

A、pure aluminum (aluminum content 99.00%) 1xxx				
B、 Alloy group is divided by major alloy element	a、Cu 2xxx	b、Mn 3xxx	c、Si 4xxx	d、Mg 5xxx
	e、Mg+Si 6xxx	f、Zn 7xxx	g、other elements8xxx	h、spare group9xxxvv

Alloy	Status	б0.2/Mpa	б b/Mpa	Φ/%	Hardness (HB)	Shear strength/Mpa	Fatigue strength/Mpa
1100	H18	165	152	5	44	90	60
3003	H16	175	175	5-14	47	105	69
5005	H14	152	159	6	--	97	--

The most important factors for Aluminum composite panel used in curtain wall are shear strength and fatigue strength. Therefore, it shall choose 3003 aluminum alloy coil for curtain wall.

(2) Choice of aluminum band supply status

Status code is the simple expression of supply status. Standard GB/T16474-1996 is stipulated according to status code naming rule specified in American national standard ANSI H35.1-93 aluminum alloy and status code system. Basic status code is expressed in one English capital letter. For example: H-process hardening status, H1-pure process hardening status, 8-hard status.

The meaning of supply status code is shown in the following table:

status code	meaning
H18	Hardness, approximate 75% cold deformation after anneal
H24	1/2 hardness, approximate 35% cold deformation after anneal
H16	3/4 hardness, approximate 35% cold deformation after anneal

Aluminum Composite Panel Introduction

Raw material and technical requirements

Aluminum material

Product brand, status and specification for Aluminum composite panel are shown in the following table:

Number	Status	Specification		Inside diameter of paper tube/mm
		Thickness/mm	Width/mm	
1100	H18	0.20~1.00	1000~1580	400or500
3003	H16、H14、H28、H24	0.20~1.00	1000~1580	
5005	H16、H14、H26、H24	0.20~1.00	1000~1580	

(3) Dimensional deviation of aluminum band

Dimensional deviation of aluminum band is shown in the following table:

Thickness/mm	Thickness deviation/mm	Width deviation/mm
0.20~0.30	±0.015	±1.5
＞0.30~0.50	±0.020	
＞0.50~1.00	±0.025	

(4) Aluminum band quality requirements:

Except for satisfying mechanical properties and supply status etc., aluminum band shall also satisfy the following requirements:

(1) Paper sleeve length shall not be less than width of the band but no greater than 10mm.

(2) Side camber in 2m section at random of the band shall be no greater than 3mm.

(3) When spread on platform as desired, clearance between band and plane shall be no greater than 3mm and ripple marks in every one meter no more than 3.

(4) At band end face, string of coils is no greater than 2mm and tower-shaped no greater than 5mm (except for 5 circles on both ends).

(5) Appearance quality

a.Band surface shall be well processed and texture uniform, flat and smooth. Cracks, perforated pore, crack leak, pinch mark, corrosion, press pit, pine branched pattern, metal or nonmetal press-in are not allowed on surface.

b.No defects like obvious across grain, black stripe, dark and light stripe, obvious oil stain, serious scratch and periodic print etc. that may affect its service are allowed on band surface.

Aluminum Composite Panel Introduction

Raw material and technical requirements

Aluminum material

c.Band shall be wrapped tight and tidy without cracked edge, burr and knocking damage.

d.Coil-down are not allowed.

e.No joints on band are allowed.

Note: Visually inspect aluminum band appearance quality. Magnifier is unnecessary.

Raw material and technical requirements

Core material

Core material of Aluminum composite panel formerly uses PVC and now PE. The latter is provided with many advantages, such as non toxicity, good factory behavior, wide molding technology scope, extremely low water absorption, perfect chemical stability, low density, low price and extensive raw material source etc.

Low density PE is produced by high-pressure method, hence also called high-pressure polyethylene. It is to compress ethane under 150-300Mpa high-pressure conditions and to use oxygen or peroxide as initiator to polymerize ethane at 180-200℃ temperature according to free radical polymerization reaction mechanism. The molecule has long and short branched chain in low density, which usually is 0.910-0.925g/cm3. Crystallinity is 55-65%. Thereby it is called low density polyethene, LDPE for short. Among all kinds of PE, LDPE is the one only that contains long branched chain. Its processability, flexibility and transparency are superior to all other kinds of PE. Its melting point is 105-115℃ and breaking elongation 300-600%.

Performance inspection:

In PE production process, it is to mainly check items like density, cleanness, solution index, molecular weight distribution, vicat softening point and crystallinity etc.

Density inspection usually adopts weight method and gradient tube method. The latter is specified in national standard GB 1033-1986.

Cleanness has two indexes, color particle and impurity. Usually visual inspection will do.

Solution index inspection makes use of solution flow rate meter. Heat solution to 190℃. Check mass of solution passing moedel in every 10 minutes (8/10 minutes) under 2.16kg pressure.

vicat softening point inspection is conducted by vicat softening point gauge.

Aluminum Composite Panel Introduction

Raw material and technical requirements

Core material

It is to measure the temperature when piercing depth is 1mm under specified conditions. The unit is ℃. Sample requirements: thickness 3-6mm and length and width greater than 10mm each.

Molecular weight distribution and crystallinity are usually skipped at factory.

Most factory uses recycled PE to lower production cost, which is called processing scrap. Processing scrap is leftover material of other products, such as cutting edge of film and panel material etc. The processing scrap, though heated several times, has not been exposed in outdoor sunlight for long time. Its solution index has no much change. The strength retention rate is generally above 90%. It can directly go into production only by adding 0.2% antioxidant. Tests show that it can also be directly used without adding any antioxidant.

■ 1、PE for common Aluminum composite panel

Test method

■ (1) Appearance and color

Sample 200g from product at random and conduct visual inspection in natural light.

■ (2) Solution index and density

Set up temperature and pressure. Raise temperature until relatively stable and add in sample material. Choose range and enter into waiting state. Use cutter to take sample according to specified time interval and weigh the sample. Calculate solution index (MFR) and solution density (ρ) by the following formula: MFR=600×m÷t（g/10min）

In which: MFR—solution flow rate (g/10min)

m—sample average mass (g)

t—time that the sample flow out of model (s)

ρ＝14×m÷L（g/cm3）

In which: ρ—solution density (g/cm3)

m—sample average mass (g)

L—travel 5.4/6.35/(3.17mm)

(3) Water content

Put PE material in weighing bottle. Take 5g samples by analytic balance with 0.1mg truth. Dry it in 100-105±2℃ constant temperature oven for 2 hours. Remove the sample to drier and cool to room temperature for weighing.

Aluminum Composite Panel Introduction

Type, performance and application of Aluminum composite panel

A＝(W1－W2)÷W1×100%

In which:

A—water content, %

W1—sample mass before drying, g

W2—sample mass after drying, g

(4) Vicat softening point

Use vicat gauge to measurevicat softening point, which is usually controlled at about 97 c

■ 2、 Inflaming retarding PE for fireproof Aluminum composite panel

It is usually to modify Aluminum composite panel property by adding fire retardant or grafting etc. to improve its flame resistance. According to different fire retardant classes, common inflaming retarding system includes aluminum hydroxide inflaming retarding system, magnesium hydroxide inflaming retarding system and halogen series inflaming retarding system etc. The most typical system at present is aluminum hydroxide inflaming retarding system. For example, both German ALUCOBOND and Japanese Mitsubishi adopt this system. Tests show aluminum hydroxide content exceeds 70%. Most domestic enterprises also adopt this system. Filler content all exceeds 60%. See the following table for performance requirements of inflaming retarding PE for fireproof Aluminum composite panel:

Test items	Index requirements	Test result	Test code
Density/（g/cm3）	1.40~1.55	1.41	GB/T1033-1986
Solution index (mass) /（g/10min）	1.0~2.5	2.23	GB/T368-1983
Solution flow rate (volume)（cm3/10min）	0.8~2.0	1.7	GB/T3682-1983
Oxygen index	≥32	32.5	GB/T2406-1993
Tensile yield stress/Mpa	≥5.0	7.2	GB/T1040-1992
Bending strength/Mpa	≥7.5	10.0	GB/T9341-1988
Bending modulus/Mpa	≥450	707.9	GB/T9341-1988

See the following table for flame resistance indexes of for fireproof Aluminum composite panel:

Aluminum Composite Panel Introduction

Type, performance and application of Aluminum composite panel

Test items	Detection standard	Technical requirements
Minimum value of burning residue length/mm	GB/T8625-88	＞0
Average value of burning residue length /mm	GB/T8625-88	≥150
Flue gas temperature, ℃	GB/T8625-88	≤200
Flame tip height /mm	GB/T8626-88	＜150
Smoke density grade	GB/T8625-88	≤75

Raw material and technical requirements
Coating

Decorative surface of Aluminum composite panel is to cover different coating on aluminum panel surface to satisfy demands of different users. At present, domestic Aluminum composite panel production mainly employs three kinds of coating systems, polyester, crylic acid and FI-carbon coating, which are used as primer, final coating, black out paint and back paint for Aluminum composite panel.

- (1) Primer

Key function of primer is to improve finish coating adhesive force on aluminum panel. Therefore it is required that primer paint film is perfectly adhesive to both base material and finish coating film. Film thickness is usually 7-10μm. Except for good mechanical properties, paint film shall also be of excellent corrosion protection. Primer usually uses epoxy coating. Else varieties include polyester and polyurethane as well as FI-carbon resin coatings.

- (2) Finish coating

Finish coating has multiple colors to suit for customer individuality. Different types of coatings have different colors and properties. For example, PE has good brightness and vivid colors. PVDF is fadeless for as long as 20 years. Nanometer board is of good brightness in addition to all PVDF properties. Its self-cleaning function is the most important and a new technology to Aluminum composite panel.

Raw material and technical requirements
Polymer film

Polymer film uses American Du pont raw material. Polymer content is usually above 70%, which guarantees fastness of aluminum and PE core material. External wall service life is normally about 15-20 years.

Aluminum Composite Panel Introduction

Type, performance and application of Aluminum composite panel

- 1. Type: Aluminum composite panel is a generic term, including many types. It is usually classified by purpose, surface coating, color, surface pattern, specification and size, special function, surface treatment method and overcoating etc., which has been discussed in the foregoing.
- 2. Performance

Aluminum composite panel is a kind of laminar composite material, which compound precoated aluminum panel and plastic core material together by polymer binding material under high temperature and certain pressure conditions. It not only keeps main characteristics of raw components like aluminum panel and plastic etc. but also bears new characteristics that raw components lacks. The integral performance of Aluminum composite panel is not a simple sum or average of the performance its components. It involves composition effect, which is virtually the result that component materials and the interface these materials formed interact, mutually depend and complement with each other.

Composite material has the following interface effect:

1) Transmission effect. Interface can transfer force, i.e. transfer external force to every composite material as a bridge among basis materials.

2) Blocking effect. Combination interface can prevent cracks from expanding, stop material damage and reduce stress concentration.

3) Discontinuity effect. Discontinuity of physical properties and boundary friction will occur on interface, behaving as electricity resistance, heat tolerance and dimensional stability etc. properties of composite material.

4) Scattering and absorption effect. Light wave, sound wave, thermoelastic wave and shock wave are scattered or absorbed by interface, behaving as heat insulation, sound insulation, mechanical shock resistance and thermal shock resistance etc. properties of composite material.

5) Inductive effect. The phenomenon occurs when contact surface of two kinds of composite materials changes because of inductive effect, such as strong elasticity, low expansibility, impact resistance and heat resistance etc.

The interface performance generated by the above interface effect and the material property of aluminum and plastic, which are the two main composite materials of Aluminum composite panel, as well as surface coating performance, form excellent characteristics of Aluminum composite panel, such as flatness, rigidity and processability etc.

Aluminum Composite Panel Introduction

Type, performance and application of Aluminum composite panel

Aluminum composite panel is mainly used in curtain wall and interior and exterior decoration. Curtain wall is external building block of buildings, also called hanging wall. It bears not agent structure load but deadweight, wind load, earthquake action and temperature effect. Deadweight is constant and has low density and is out of major function. The latter three loads are variable loads. Among which, wind load is the major load. Its value can reach 2.0-5.0 Kpa. When Aluminum composite panel is used for curtain wall, wind resistance is the major consideration factor. Under vertical effect of wind, Aluminum composite panel mainly occurs flexural deformation and shear failure. So bending strength, modulus of bending, penetration resistance and shear strength are the important performance parameters of Aluminum composite panel for curtain wall.

- 1.Coefficient of thermal expansion

  It is a design parameter special for design department. As product tends to expand due to heat and shrink due to cold, it shall reserve expansion joint in structure. Otherwise, it will occur warp, arching and deformation that affect decorative effect. If coefficient of thermal expansion is too big, Aluminum composite panel will have more obvious warp and deformation.

- 2.Heat distortion temperature

  It is an important index to reflect core material and bonding layer's resistance to temperature deformation. If heat distortion temperature is too low, plastic may deform at somewhat high temperature and hence affect decorative effect. In severe cases, it may appear adhesive failure as deformation increases.

- 3.180 ○ peel strength

  It is an important index to reflect aluminum and core material bonding property. If it fails to reach respective national standards, product quality may seem normal at the beginning. After a certain period, product itself or its structure may occur serious deformation and adhesive failure and bubbles under stress effect, which will seriously affect quality of structures and building safety. If it is too high, it may give birth to mass release of internal stress and hence tend to aluminum panel hogback.

Aluminum Composite Panel Introduction

Type, performance and application of Aluminum composite panel

- 4.Penetration resistance and shear strength

  It is one of the important parameters for designer's structural design. It mainly reflects key properties of raw material and the value is determined by raw material.

- 5.Bending strength and modulus of bending

  Bending is one of the major stress patterns of Aluminum composite panel. It basically means its fatigue resistance and wind load received when aluminum panel is bent. The better the bending strength and modulus of bending are, the stronger its wind pressure resistance and longer its service life.

Bond area of aluminum panel and plastic material is the weak link of shear damage. Therefore 180 ο peel strength is an important performance index of Aluminum composite panel.

Characteristics of face panel coating include coating thickness, hardness, brightness, impact toughness, adhesive force, attrition resistance, boiling water resistance and chemical stability etc. Therein chemical stability includes resistance to soiling, oil resistance, acid and alkaline resistance, solvent resistance and wash resistance etc. Resistance to soiling reflects its self-cleaning capability in application. Oil resistance, acid and alkaline resistance reflects its resistance to corrosion. Solvent resistance presents coating hardening degree, which affects coating quality and service life. Wash resistance index guarantees that product will not be adversely affected by cleaning after application.

Atmospheric exposure test can be divided into two test methods, outdoor insolation test and accelerated aging test.

Durability

Durability is an important property of aluminum plastic panel, which includes saltfog resistance and weathering resistance. Saltfog resistance index guarantees product employment in coastal area. Weathering resistance means how the product can resist weathering destructiveness. Durability of aluminum plastic panel mainly relies on its surface coating performance. There are lots of elements to affect surface coating performance, including coating technology and thickness except for its brands

Aluminum Composite Panel Introduction

Type, performance and application of Aluminum composite panel

and quality. To ensure its durability satisfies requirements, external wall coating shall adopt FI-carbon resin with 70% FI-carbon contents. Coating thickness of inner and external wall shall be greater than 16μm and 25μm accordingly.

Weathering resistance test include two methods, outdoor insolation test and accelerated aging test.

Application area of Aluminum composite panel

Aluminum composite panel is extensively used in many fields, including the following major aspects.

1) Building curtain wall

2) Exterior decoration

3) Interior decoration

4) Old building external wall refitting and revamping

5) Signboard, designation panel and ad signboard

6) Fence wall, balcony, device cell and indoor compartment

7) Vehicle interior and exterior decoration

Aluminum Composite Panel Introduction

The excellence of aluminum-plastic signboard

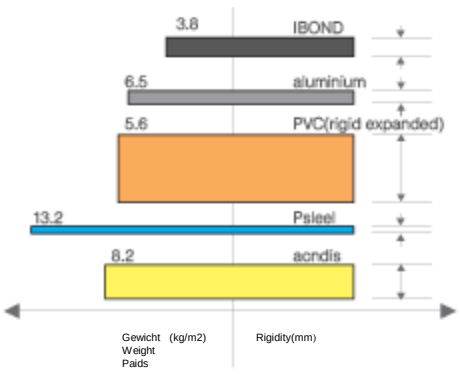
- 1、Smooth Surface, Rich Texture, Various Color : We can provide the RAL and Pantone colors, including the high gloss, matt gloss, brushed, mirror, wooden finished board and customized as your requirement.
- 2、Various Designs and Length : Width is from 1000mm to 1550mm. Length could be customized as your requirement beyond the standard size accord with the processing techniques, no need to piece together.
- 3、Simple Processing, Various Modalities : It could be processed to various forms and has much process such as cutting, bending, punching, sticking and painting.
- 4、Lowest Rate of Expand and Shrink : Dimensions stable, does not expand and shrink under the adverse circumstance, with wide temperature resistance (-50℃~80℃)

Time Color	Variation	Chalking
	ECCA/T3 ASTMD-2244-89	ASTMD-659-86
	dE	Index: 1-10
5 year	3	8
7 year	3	7
10 year	4	7

dE 3= Very Good Index 10= No Chalking
dE 4= Good Index 1= Strong Chalking
dE 5= Satisfactory

IBOND Signboard Technical Data

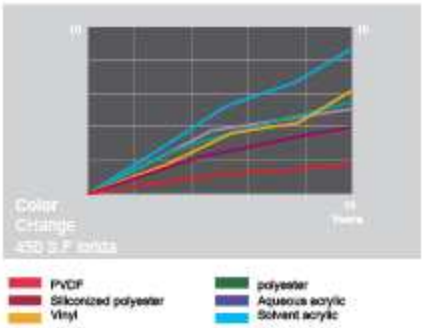
			2mm	3mm	4mm	6mm
Panel thickessThickness of Aluminium		(mm)		0.30		
LayersWeight		(kg/m2)	2.90	3.80	4.75	6.60
Technical Properties:						
Section Modulus	W	(cm3/m)	0.51	0.81	1.11	1.71
Rigidity(POsson'rationμ =0.3)	E.1	(KNcm3/m)	345	865	1620	3840
Alloy of Aluminium Layers						
Modulus of Elasticity	E	(N/mm2)				
Tensile Strength of Aluminum		(N/mm2)				
0.2% Proof Stress		(N/mm2)				
Elongation		(%)				
Linear Thermal EXpansion			Rm:145-185 Rp0.2: 110 - 175 A50>3% 2. 0mm/m (100. C temperture difference)			
Thermal Prope rties:						
Thermal Resisance	R	(m2K/m)	0.0047	0.0080	0.0113	0.0180
Heat Transition Coetticient	U	(w/m2k)	5.72	5.61	5.50	5.30
Range of Application		oC	-50~+80			

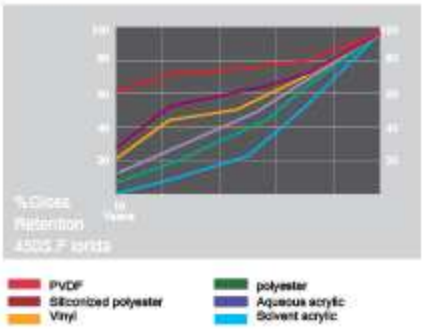


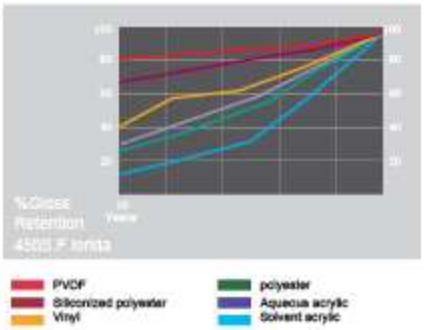
- 5、High adhesive intensity : The American DuPont technology could insure the board would not distortion, cockle, shelling during the cutting and bending.
- 6、Environment friendly : It is the green building material, no radiation and pollution.
- 7、Superior weather-resistance and rub-resistance: Surface treatment with high-grade ultraviolet-resistant polyester paint (ECCA) request, guarantee 8-10 years; if use the KYNar500 PVDF paint, guarantee 15-20 years.
- 8、Superior Rigidity : Unbelievable light with amazing hardness.

Aluminum Composite Panel Introduction

Feature







- 1、Weather-resistance:Superior weather-resistance and ultraviolet(UV) resistance, acid-resistance and alkali-resistance, suitable for all natural environments. It can be guaranteed 15 years without change of color, its temperature range from-40 to 80;

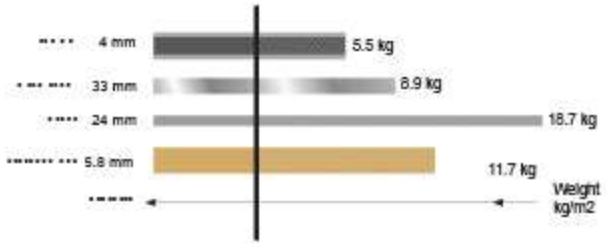
  Quality

  The fully automatic coil coating process is computer controlled throughout all the stages. Coating quality is tested according to the standards established by the ECCA . The long-term durability of coatings can be compared by measuring

  ·Color change ·Gloss retention ·Chalking

  The superiority of PIVOT Ultra-cote UV resistant lacquer systems (PVdF) is shown in the three graphs. The values indicated are taken from tests conducted by the American Coil Coating Association (NCCA) on lacquered surfaces which were exposed to the extreme climatic conditions of South Florida for several year
- 2、Economic：The ACP use high quality aluminum sheet and plastic core, it's light to transport, saving the project time.
- 3、Light weight：No pollution, is green building decorative material; Can be easily processed and installed; Light weight, good

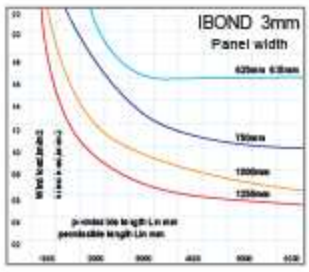
  strength and flexibility
- 4、Environment： Superior aging resistance, no coating change, no pollution, anti-acid, and anti-alkali, solvent resistance.
- 5、Color：We can provide 50 kinds of color for your choose. but any color and size are available according to your need.
- 6、Strength：The ACP use high quality aluminum, has greatly enhanced the strength of ACP, ensuring that the curtain wall wind pressure resistance, prevention of leakage, and the shock effect.
- 7、Surface smooth：The fire-resist ACP provide superior and smooth surface, satisfying the modern building on the pursuit of high-perception. The ACP's surface is much more smooth than aluminum sheet.

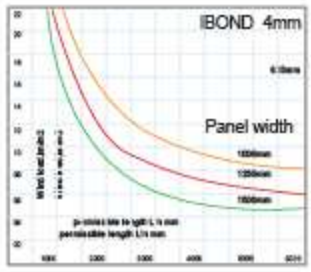


IBOND compared with the solid aluminum panel

Required thickness and actual weights of panels with same rigidity

Rigidity	Section Modulus	Thickness	Weight	Aluminu	
E.J	W			Weight	Thickness
125 kn cm2/m	1.25 cm3/m	3 mm	4.5 kg/m2	2.7 mm	7.3 kg/m2
2400 kn cm2/m	1.75 cm3/m	4 mm	5.5 kg/m2	3.3 mm	8.9 kg/m2





Test and Identification Methods of Combustion Properties for FireproofAluminum Composite Panels and Common Aluminum Composite Panels

Test and Identification Methods of Combustion Properties for Fireproof Aluminum Composite Panels and Common Aluminum Composite Panels

They are differentiated from the classification method of the combustion properties according to the regulation of the national standard GB8624-1997 Refer to the appendix Classification Method of Combustion Properties for National Standard Building Materials in PRC below.

1. For its plastic core material takes the inflammable PE material as the bas material, the common aluminum composite panel is of the level-B2 combust material. When it is detected in the vertical combustion boiler with the level-I fireproof performance, for the hot transfer rate of the aluminum composite pa is fast and the core material is delaminated with the aluminum composite pa under the high temperature, it will cause the polyethylene (PE) core materia contacts with the flame directly to combust and drop under the high temperature and ignite the fire. Hence, it can not carry out various level-B1 indexes.

2. For its plastic core material uses the halogen free flame retardant PE material, the test will be carried out for the fireproof aluminum composite pa in the vertical combustion boiler during the level-B1 detection. Although the room temperature in the combustion boiler is high and the methane burns vigorously, it will yet not catch fire to burn after the heat is transferred by the aluminum composite panel. It will not generate noxious and corrosive gas a the dripping will not take place during the detection. Various indexes can me the level-B1 fire retardant requirement .

Comparison of Test Results for Fireproof Aluminum Composite Panel with Common Aluminum Composite Panel

Level	Name
A	Non-combustible Material
B 1	Fire Retardant Material
B 2	Combustible Material
B 3	Inflammable Material

Table 1: Level and Name of Combustion Properties

Table 2: Test Result for Level-B1 Fireproof Aluminum Composite Panel.

Serial Number	Test Item	Test Method	Technical Index	Test Result	Conclusi
1	Minimum Remaining Combustion Length <mm>	GB/T8625-88	>0	430	Pass
2	Average Remaining Combustion Length <mm>	GB/T8625-88	≥ 150	487	Pass
3	Average Smoke Temperature <℃>	GB/T8625-88	≤ 200	97	Pass

Test and Identification Methods of Combustion Properties for FireproofAluminum Composite Panels and Common Aluminum Composite Panels

Test and Identification Methods of Combustion Properties for Fireproof Aluminum Composite Panels and Common Aluminum Composite Panels

Table 3: Test Result for Level-B2 Common Aluminum Composite Panel

Serial Number	Test Item	Test Method	Technical Index	Test Result	Conclusion
1	Minimum Remaining Combustion Length <mm>	GB/T8625-88	>0	0	Failed
2	Average Remaining Combustion Length <mm>	GB/T8625-88	⩾150	0	Failed
3	Average Smoke Temperature <℃>	GB/T8625-88	⩽200	620	Failed
4	Height of Flame <mm>	GB/T8626-88	<150	15	Failed
5	Smoke Density Rating (SDR)	GB/T8627-1999	⩽75	28	Failed

Differentiating Fireproof Aluminum Composite Panel, Counterfeit Fireproof Aluminum Composite Panel and Common Aluminum Composite Panel from Appearance Color

From the perspective of the color for the aluminum composite panel core material, the color of the Real level-B1 Fireproof Aluminum Composite Pan usually white for its core material uses the halogen free flame retardant PE material and includes a large number of inorganic fire retardants after the activation processing. From the perspective of the appearance, the peel su and section of the Real level-B1 Fireproof Aluminum Composite Panel are white, while the peel surface and section of the counterfeit level-B1 Firepro Aluminum Composite Panel are gray white and dark white. The common Aluminum Composite Panel usually uses the black core material. However vicious competition in the whole Aluminum Composite Panel industry caus various manufacturers use a large number of PE film recycling materials (regenerated materials) for reducing their cost in recent years. Hence, som material in the current market is white, which makes the common Aluminu Composite Panel with white peel surface and section of the core material counterfeit the fireproof Aluminum Composite Panel.

Type of Fireproof Aluminum Composite Panel in Current Market

1. Counterfeit Level-B1 Fireproof Aluminum Composite Panel: The core material is halogen flame retardant, whose color is usually dark gray white

Test and Identification Methods of Combustion Properties for FireproofAluminum Composite Panels and Common Aluminum Composite Panels

Test and Identification Methods of Combustion Properties for Fireproof Aluminum Composite Panels and Common Aluminum Composite Panels

and the density is rather lower, so it can not meet the requirement for the fireproof and environmental protection of the building material in the market.

2. Real Level-B1 Fireproof Aluminum Composite Panel: The core material is halogen free flame retardant, whose color is usually white and the density is rather higher, so it can meet the requirement for the fireproof and environmental protection of the building material in the market.

The halogen flame retardant material refers to add the polymers with the halogen or halogen flame retardants into the PE plastics and be equipped with the noxious antimony compound, and then produce this material by simple physical mixing method. Halogen – The antimony can provide obvious flame retardant effect. However, once the fire hazard takes place, it is easy to generate a large number of noxious carbon monoxide and hydrogen halide gas with strong corrosion for the high temperature decomposition and combustion, and cause the secondary pollution for the environment and is disadvantage of the environment requirement for current building material.

The halogen free flame retardant material refers to the flame retardant composite material that is produced by adding the halogen free flame retardant and other flame retardant intensifier without halogens into the grafting modified PE, and using special patent technology and high efficient plasticized mixing technique. Once the fire hazard takes place, the speed of catching fire to burn is slow, it will not decompose the noxious gas and the melting material will not drip. In this way, it will provide the personnel in the fire hazard field with enough escaping time and doesn't pollute the field. Hence, the personnel in the fire hazard field will not be choked to die for the absorption of much noxious gas.

To judge the Fireproof Aluminum Composite Panel, people like to burn its core material by the lighter. During the slow combustion of the core material you will detect the combustion time is short for the core material of the counterfeit level-B1 Fireproof Aluminum Composite Panel. However, it will generate a large number of black smoke accompanying with fierce pungent smell, and the melting material will cause the dripping.

For the halogen free core material of the Real level-B1 Fireproof Alumi

Test and Identification Methods of Combustion Properties for FireproofAluminum Composite Panels and Common Aluminum Composite Panels

Test and Identification Methods of Combustion Properties for Fireproof Aluminum Composite Panels and Common Aluminum Composite Panels

num Composite Panel, the halogen free material will not generate dense sm and the smoke is slight, there is not any pungent smell, and the combustion speed is slow. There is no the dripping phenomenon during the combustion. Furthermore, its surface will generate dense oxide to cover the combustion surface of the core material and isolate it from the oxide in the air during the combustion. At the same time, it will generate the moisture by the reaction during the combustion, to reduce the combustion temperature and achieve t flame retardant and self extinguishing.

Test Method of PVDF Fluorocarbon Resin Content

Test Method of PVDF Fluorocarbon Resin Content

As is well known that for the ingredient of the super weather resistance fluorocarbon coats, the PVDF content in the total coats must be equal to or greater than 70 percent. It can ensure the quality of the fluorocarbon coats an the long beauty of the buildings only when above conditions are met. Howeve there are some PVDF coats with low cost and poor quality in the market. Although it is hard to differentiate these coats from Hylar5000 coats in the sho run, the weather resistance of these coats can not match with Hylar5000 coat and it will also loss the beauty and shorten the life of buildings as well as increase the cost for the recoating and maintenance. Hence, it draws the construction industry's attention.

In this case, Solvay researches on various ingredients of the fluorocarbon coa in depth and puts forward three different methods to determinate the content PVDF in coatss, so as to protect the benefit of its customers. These methods include the traditional quantitative determination – solubility, the fusion point quantitative determination – using the Differential Scanning Calorimeter (DSC)，and the pyrolytic quantitative determination in the inert gas – using th Thermogravimetric Analysis (TGA).

There are some advantages and disadvantages of three determination metho so they can be combined with each other to obtain an accurate result. The following will describe three determination methods in details.

Traditional Quantitative Determination Method

(1) Traditional Quantitative Determination Method

In addition to two resin ingredients such as PVDF and PE, the PVDF fluorocarbon coats also include the pigment for the beauty and some additives for changing the operation performance. These ingredients have different solubility in the organic solvents.

The pigment is not dissolved in the organic solvents fully.

PVDF is only dissolved in N-methylpyrolidone, dimethylsulfoxide, N, N-dimethylacetamide and N, N-dimethylfornmmide.

The Polyacrylate (PA) can be dissolved in PVDF as well as other common organic solvents.

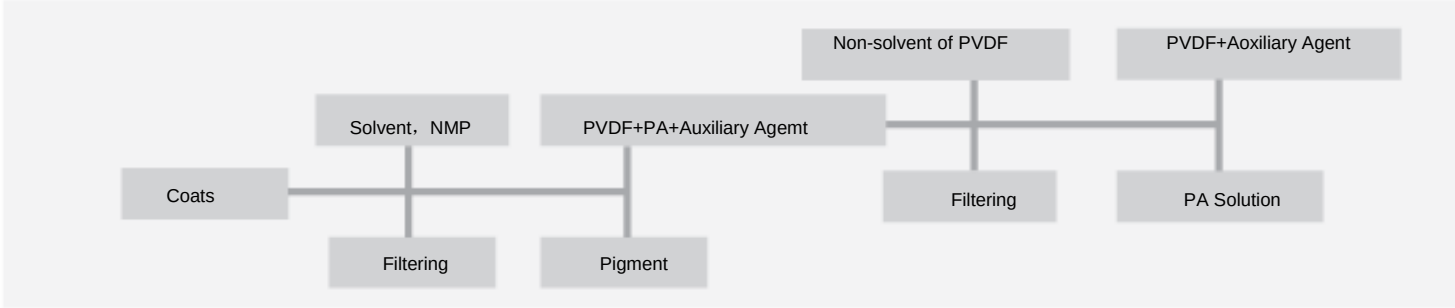
The traditional quantitative determination method is to determine the content according to different solubility of various coat ingredients. Fig.4-15 shows the flow chart of traditional quantitative determination method, which has been us for a long time. The main source of error is the

Test Method of PVDF Fluorocarbon Resin Content

Traditional Quantitative Determination Method

insoluble polymer PE. Furthermore, the use of the organic pigment may also generate the error. The disadvantage of this method is that it needs a large number of coats and is hard to collect the sample and determine the ingredi for a long time.

Fig.4-15 Flow Chart of Traditional Quantitative Determination Method



Fusion Point Quantitative Determination Method

(2) Fusion Point Quantitative Determination Method

In general, the fusion point of the crystal will reduce with the content of the soluble matter, and the reduced degree can be evaluated by the thermodynamic formula. The crystallization behavior of the polymer is more complex than general crystals for the possibility of inter-solubility with other polymers will reduce greatly with the increasing of the molecular weight. The basic principle of the inter-solubility for the polymer is the same as that of common matters, and the basic thermodynamic formula is shown as follows

$$\Delta G_{mix} = \Delta H_{mix} - T\Delta S_{mix}$$

The free energy (Δ Gmix) must be the negative value and Δ Smix is usually negative value. Hence, it will generate negative free energy only when the mixed heat is high. Under the condition of inter-solubility with the coplasticiz the fusion point of the crystal plastics can be expressed by the fusion point reduction formula of the Flory.

This formula is derived to apply to two soluble plastics and the modified fusi point reduction formula is used to evaluate the fusion point of PVDF in the in soluble mixture of its PE. This principle is simplified as follows:

$$\left[\frac{1}{T_m} - \frac{1}{T_m^0}\right] = \frac{BV_{2u}V_1^2}{\Delta H_{2u}T_m}$$

$$X_{12}RT$$

Test Method of PVDF Fluorocarbon Resin Content

Traditional Quantitative Determination Method

Where,V1 is the volume ingredient of the non-crystal plastics in the inter-soluble mixture.

Tm0 is the fusion point of the pure crystal plastics.

Tm is the fusion point of the crystal plastics in the inter-soluble mixture.

V1u is the mole volume of the non-crystal plastics unit.

V2u is the mole volume of the crystal plastics unit.

△H2u is the full crystallization heat of the crystal plastics.

χ12 –s the Flory-Huggins parameters.

The △H2u of PVDF is determined to be 1.6kcal／mole (25cal/g or 104.2j/g) by using the fusion point reduction principle of original Flory. Under the temperature 160℃, the parameter B is equal to -2.98 cal/cm3. After the Tm0 and Tm are determined, the content of PVDF in coats can be obtained.

To verify the reliability of the fusion point quantitative determination method, Fig.4-16 collects the material of PVDF fusion point reduction from the literature. The fusion point of the original PVDF is higher than that of Hylar 5000 in the literature. However, Fig.4-16 demonstrates the fusion point reduction principle is practicable. To make the determination method simple, Fig.4-17 provides the relationship between the fusion point reduction degree of PVDF (△Tm= Tm0- Tm) and the content. You can evaluate the ingredient of coats if only you determine the fusion point for two times.

The fusion heat of PVDF in the inter-soluble mixture can also assist in the fusion point determination method. The DSC can both determine the fusion point and crystal point and provide the fusion heat. Fig.4-18 shows the relationship between the relative fusion heat and the ingredient of PVDF in coats. The relative fusion heat is equal to the fusion heat of PVDF in the inter-soluble mixture divided by the fusion heat of the pure PVDF.

The principle of the fusion point quantitative determination method is based on two inter-soluble plastics, and the PVDF is inter-soluble with several plastics, for example, the PE with high content of the methyl methacrylate unit. Some manufacturers add the coagulated PE to improve the hardness or change other properties. Hence, this may reduce its inter-solubility with PVDF. In this case, the fusion point of PVDF may be high,

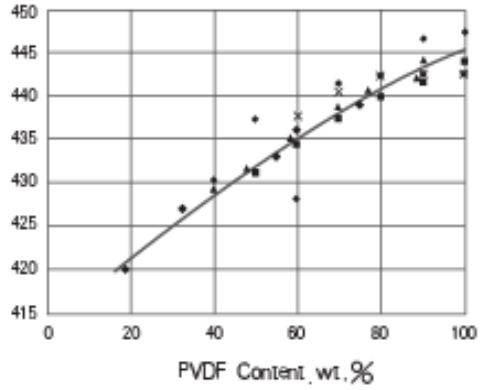


Fig.4-16 Effect of PE Content on Fusion Point of PVDF in Mutual Mixture

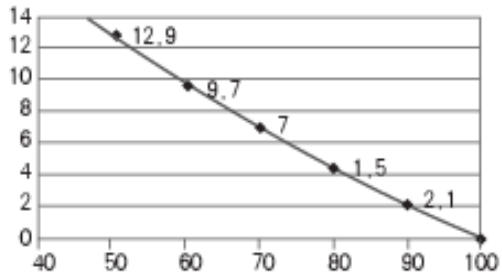
● PVDF/PMMA Tempering Mixture

▲ PVDF/PMMA Melting Mixture;

◆ PVDF/PMMA Solution Dry Mixture;

■ PVDF/PEMA Tempering Mixture;

X PVDF/PMMA Tempering Mixture



The content of PVDF in the plastics.%

Fig. 4-3-10 Relationship between Fusion Point Reduction Degree of PVDF (△Tm= Tm0- Tm) and Its Content

Test Method of PVDF Fluorocarbon Resin Content

Traditional Quantitative Determination Method

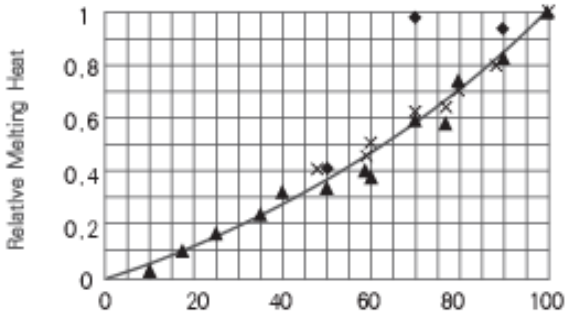
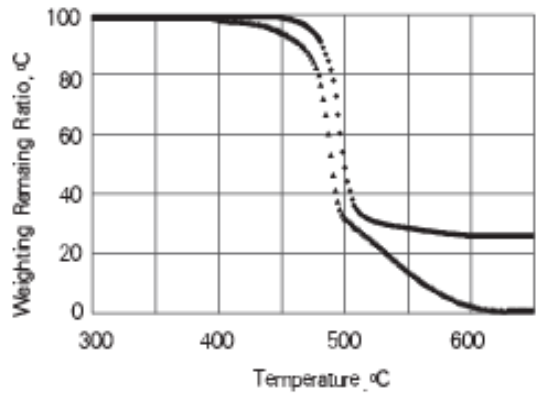


Fig.4-18 Relationship between Relative Fusion Heat and Ingredient of PVDF in Coats
The content of PVDF in the polymer, wt%
The data comes from the literature and will be converted into the relative fusion heat.
Data source:
▲ Nishi and Wang
* Kwei
◆ Morales

Pyrolytic Quantitative Determination Method in Inert Gas



and it will not be used individually if the fusion point is reduced, so the fusion specific heat becomes a necessary determination tool. Especially, if the coat consist of plastics that are not inter-soluble with PVDF fully (such as polyme and the fusion point is close to the pure PVDF, the determination of fusion specific heat becomes a necessary tool.

■ (3) Pyrolytic Quantitative Determination Method in Inert Gas

The plastics will cause the pyrolysis under the high temperature and non-oxidizing condition, and the pyrolysis can be carbonized further depending on the molecular structure. The super weather resistance coats mainly include PVDF, PE and inorganic pigment. In general, the pyrolytic quantity is equal to zero, the PE will not generate the non-oxidizing pyrolysis under the temperature lower than 500℃, and the carbonized quantity of PVDF is abou 34 percent. Fig.4-19 shows the carbonized result of PVDF in the nitrogen by using the TGA.
It supposes that the ingredient of coats is not interactive during the pyrolysis and the pyrolysis quantity Li of some ingredient under a certain temperature is proportional to the weight ingredient (W1) in coats:

$$L_i = L_i^0 \times W_i$$

I indicates some ingredient, such as PVDF, PE (A) or inorganic pigment (P). Assume the pyrolytic quantity of some pure ingredient under a certain temperature is Li0, the total pyrolytic quantity of coats under a certain temperature can be expressed by the following formula:

$$L = \frac{W_p * L^0_p + W_{PVDF} * W^0_{PVDF} + X_A * L^0_A}{W_p + W_{PVDF} + X_A} = \frac{\sum W_i * W^0_i}{\sum W_i * W^0_i}$$

LP＝0%(The inorganic pigment will not generate pyrolysis under this temperature)；
LA＝100%；
WP+WPVDF+WA＝100%

Test Method of PVDF Fluorocarbon Resin Content

Pyrolytic Quantitative Determination Method in Inert Gas

WP can be determined by the air pyrolysis. Certainly, the use of the organic pigment will cause serious error. In general, the organic pigment is high cost and not weather resistance. To reduce the cost and the content of PVDF in coats, the use of the expensive organic pigment may not be rational. L is determined by TGA, and then WPVDF can be obtained by the calculation. To verify the reliability of this determination method, we get the coats with different PVDF contents, where the content of the pigment (TiO2/Shepherd Blue#3＝1/1) is 33.3％. It will cause the pyrolysis in the inert gas under the temperature 760℃. The pyrolytic quantity of PVDF itself under this temperature is 66.6±1.8%. Fig.4-20 demonstrates this principle is practicable. In this experiment, the PE and pure PVDF coats provide 32.1% and 34.0% of the pigment content respectively by using the linear relation, which are close to the expected value 33.3％. It demonstrates this determination method can be used to carry out the quick quantitative analysis of the PVDF content in coats reliably.

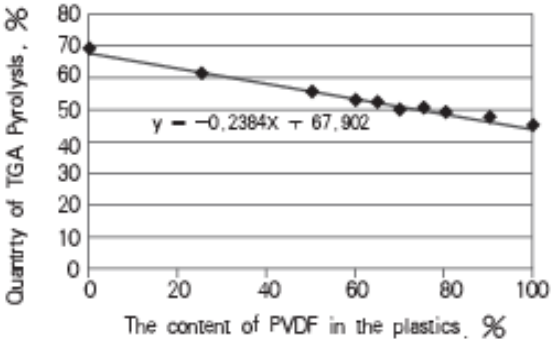


Fig.4-20 Reliability Determination of Pyrolytic Quantitative Analysis Method in Inert Gas

Conclusion

(4) Conclusion

Above describes two micro-determination methods for the reference. These two methods can be used together with each other. However, the investment of instruments and the maintenance cost are high. In face, DSC and TGA are used in the some institutes.

Test Method of Folding Life under Cyclic Deformation of Aluminum Composite Panels

Test Method of Folding Life under Cyclic Deformation of Aluminum Composite Panels

This method simulates the bending fatigue condition of slotting and bending system for Aluminum Composite Panels under the continuous inward (positi wind pressure) and outward (negative wind pressure) action of the wind load and it is applicable to evaluate the capacity of the folding life under the cyclic deformation of Aluminum Composite Panels.

Fig.B.1 Schematic Diagram of Angular Strength Test Machine

4X Magnifier

Steel ruler with the accuracy 1mm

B.1 General Regulation

Test Instruments and Equipments:

The folding life performance test machine under cyclic deformation consists of frames, pneumatic actuation parts, fixture clamping parts and operation control parts as shown in Fig.1. The instrument simulates the deformation of Aluminum Composite Panels under the wind load by controlling the central stress of Aluminum Composite Panels.

B.2 Determination Method

Fig.B.2 Test Installation Diagram

1.Determine the range of swing and the expansion/contraction frequency: connect the control parts to the 220V power supply and determine the swing by adjusting the position of magnetic switches according to the requirement of test. Adjust the supply pressure and the displacement of compressed air to determine the expansion/contraction frequency.

2.Sampling: Feed the material according to the dimension in the sampling installation diagram (Fig.2), slot and manufacture rivet holes with the diameter Φ5.2～Φ5.5. Bend the sample according to the test solution and rivet it with the supporting part by the Φ5 rivet.

3.Fixture: Loose the positioning device of fixture parts, and place the prepared sampling on instruments, and use the Φ5 rivet to fix samplings in the sample bed. Drill holes with Φ6.5 in samplings by the gun drill according to the hole on the clamp of fixture parts. Use M6 screws to fix clamp plates, samplings and clamps.

4. Press the Reset button of control parts and clear the counter. Press the Start button to start the test. When the length of crack at the right corner of the sampling can meet the requirement, press the Stop button and record the expansion/contraction times of samplings and then complete the test.

Test Method of Folding Life under Cyclic Deformation of Aluminum Composite Panels

Test Method of Folding Life under Cyclic Deformation of Aluminum Composite Panels

B0.3 Evaluation Method

If the cracking of any part for Aluminum Composite Panels at the slotting and bending point of Aluminum Composite Panels is up to 50mm, the vibration times are the test times of the dynamic fatigue strength of Aluminum Composite Panels.

Test Method of Folding Life under Cyclic Deformation of Aluminum Composite Panels

Test Method of Natural Environmental Exposure for Aluminum Composite Panels

C.1 Scope

This specification specifies the exposure field, test bed, test sampling and test steps for the test method of the natural environmental exposure for Aluminum Composite Panel coatings.

This specification is applicable to the open natural environmental exposure test, and used for evaluating the weather resistance of coatings for the exposure under the outdoor natural condition.

C.2 References

The clauses in the following documents that were cited by this Standard became clauses of this Standard. For documents with a date, all their subsequent modifications (excluding the errata content) or revisions do not ap this Standard. However, parties having reached an agreement based on cited standards are encouraged to st whether the latest versions of the cited documents are applicable.

GB/T 1766—1995 Paint and Varnish -- Rating schemes of degradation of coats (ISO 4628-1: 1980 NEQ)

GB/T 9754 Paints and Varnishes -- Measurement of Specular Gloss of Non-metallic Paint Films at 20°, 60° a 85° (GB/T 9754-1988 ISO 2813: 1978 EQV)

GB/T 4957 (All parts) Non-conductive Coats on Non-magnetic Metal Substrates -- Measurement of Coats Thic -Eddy Current Method (GB/T 4957-2003 ISO 2360: 1982 EQV)

GB/T 11186.2—1989 Methods for Measuring Color of Paint Films - Part 2: Color Measurement (EQV ISO7724 1984)

C.3 Definition

This standard adopts the following definitions:

C.3.1 Weather Resistance

The endurance of Aluminum Composite Panels under the action of natural weather factors

C.3.2 Natural Environmental Exposure

The test used to observe the change of performance for the test piece by placing Aluminum Composite Panels into the natural environment to imple

ment the integrated action of various weather factors

C.3.3 Open Exposure

The exposure method that places samples into the ventilated air and there is no cover on it or pad under it

C.4 Exposure Test Field

C.4.1 The exposure test field should be selected to establish at the most rigorous district that represents various types of climates or under the actual use environment of products to be tested.

C.4.2 The exposure test field should be even, spacious, without accumulated water, and the height of grasses should not exceed 0.3m.

C.4.3 There should not be the factory chimneys and facilities that can emit a large number of corrosive gases around the exposure plant, to prevent from the effect of local serious pollution.

C.4.4 The exposure test field should be equipped with the meteorological observation instrument, which is located around the national weather station to make use of much observation material of this station directly. The meteorological data mainly includes the air temperature and humidity, sunshine duration, solar radiation, rainfall, wind speed and wind direction.

C.5 Exposure Test Bed

C.5.1 The exposure test bed is the support used for the exposure test sample within the exposure field, whic should be made of the inert materials that don't affect the test result, such as the wood, reinforced concrete, aluminum alloy or the steel with the anticorrosive coats. The structure should be firm as soon as possible to endure local maximal wind power.

C.5.2 Samples within the exposure test bed should be isolated from the metal and should not contact with th wood or the porous material as much as possible. It is recommended to use the porcelain isolators to fix samples.

C.5.3 The placement of the exposure test bed should ensure the free ventilation between test beds. In order to prevent the sunshine shield and provide the convenience for work, the row spacing should not be less tha 1m.

Test Method of Natural Environmental Exposure for Aluminum Composite Panels

C.5.4 The distance from the bottom of the exposure test bed to the ground should not be less than 0.5m.

C.5.5 The exposure test bed is oriented to the equatorial and is 45º with the horizontal line to expose samples. To make the surface of samples suffer from the maximal sun radiation, the exposure test bed should be placed in local latitude angle with the horizontal line.

C.6 Test Samples

The sample size for the natural weather exposure test is specified as 300mm×300mm. At the same time, it will prepare three exposure samples and one standard sample for the contrast. The distance from the plate edge for cutting should not be less than 50mm.The standard samples should be stored in the place that provides excellent indoor ventilation, drying and without the lighting radiation.

C.7 Test Steps

C.7.1 You should observe the appearance of coating films for samples, such as the gloss, color and physical and mechanical performance to be tested, and carry out the original record, mainly including the name of manufacturers, original gloss, thickness of paint film coats, surface status of paint films as well as the test date.

C.7.2 The result of the exposure test will vary depending on the test season. However, this effect will be reduced with the increasing of the exposure time. In general, the exposure test season is specified at the end of spring and at the beginning of summer.

C.7.3 Year and month are taken as the time unit of the exposure test. Unless special otherwise stated, it will be checked once every month within 1 year of the use, and then it will be checked for once every three months after 1 years. It can also take a certain sun radiation that the sample surface suffers from as the exposure period. When the weather changes suddenly, it should be checked at any time. If any abnormity takes place, it should be recorded or taken photo.

C.7.4 The exposure term of samples may comply with the requirement of product standards or put forward the forecasted time (month and year), or

Test Method of Folding Life under Cyclic Deformation of Aluminum Composite Panels

Test Method of Natural Environmental Exposure for Aluminum Composite Panels

take the sun radiation the samples suffer from as the exposure term, or specify the duration as the exposure term when the exposure samples reach some aging damage degree.

C.7.5 The gloss and color of the exposure Aluminum Composite panel samples should be measured according to GB/T 9754 and GB/T 11186.2, and the rating of degradation for paint film coats should be carried out according to GB/T 9277.

Identification Method of Common Plastics

Identification Method of Common Plastics

Name	English	Combustion Condition	Status of Combustion Flame	Condition after Keeping away from Flame	Smell
Polypropylene	PP	Easy	Melt drippingyellow for upper and blue for down	A few smoking, continue the combustion.	Petroleum Smell
Polyethylene	PE	Easy	Melt dripping yellow for upper and blue for down	Continuethe combustion.	Paraffin Burning Smell
Polyvinyl Chloride	PVC	Hard to soften	yellow for upper and green for down, with smoking	Keeping away from flame to extinguish	Pungent Acid Smell
Polyformaldehyde	POM	Easy to melt dripping	yellow for upper and bluefor down, without smoking	Continuethe combustion.	Strong Pungent Formaldehyde Smell
Polystyrene	PS	Easy	Melt dripping	Continuethe combustionsurface oil, bright	Special Ethylene Smell
Nylon	PA	Slow	Melt to bubble, light blue, white, without smoking	Bubbling, slow to extinguish	Special Wool, Nail Smell
Poly(methylethacrylate)	PMMA	Easy	Soften ingand bubbling, orange yellow,dense black smoking, ite, without smoking	Continue the combustion.	Strong Fruit Odor, Rotten Vegetable Smell
Polycarbonate	PC	Easy to soften and bubble	With a few black smoking	Keeping away from flame to extinguish	Without Special Smell
Poly(tetrafluoroethylene)	PTFE	Non-nflammable	Orange, With some black	Keeping away from flame to extinguish slowly	Decomposn Pungent Hydrogen Fluoride Smell in Blaze
Polyethylene terephthalate	PET	Easy to soften and bubble			Acidic Smell

Contrast Table of Different Aluminum Series

Contrast Table of Different Aluminum Series

Item / Series	1000	3003	5005
Alloy Components	Pure Aluminum	Aluminum-manganese Alloy	Al-Mg Alloy
Surface Hardness, HB	44	47	45
Extension and Manufacturing Characteristics (%)	5	6 - 14	7
Bending Strength (MPa)	152	175	159
Shearing Strength (MPa)	90	105	97
Advantages	Smooth panel surface and light mass	More smooth panel and optimal rigidity	Antirust aluminum with excellent weathe resistance and anti-corrosive performance, back of Aluminum Composite Panels needs carry out the paint baking process
Key Scope of Application	Internal and external decoration, as well as advertisement	Be more applicable to the exhibition show, panel printing and screen printing	Internal and external decoration

Effect of Different Aluminum Alloys on Mechanical Properties of Aluminum Composite Panels

Aluminum Alloy	Thickness of Aluminum	Total Thickness	Coats	Bending Strength (MPa)	Bending Elastic Modulus (MPa)	Perforation Resistance (KN)	Shearing Strength(MPa)
1100 Aluminum Alloy	50	4	PVDF2	127.91	30666.97	8.38	26.01
3003 Aluminum Alloy	50	4	PVDF3	161.11	33550.41	9.69	30.29
5005 Aluminum Alloy	50	4	Double Faced	133.59	31387.73	8.71	27.75
Contrast			PET	Fig.1	Fig.2	Fig.3	Fig.4

Characteristics:

The 1100 Aluminum Alloy can provide products stably, the 3003 Aluminum Alloy can provide high hardness and excellent anti-deformation capacity, and the 5005 Aluminum Alloy can provide high toughness and excellent bending performance.

Classification of Use:

The 3003 (or 3105) Aluminum Alloy is taken as the advertisement panel and can provide excellent surface smoothness and anti-deformation performance. The 5005 Aluminum Alloy is taken as the high-level buildings, and the folding edge will improve its service life greatly.

Contrast Table of Different Aluminum Series

Effect of Different Aluminum Alloys on Mechanical Properties of Aluminum Composite Panels

Fig.1 Bending Strength MPa

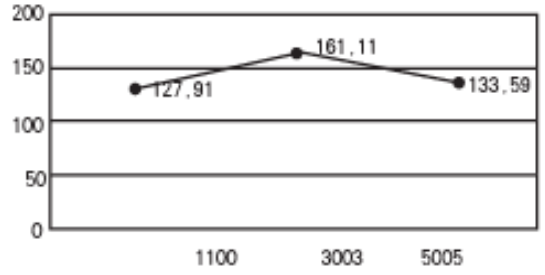


Fig.2 Bending Elastic Modulus MPa

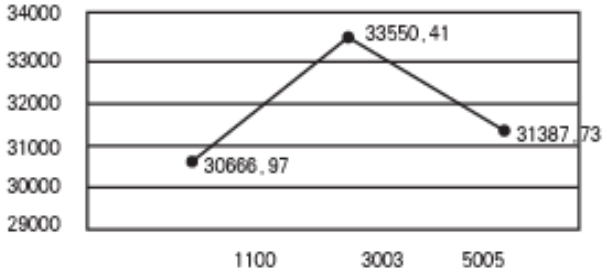


Fig.3 Penetration Resistance KN

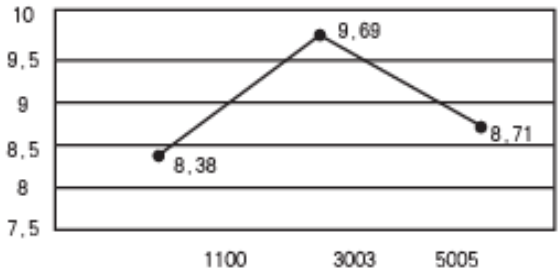
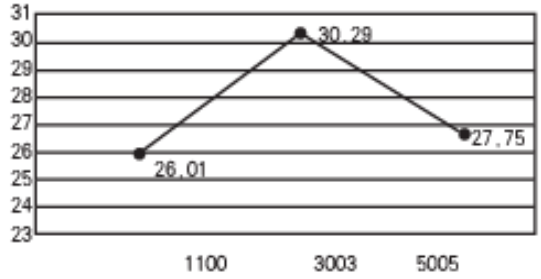


Fig.4 Shearing Strength MPa



Performance Contrast Table of Different Core Materials

Performance Contrast Table of Different Core Materials

Item / Classification	LDPE	PP	Flame Retardant Core Material
Main Components	High Pressure and Low Density PE	Polypropylene	Magnesium Hydroxide Flame Retardants
Environmental Protection Performance	Recyclable and in-noxious	Recyclable and in-noxious	Recyclable and in-noxious
Specific Gravity (kg/m^3 (4mm))	5.7	5.4	6.7
Advantages	Easy to bend and deform, excellent toughness and multiple forms	High hardness, a new composite material, the weight is reduced by 60 percent than that of the steel plate. The weight is reduced by about 30 percent. Furthermore, it can provide excellent ratio of mass to rigidity.	Fireproof and flame retardant
Key Scope of Application	Indoor and outdoor decoration, advertisement ID and curtain wall application	Plane advertisement, printing, screen printing, internal and external decoration and isolation plate of container, steamboat, automobile and train	For the site with high requirement for the fireproof performance, the fireproof level can b up to level A or level B according to the difference of requirements.v

Effect of Different Plastic Core Panels on Mechanical Properties of Aluminum Composite Panels

Plastics	Thickness of Aluminum	Total Thickness	Coats	Bending Strength (MPa)	Bending Elastic Modulus (MPa)	Perforation Resistance (KN)	Shearing Stren (MPa)
PEPlastics	30	2	Double-sidePET	95.54	24643.84	4.71	27.21
PP Plastics	30	2	Double-sidePET	107.48	26922.42	5.51	31.83
Contrast				Fig.1	Fig.2	Fig.3	Fig.4

Characteristics:
The PE product is mature.
PP can provide high hardness and excellent anti-deformation capacity.
Classification of Use:
The advertisement board can use PP.

Performance Contrast Table of Different Core Materials

Effect of Different Plastic Core Panels on Mechanical Properties of Aluminum Composite Panels

Fig.1 Bending Strength MPa

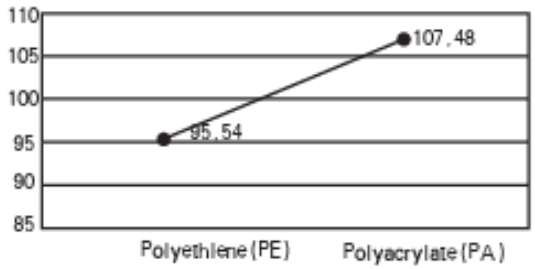


Fig.2 Bending Elastic Modulus MPa

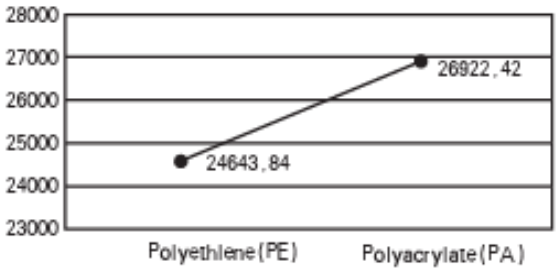


Fig.3 Penetration Resistance KN

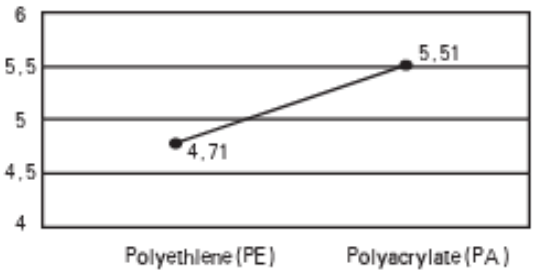
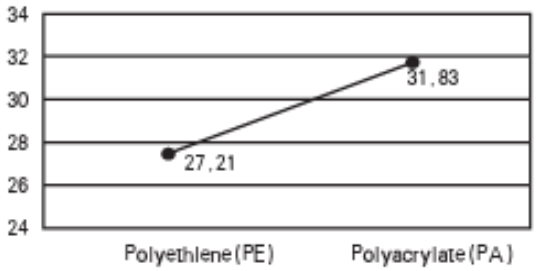


Fig.4 Shearing Strength MPa



Manufacturing Method of Aluminum Composite Panels

Manufacturing Method of Aluminum Composite Panels

Aluminum Composite Panels are simple to manufacture and convenient to fabricate. Furthermore, it can carry out several manufacturing operations as follows:

■ 1 Trimming:

Trimming: The trimming of Aluminum Composite Panels must be carried out on the trimming equipment designed for the metal plate. It should ensure the flatness of Aluminum Composite Panels during the manufacturing, and there should not be the impurity and foreign matter on the platform of trimming machines. It should ensure the cleanliness for the platform of trimming machines. During the trimming, refer to the table below for reserved appropriate machining allowance and the front angle of inclination for the trimming machine.

Panel Materials Specification of Aluminum Composite	Allowance Machining	for trimming Machine
3mm Aluminum Composite Panels	0.04 mm	1°
4mm Aluminum Composite Panels	0.04 mm	1° 302
4mm Aluminum Composite Panels	0.2mm	1° 302

Test Tools and Methods: Visual inspection by steel ruler.

Sawing: The sawing of Aluminum Composite Panels must be carried out on the sawing equipment designed for the metal plate. It should ensure the flatness of Aluminum Composite Panels during the manufacturing. It should use the plate to fix and manufacture in the cutting saw movement way during the sawing, to ensure the flatness of the manufacturing edge and the linearity of the manufacturing plate. The blade of the sawing machine is dedicated manufacturing saw for the metal plate. The rotation speed of the machining equipment should not be less than 3000 rpm, and the machining movement speed should not be greater than 5m/min.The movement of the saw must feed against the linear rolling guide, and the saw should move smoothly. After the cutting of Aluminum Composite Panels, there should not be the burr and foreign matter of the plate sandwich for the machining edge.

Manufacturing Method of Aluminum Composite Panels

Manufacturing Method of Aluminum Composite Panels

■ 2 Slotting:

The molding process of the curtain wall for Aluminum Composite Panels doesn't allow machine the folding edge directly. It should carry out the slotting and prepare for the folding edge before the bending. The slotting depth must be controlled for 0.3mm of plastic core material after the frontal Aluminum Composite Panel, to ensure enough toughness of Aluminum Composite Panels and prevent the aluminum fracture at the folding edge.

The slotting of Aluminum Composite Panels must be carried out on the dedicated machine equipment. It should use flat base plates at the back of Aluminum Composite Panels during the manufacturing, to ensure the flatness of Aluminum Composite Panels for the slotting process. It should use plates to fix and manufacture in the slotting saw movement way during the slotting, to ensure the slotting size and the linearity of the manufacturing slots. The saws of machining equipments are dedicated slotting saw for the metal plate. The rotation speed of the machining equipment should not be less than 3000 rpm, and the machining movement speed should not be greater than 5m/min.The movement of saws must feed against the linear rolling guide and the saw should move smoothly.

■ 3 Bending

It should use the tool with handles to bend the folding edge for one time during the bending. It should not be bent or deformed for several times. The contact placement between the bending tools and Aluminum Composite Panels should be equipped with the soft material (felt, plastics and rubber pad). It should make the force distributed evenly during the bending, to prevent the deformation of Aluminum Composite Panels.

During the second bending, the pad should be placed on Aluminum Composite Panels (Material requirement: wood block and hard plastic block). The platform should be placed at the bottom of the concave right edge folding (there is no impurity for the platform). It is required to place the pad at the folding edge during the second folding edge.

Manufacturing Method of Aluminum Composite Panels

Manufacturing Method of Aluminum Composite Panels

■ 4 Rolling

Vertical and parallel rolling refers to the relationship between the bending direction and the extension texture of Aluminum Composite Panels. The bending radius of Aluminum Composite Panels without the surface process refers to the minimal bending radius under the condition that the surface of Aluminum Composite Panels doesn't show obvious wrinkle. The bending radius of Aluminum Composite Panels for the coats is the minimal bending radius. However, not any abnormity such as the crack and broken mark can almost be detected at the bending point.

For the rolling process, the bending angle depends on the diameter and space of the axis. It will always show the flat part of the start point and end point during the bending (the flat part should be 5 times of the thickness for Aluminum Composite Panels at least). If it is required that there is no the flat part for the project design, it should cut the flat part before the bending process.

For the rolling process, the rubber pad or the material with the hardness lower than Aluminum Composite Panels should be placed at the mould mouth, to prevent the extension of Aluminum Composite Panels. The surface of the bending equipment axis should be clean and there should not be the dent or impurity, to prevent the concave and convexity of Aluminum Composite Panels and twisting of Aluminum Composite Panels surface during the bending process.

5 Drilling

The drilling of Aluminum Composite Panels complies with the mechanic drilling process. It doesn't allow the drilling process of Aluminum Composite Panels on the non-mechanic equipments.

6 Punching

The punching of Aluminum Composite Panels complies with the mechanic punching process. It doesn't allow the punching process of Aluminum Composite Panels on the non-mechanic equipments.

Manufacturing Method of Aluminum Composite Panels

Manufacturing Method of Aluminum Composite Panels

The punching shear loss will take place on Aluminum Composite Panels during the punching, so the size of holes (in general, the diameter should be greater than 4mm) should not be too large, otherwise, it will cause the deformation of the hole edge.

The allowance of holes for the punching should be as small as possible, and it is usually applicable to be 5 percent of the thickness for Aluminum Composite Panels (This data is only for the reference).

The punch should not use the direct column one. It is suggested to use the trapezoidal punch to carry out the separate punching shear during the punching.

■ 7 Other process types, such as the surface treatment, including the screen printing and plane printing.

Fabrication Method of Aluminum Composite Panels

Fabrication Method of Aluminum Composite Panels

■ 1. The specification and color of Aluminum Composite Panels should meet the requirement of the project design.

■ 2. The manufacturing allowance of Aluminum Composite Panels should comply with the regulation in Table 1.

Table 1 Manufacturing Allowance of Aluminum Composite Panels (MM)

Test		Allowance	Test Tools
Edge Length	2000	±2.0	Steel Tape and Steel Ruler
	>2000	±2.5	Steel Tape and Steel Ruler
Opposite-side Size	2000	2.5	Steel Tape and Steel Ruler
	>2000	3.0	Steel Tape and Steel Ruler
Diagonal Length	2000	2.5	Steel Tape and Steel Ruler
	>2000	3.0	Steel Tape and Steel Ruler
Bending Height		1.0	Steel Tape and Steel Ruler
Flatness		2/1000	Steel Tape and Flat Ruler
Center Space of Holes		±1.5	Steel Tape and Steel Ruler

■ 3. Deep Processing of Aluminum Composite Panels:

The attention should be paid to the surrounding environment and the metal scraping from the cutting should be cleaned in time, to prevent from scratching the surface of Aluminum Composite Panels during the processing. The manufacturing and storage of Aluminum Composite Panels should not be carried out in the damp environment, and there should not be water accumulation around the manufacturing field. It is strictly prohibited to cause the water accumulation on Aluminum Composite Panels. If Aluminum Composite Panels are in the rain during the transportation and shipment, they should not be placed together immediately, but be placed only after Aluminum Composite Panels are dried completely.

■ a、Cutting: Aluminum Composite Panels can use the circular saw cutting, wire saw cutting and punching shear cutting.

Manufacturing Method of Aluminum Composite Panels

Fabrication Method of Aluminum Composite Panels

- b、Slotting: The slotting process should be carried out on the dedicated slotting machine of Aluminum Composite Panels. The slotting cutter dedicated for Aluminum Composite Panels with different shapes and angles is used to carry out the slotting process from the back of Aluminum Composite Panels, and the saw blade with different shapes and angles can meet the design requirement of different bending angles. The slotting depth should be strictly controlled to reserve 0.3mm of the plastic core material after the frontal Aluminum Composite Panels at least. The processing of Aluminum Composite Panels with different thicknesses should use the slotting depth control wheel accompanying with this thickness. The slotting should not be carried out at the same place. The slotting should not be carried out at one side of the decoration plate.

  c、Bending: The slotting bending of Aluminum Composite Panels should be carried out according to the bending procedure, the method of slotting before bending is taken. The bending can be carried out by manual. The material and fittings for the connection and fixation should be prepared in advance before the bending, and it should not bend repeated.

- d、Rolling: Aluminum Composite Panels must be cool-rolled and the bending process can not be carried out by the heating. The rolling process of Aluminum Composite Panels should be carried out on the bending equipments dedicated for the metal plate (the bending equipments such as the bender, three-axle bender and bending roller). It should try to manufacture the sample during the process to find out the times of rolling and the resilience coefficient for the process by the samples. It should note to protect the frontal paint baking. In general, 2mm thickness of the PE soft panel or rubber pad can be used between the frontal Aluminum Composite Panel and the roller, to play the role in protecting the surface of Aluminum Composite Panels during the processing. The minimal rolling radius of Aluminum Composite Panels should meet the requirement in Table 2.

Table 2: Minimal Rolling Radius of Aluminum Composite Panels (mm)

Minimal Bending Arc Radius of Common Aluminum Composite Panel (R)		
Panel Thickness	4	6
Vertical Radius	100	150
Parallel Radius	150	200
Minimal Rolling Radius of Fireproof Aluminum Composite Panels (R)		
Panel Thickness	4	6
Vertical Radius	250	400
Parallel Radius	350	600

Fabrication Method of Aluminum Composite Panels

Fabrication Method of Aluminum Composite Panels

■ e、Drilling: The drilling of Aluminum Composite Panels can be carried out on common metal processing equipments by common twist drill, and the three-side incline core drill and the flat-bottom reaming drill can be used to carry out the conical port enlarging process on Aluminum Composite Panels. The distance from the center of holes to the edge of the center-to-center distance should not be less than 2 times of the aperture, and the center-to-center distance of holes should not be less than 3 times of the aperture. During the drilling, there should not be the impurity and uneven surface of the drilling platform, to prevent the concave and convex of Aluminum Composite Panels and twisting Aluminum Composite Panels surface.

■ f、Punching: The common plate severing machine can be used to carry out the punching process, the punching diameter should be greater than 4mm, and the distance from the center of holes to the edge of the panel should not be less than 2 times of the aperture, and the center-to-center distance of holes should not be less than 3 times of the aperture. There should not be the impurity and uneven surface of the drilling platform, to prevent the concave and convex of Aluminum Composite Panels and twisting Aluminum Composite Panels surface.

■ g、Corner Combining: The combining of Aluminum Composite Panels into the box shape should cut four corners before the folding. The seam at the corner during the folding should be tight and smooth, and it should be punched by using dedicated punching machines. During the corner combining, the Aluminum Composite Panels with the thickness not less than 1.5mm should be placed by at the back of the seam, and the rivets should be used to connect Aluminum Composite Panels with the lining plate.

■ 4. Assembly of Curtain Wall for Aluminum Composite Panels:
The assembly of Aluminum Composite Panels refers to fabricate into the box-shaped plate after the slotting. The assembly technique includes the folding, corner combining and the connection with the reinforced

aluminum material at the edge. For the curtain wall application, the connection will use the bulbed rivet. Some design uses the structural two-sided tape to assist in connecting the reinforced aluminum material and the aluminum plate at the back.

■ a、Rivet Connection:

The curtain wall of Aluminum Composite Panels should use the bulbed rivet with the stainless steel core material, and the countersunk rivet should not be used to the curtain wall.

-- For the rivet connection, it should reserve the seam no more than 0.3mm between the hole and the rivet, to prevent Aluminum Composite Panels from the deformation by the extrusion.

-- The rivet should not extrude the protection film of Aluminum Composite Panels. It should remove the protection film around the rivet.

-- Use the rivet connection to prevent the electric corrosion for the metal with different materials, and a layer of insulated material pad should be placed at the connection point of different metal layers.

■ b、Bolt Connections:

-- Aluminum Composite Panels should be connected by the stainless steel bole with the sealed washer.

-- During the connection, it should reserve a 0.3mm of seam between the hole and the bolt, to prevent Aluminum Composite Panels from the deformation by the extrusion.

-- The washer and nut should not extrude the protection film of Aluminum Composite Panels. It should remove the protection film around the rivet.

[Description] The hot air can be used to weld plastics or connect Aluminum Composite Panels. It is not recommended to use the hot air method to connect during the fabrication of curtain walls for Aluminum Composite Panels.

■ 5. Fabrication of Reinforced Rib for Curtain Wall of Aluminum Composite Panels

■ a、Assembly of Reinforced Rib: The structural assembly method should be used to reinforce the back of Aluminum Composite Panels. Both sides of the reinforced rib should be connected with the reinforced material at the edge of panels effectively.

Fabrication Method of Aluminum Composite Panels

Fabrication Method of Aluminum Composite Panels

- b、The materials and coats of the reinforced rib should be compatible with the structural adhesive or tape.

- c、The assembly method should meet the requirement of the construction specification for the structural adhesive when the reinforced rib and the back of Aluminum Composite Panels use the structural adhesive to carry out the structure assembly.

- d、For the component after the structure assembly and connection, there should not be degumming and separation between the back of Aluminum Composite Panels and the reinforce rib.

- e、If the structural bonding tape is used, it should apply enough pressure and maintain the time up to the bonding force between the bonded parts.
  [Description] If the size of panel is large, it should be reinforced in the structural assembly way at the back of Aluminum Composite Panels according to the design wind load value of the project. The reinforced material should use the aluminum alloy (may be U-shape, C-shape or square tube). The reinforced rib and the back of Aluminum Composite Panels should use the structural adhesive or tape to connect effectively. It is required that the structural adhesive or structural tape be compatible with the reinforced rib and the back of Aluminum Composite Panels (or the surface of naked aluminums after the chemical processing).

- 6. The fittings and connector of curtain walls for Aluminum Composite Panels should comply with the following regulation:

- a、The hanging and supporting parts used for curtain walls of the unit Aluminum Composite Panel should use the aluminum alloy or stainless steel and provide the adjustable range.

- b、The connection between the hanging parts and the embedded parts of the unit curtain wall should use the penetration bolt.

  c、When the screw connection is used between the panel and the skeleton or among the skeletons, the local wall thickness of the aluminum material connection parts should not be less than nominal diameter of screws.
  [Description]

- 3 If the thickness of the aluminum material is less than the nominal diameter of screws, it can be reinforced at the connection part locally.

Construction and Installation of Curtain Walls for Aluminum Composite Panels

Construction and Installation of Curtain Walls for Aluminum Composite Panels

■ 1. The installation of the fitting steel and the aluminum angle ruler should be determined by calculating the load and action for Aluminum Composite Panels under the most unfavorable working condition.

■ 2. The installation of curtain wall columns for Aluminum Composite Panels should comply with the following regulation:

1 The allowance of the column installation axis is ±2mm.

2 The allowance of the installation elevation for two adjacent columns is ±3mm, the allowance of the maximal elevation for the same layer of columns is ±5mm, and the allowance of the distance between two adjacent columns is ±2mm.

3 The column should be fixed in time after it is installed in place and adjusted.

[Description] The installation accuracy and quality of curtain walls column for Aluminum Composite Panels will have an effect on the installation quality of the whole curtain wall, and is a critical factor of the installation and construction of curtain walls. Hence, this regulation should control the difference between the axis of curtain walls plane and the outer plane axis by the 3D adjustment of the connection parts. Especially for curtain walls whose building plane is the arc, round and surrounding closure, special care should be taken to the installation and construction for the distance between the internal and external axis has an effect on the perimeter of curtain walls and the closure of the metal and stone plate.

The length of the column is usually determined according to the building requirement, force condition, construction and transportation condition. In general, one floor height of the building is a whole column and there should be some slot greater than 15mm. The core column connection method can be used between the columns, to accommodate to and eliminate the effect of the deformation of the building for the force and temperature difference.

■ 3. The installation of curtain walls beam for Aluminum Composite Panels should comply with the following regulation:

1 The beam should be installed fixed and the seam should be tight. If there is the extension/contraction seam between the beam and the column, the design requirement should be met. When the sealed

adhesive seam is used, the construction of the adhesive seam should be even, tight and continuous.

2 The allowance of both ends for the same beam or the horizontal elevation of two adjacent beams is ±1mm. For the allowance of the elevation for the same layer of beam, when the width of one curtain wall is not greater than 35m, it can get 5mm, and when the width of one curtain wall is greater than 35m, it can get 7mm.

3 After one layer of the height is installed completely, the check, correction and fixation should be carried out in time.

[Description] In general, for the connection between the beam section and column, enough gap should be reserved between two beams, or the elastic rubber pad with enough compressed deformation capacity (no lower than 20 – 35% usually) is used, to accommodate the possible deformation of the structure or the extension/contraction deformation caused by the temperature change of the beam. In general, the bolt connection can be used between both ends of the aluminum beam and the column, or the connection method of the beam extension deformation may be used at one end. The welding connection can be used between the steel beam and the column.

■ 4. The installation of other main attachments for curtain walls should comply with the following requirements.

1 The fireproof and insulation material should be placed smoothly and fixed reliably, and there should not be seam at the connection point.

2 The condensation water outlet pipe and its attachments should be connected with the reserved hole of the horizontal elements tightly, and the connection point with the drainage hole of the internal liner panel should take the sealing measure.

3 Other ventilation slot, hole and rain outlet port should be constructed according to the design requirement and should not be neglected.

4 The sealing process should be taken at the sealing point.

5 The temporary bolts used for the installation and construction should be removed in time after curtain walls is fixed.

[Description] The fireproof and insulation material should be placed smoothly and fixed reliably, and there should not be seam at the connec

tion point, and the design requirement should be met. If the condensation water outlet pipe and its attachments are not connected with the reserved hole of the horizontal elements tightly, or the connection point with the drainage hole of the internal liner panel doesn't take the sealing measure, the condensation water may enter into the internal curtain wall and cause the internal immersion and corrosion, and have an effect on the performance and service life of curtain walls.

■ 5. The installation of curtain walls for Aluminum Composite Panels should comply with the following regulation:

a Should check, measure and adjust the horizontal and vertical connection parts, and reduce the installation error of Aluminum Composite Panels.

b The installation of curtain walls for Aluminum Composite Panels should be in the same direction as noted in the protection film.

c The seam between the panels should be 8mm at least.

d When Aluminum Composite Panels are riveted, it is suggested to be fixed in the sequence from the middle to both ends of the panel. Taking the extension/contraction of Aluminum Composite Panels caused by the temperature change into account, the aperture on Aluminum Composite Panels should be 1mm greater than the diameter of rivets, to ensure the flatness of Aluminum Composite Panels.

e For the rivet which carries out the structural fixation outdoors, the diameter of stems should be 5mm and the diameter of rivet headers should be 11mm～14mm.

f When the curtain wall seam of Aluminum Composite Panels is filled with the silicone sealant for buildings (wet-process sealing hidden panel seam), the width and thickness of Aluminum Composite Panels should comply with the technical parameters of the silicone weather-resistant sealant and meet the requirement of the calculated result.

g The shell nosing of curtain walls should take reliable waterproof sealing measure.

h The protection film on the panel surface should be removed within the date noted in the protection film.

Construction and Installation of Curtain Walls for Aluminum Composite Panels

Construction and Installation of Curtain Walls for Aluminum Composite Panels

[Description]

- 1 This clause specifies related regulation on curtain walls installation of Aluminum Composite Panels:
- 2 For the coating process of Aluminum Composite Panels is the roll coating, there are some difference of the color in the horizontal and vertical direction, and it is specially obvious for the coats with the metal color. Hence, to ensure the color consistence of curtain walls for Aluminum Composite Panels, the same installation direction should be ensured.
- 3 Enough deformation seams between the panels should be reserved, to prevent the extrusion caused by the deformation of the main body structure.
- 4 The edge of curtain walls should use Aluminum Composite Panels or aluminum material to seal or take the waterproof and sealing measure.
- 5 The protection film should be removed in time after the construction is completed, to reduce the possibility that it is hard to remove, miss the sealing adhesive or cause serious surface pollution of Aluminum Composite Panels by the degradation of the protection film.
- 6 The Aluminum Composite Panels block should be installed according to the design requirement and fixed after the adjustment is completed.
- 7 The installation allowance of curtain walls for Aluminum Composite Panels should comply with the regulation in Table 1 and 2.

Construction and Installation of Curtain Walls for Aluminum Composite Panels

Construction and Installation of Curtain Walls for Aluminum Composite Panels

Table 1: Assembly Allowance of Vertical and Horizontal Panel Material for Curtain Walls of Aluminum Composite Panels (mm)

Item	Size Scope	Allowance	Test Method
Spacing Size between Two Adjacent Vertical Panel Materials (Fixed End)	--	±2.0	Steel Tape
Composite PanelTwo Adjacent Aluminum	--	±1.5	measure tapeSteel
Spacing Size between Two Adjacent Horizontal Panel Materials	If the spacing is less than or equal to 2000,	±1.5	Steel Tape
	If the spacing is greater than 2000,	±2.0	
Difference of Division Diagonal	If the diagonal length is less than or equal to 2000,	⩽3.0	Steel Tape or Extension/Contraction Ruler
	If the diagonal length is greater than 2000,	⩽3.5	
Horizontal Elevation Difference of Two Adjacent Horizontal Panel Materials	----	⩽2	Steel Tape or Gradienter
Horizontal Degree of Horizontal Panel Material	f the length of the component is less than or equal to 2000,	⩽2	Gradienter or Level Ruler
	If the length of the component is greater than 2000,	⩽3	
MaterialLinearity of Vertical Panel	----	2.5	2.0m Steel tape measureand Steel Tapev

Table 2: Allowance of Curtain Walls Installation

Item			Allowance	Test Method
Vertical Seam and Vertical Degree of Curtain Walls	Height of Curtain Walls (H)	H⩽30m	⩽10mm	Laser Theodolite or Theodolite
		30m＜H⩽60m	⩽15mm	
		60m＜H⩽90m	⩽20mm	
		H＞90m	⩽25mm	
Flatness of Curtain Walls			⩽2.5mm/2m	2m Steel tape measure and Steel Tape
Linearity of Vertical Seam			⩽2.5mm/2m	2m Steel tape measure and Steel Tape
Linearity of Horizontal Seam			⩽2.5mm/2m	Tapeand Steel measuretape 2m Steel
Width of Seam (Compare with the design value)			±2.0mm	Callipers
Difference of Seams between Two Adjacent Panels			⩽1.0mm	Depth Indicator

Construction and Installation of Curtain Walls for Aluminum Composite Panels

Construction and Installation of Curtain Walls for Aluminum Composite Panels

■ 8. In curtain walls of Aluminum Composite Panels, the silicone sealant for buildings should not be constructed in rain. The sealant injected temperature should comply with the product and design requirement. Furthermore, the sealant injected surface should be cleaned and dried before the sealant is injected.

[Description] The construction of the silicone sealant for buildings should strictly comply with the construction process. The sealant should not be injected if the lighting is not enough at night or the seam is damp for rain. If it is necessary to construct for various reasons, necessary protection measure should be taken, and the sealant injected temperature should comply with the design requirement and the product requirement, and should be within the specified temperature range of products. Furthermore, the sealant injected surface should be cleaned and dried before the sealant is injected.

The construction thickness of the silicone sealant for buildings between the frame supporting curtain wall panel materials should be usually controlled within 3.5mm～4.5mm. If the material is too thin, the sealing quality can not be ensured and the rain leakage can not be prevented. At the same time, it is disadvantage of the deformation caused by the hot-swelling and cold-shrinkage of the aluminum alloy frame. When it suffers from the tensile stress, it is easy to be broken or damaged and lose the sealing and anti-leakage function if the sealant seam is too large. The construction thickness of the silicone sealant for buildings should not be less than two times of the thickness or should be determined according to the actual calculated thickness. The construction thickness and width of the sealant for the narrow seam stone material curtain walls should comply with the design requirement, the deep sealant seam bottom should be filled by the PE foamed material, to ensure the design and construction position of the silicone sealant for buildings.

The silicone sealant for buildings should be pasted at two opposite sides within the seam and should not be pasted at three sides. Otherwise, the sealant is easy to be torn down and will lose the sealing and anti-leakage function when it is pulled and pushed. To prevent the three sides paste, the tape without the paste can be placed at the bottom of the sealant seam (at the bottom of the seam) to separate the seam bottom and the sealant before the construction of the silicone sealant for buildings.

Design of Curtain Wall Panel for Aluminum Composite Panels

General Requirement

■ I. General Requirement

■ 1. The design of curtain walls panel for Aluminum Composite Panels should use the surrounding folding method. Furthermore, it should not contact with the surface layer Aluminum Composite Panel during the slotting. The thickness of the remaining plastic core material should not be less than 0.3mm after the slotting. The core material of Aluminum Composite Panels should not expose to the atmosphere directly. Aluminum Composite Panels without folding should use the aluminum material inlay to fix around it or use the weather-resistant sealants to seal.

[Description] Aluminum Composite Panels usually increases its rigidity by the surrounding folding, and can prevent the core material of Aluminum Composite Panels to expose the atmosphere. At present, some projects also use Aluminum Composite Panels without folding and adding of aluminum material method. At this time, Aluminum Composite Panels should be embedded into the aluminum frame or use the sealant to seal the core material. It should be noted to take some measure to prevent the panel core from exposing the atmosphere directly when it adopts the open curtain walls.

■ 2. The folding of Aluminum Composite Panels can set the reinforced frame and mid rib according to the requirement. Curtain walls panel of Aluminum Composite Panels for the high-level building should not take the aluminum angle ruler as the frame. The aluminum material should be taken as the reinforced frame and middle rib. The reinforced frame or rib can take the metal square tube, slot-shape or angle-shape material. The reinforced frame or rib should be connected with the panel reliably and should take the anti-corrosive measure. The connection between the frame and the folding of Aluminum Composite Panels can use the aluminum rivet, both ends of the middle rib should be connected with the frame reliably, and its connection should meet the requirement of the load transfer to connect reliably.

[Description] The folding of Aluminum Composite Panels can not be taken as the frame of curtain walls panel for Aluminum Composite Panels, and the frame and middle rib should be set according to the requirement. For the intensity of the wind load that the high-level building suffered is large, it is detected that the aluminum angle ruler will be damaged before the panel of Aluminum Composite Panels is

General Requirement

damaged if the amplitude is large during the folding life test under the cyclic deformation of Aluminum Composite Panels. Hence, curtain walls panel of Aluminum Composite Panels for the high-level building should not take the aluminum angle ruler as the frame, but select the aluminum material.

■ 3. In addition to test curtain walls of Aluminum Composite Panels according to the specified physical performance test items, the folding life test under the cyclic deformation should be carried out for the panel of the super high-level building and important project, to verify the reliability of the panel design.

[Description] The folding life test under the cyclic deformation for Aluminum Composite Panels is to simulate the action of the wind load, fix Aluminum Composite Panels in the aluminum frame keel, and make it generate inward (positive wind pressure action) and outward (negative wind pressure action) bending continuously, and then test the times of the final damages.

The connection method of Aluminum Composite Panels in curtain walls is mainly divided into two types, the one is continuous folding method, and the other is the slotted folding method. At present, the most broadly used one is the slotted folding method. Aluminum Composite Panels must remain 0.3mm of the core layer and 0.5mm of Aluminum Composite Panel after the slotting. In this way, the self weight of Aluminum Composite Panels and the positive and negative wind load pressure of curtain walls will be undertaken by four 0.3mm core layers and 0.5mm Aluminum Composite Panels. Hence, it is the most weakened part of curtain wall panels for Aluminum Composite Panels and the first damaged part under the wind load at the slotted folding. Hence, understanding the folding life of Aluminum Composite Panels under the cyclic deformation can evaluate the service life of curtain wall panels for Aluminum Composite Panels according to local meteorological information, and provide effective reference foundation for the application of Aluminum Composite Panels in the high-level curtain walls.

Design of Curtain Wall Panel for Aluminum Composite Panels

General Requirement

■ II. Curtain Wall Panel Design

■ 1. Curtain walls panel division formed in the reinforced frame can be considered as the simply-supported edge along the surrounding edge of curtain walls panel material, and the supporting line of the middle rib can be considered as the fixed edge.

■ 2. The maximal bending stress standard value under the wind load or earthquake that is vertical to curtain wall panels of Aluminum Composite Panels can be calculated by the geometric non-linear finite element method or by the following formulas:

$$(7.3\text{–}1) \quad \sigma_{wk} = \frac{m w_k l_x^2}{W_e} \eta$$

$$(7.3\text{–}2) \quad \sigma_{Ek} = \frac{m q_{ek} l_x^2}{W_e} \eta$$

$$(7.3\text{–}3) \quad \theta = \frac{w_k l_x^4}{D_e t} \qquad \theta = \frac{(w_k + 0.5 q_{EK}) l_x^4}{D_e t}$$

Where, σ_{wk} and σ_{Ek} are the maximal bending stress standard values generated under the wind load or the earthquake action in the vertical direction

W_k is the standard value of the wind load (N/mm2);

qEK is the standard value of the earthquake action in the direction vertical to

curtain wall panels(N/mm2) ;

l_x is the calculated side length of the panel division(mm),

m is the moment coefficient of curtain wall panels.

E is the elastic modulus of curtain wall panels(N/mm2) ;

t is the thickness of curtain wall panels (mm);

$W_e$is the equivalent section modulus of Aluminum Composite Panels (mm3/mm) ;

D_e is the equivalent bending rigidity of Aluminum Composite Panels(Nmm2/mm) ;

η is the reduced coefficient.

■ 3. Under appropriate condition, the setting of the reinforced rib for curtain walls panel can be designed by referring to the method in this specification.

[Description] The anti-wind pressure design for curtain walls of Aluminum Composite Panels is one of the critical factors that affect the use of Aluminum Composite Panels on

Design of Curtain Wall Panel for Aluminum Composite Panels

General Requirement

Table 1: Specification and Quantity of Aluminum Composite Panels

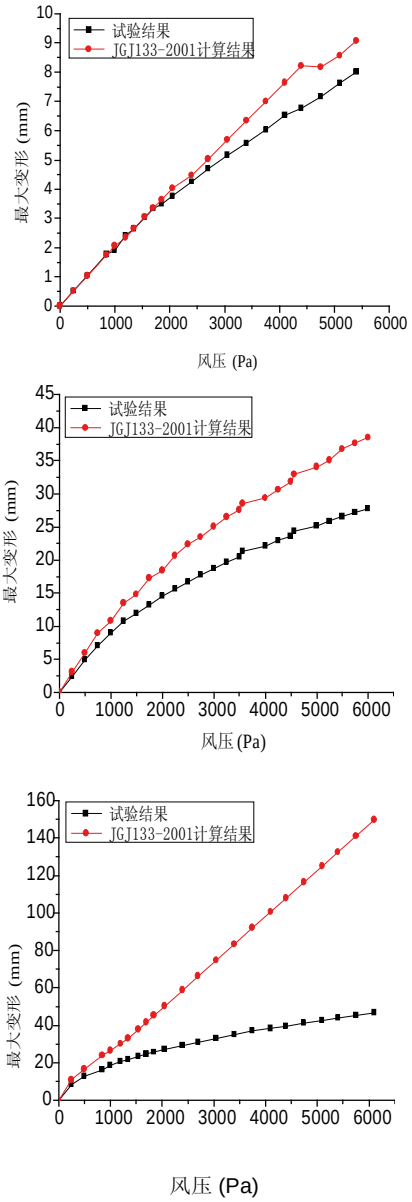
Serial Number	Dimension of Test PieceW×L (mm)	Brand Name of Aluminum Material	Qua-ntity
1	500×750	5005	3
2	500×1500	5005	3
3	750×1425	1100	3
		3003	1
		5005	3
4	1000×1100	1100	1
		3003	1
		5005	1
5	1000×2100	5005	2
6	1250×1550	5005	3
7	1250×2050	5005	3

the curtain walls for buildings. At present, the anti-wind pressure design for curtain walls of Aluminum Composite Panels is mainly based on the correction of the minor deflection calculation formula for the thin plate theory, or uses the finite element software to carry out the geometric non-linear calculation. However, it is lack of the research on corresponding anti-wind pressure test. To understand the anti-wind pressure performance of curtain walls for Aluminum Composite Panels, we select the standard plate (the thickness of plate is 4mm and the thickness of the aluminum is 0.5mm) used for 7 groups of Aluminum Composite Panels with different specifications. The specification and quantity of curtain wall panels is shown as in Table 1. It researches on the deformation performance under the wind pressure action by the windows dynamic wind pressure test equipment.

The test should be carried out according to the regulation of the national standard Wind Pressure Resistance and Test Method of Building Exterior Window (GB/T 7106-2002) and Test Method of Wind Pressure Resistance Performance for Building Curtain Wall (GB/T 15227-1994). However, the pressure applied sequence and gradient will not comply with above standards. It will make the pressure rise from 0 Pa until the test piece shows the leakage. The relationship curve between the maximal deformation and the wind load obtained from 7 groups of Aluminum Composite Panels for curtain walls (all aluminums use the 5000 series) by the test indicates that the wind load undertaken by Aluminum Composite Panels and the deformation is a non-linear relationship. Furthermore, their non-linear relationship is more obvious with the increasing of the panel size.

We compare the experiment data with the theory value obtained according to Technical Code for Metal and Stone Curtain Walls Engineering, and find that the calculated result is more different from the test value with the increasing of the wind pressure for curtain wall panels with the same size. Furthermore, the deformation under the same wind pressure action will increase with the growth of the panel size for curtain wall panels with different sizes. As is shown in Fig.1, the test result matches with the calculated result when the wind pressure is less than 3000Pa for the small sized Aluminum Composite Panels. However, the calculated result will be

General Requirement



a.500×750mm,5005series
b.750×1425mm,5005series
c.1250×1550mm, 5005series
Fig.1 Comparison of Test Result with JGJ133 Calculated Result

different from the test result much more with the increasing of the wind pressure. For Aluminum Composite Panels with large curtain wall panel size, the wind pressure deformation obtained by the specification JGJ133-2001 will be different from the result by the test. Hence, we can come to a conclusion that the calculation formula used by JGJ133-2001 after the correction of the reduced coefficient is applicable to calculate the deflection for the small sized curtain wall panel under the wind pressure action, but not applicable for the large sized curtain wall panel and large wind pressure situation. Furthermore, it will increase the materials greatly and cause the waste. For above reasons, we put forward another design method to set the reinforced rib in the appendix in Specification for Construction and Acceptance of Aluminum Composite Panel Curtain Walls Engineering. Namely, it will refer to the relationship of the bending deflection and the curtain wall panel size (setting of the reinforced rib) for Aluminum Composite Panels in Appendix A.

- 4. The bending stress standard value on the supporting line of the middle rib can use the average of the calculated result for two sides of curtain wall panels.
- 5. The maximal stress standard value generated under various loads and actions in curtain wall panels should be combined according to the regulation, and the obtained maximal stress design value should not exceed the design value of the curtain wall strength.

Table 2: Reduced Coefficient

θ	5	10	20	40	60	80	100	120
η	1.00	0.95	0.90	0.81	0.74	0.69	0.64	0.61
θ	150	200	250	300	350	400		
η	0.54	0.50	0.46	0.43	0.41	0.40		

[Description] Regardless of the side rib, the perimeter of the metal plate can cause the rotation, so it can be considered as the simply-supported edge for the calculation. The wind load and earthquake action is even distributed for curtain wall panels, and the panel division at both sides of the middle rib undertakes the force. If the spans are equal to or close to for each other, it will not cause obvious panel rotation, so it can be considered as the fixed edge for the calculation. When the non-linear finite element method is used to calculate the panels with ribs, the constraint condition of the side rib can consider the line displacement in the direction vertical to panels as zero.

Design of Curtain Wall Panel for Aluminum Composite Panels

General Requirement

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		3003	1
		5005	3
4	1000×1100	1100	1
		3003	1
		5005	1
5	1000×2100	5005	2
6	1250×1550	5005	3
7	1250×2050	5005	3

The calculation formula of the elastic thin panel is as follows:

$$\sigma = \frac{6mqa^2}{t^2} \quad \text{(Stress)}$$

$$d_f = \frac{\mu qa^4}{D} \quad \text{(Deflection)}$$

Above formula supposes the deformation of panels is the small deflection, and panels only undertake the bending action and generate the bending stress, but the film stress within the surface is neglected. Hence, the scope of application for the formula is that the deflection is not greater than the thickness of panels (namely, $\leqslant$t). When the deflection of panels is greater than the thickness of panels, this calculation formula will generate obvious error, namely the calculated stress and deflection are greater than that in the actual condition. With the increasing of the deflection and the thickness of panels, the calculated stress and deflection will be so great that it can not be accepted by the project, so it is meaningless for the calculation. The design of panels by the larger calculated result will increase the materials greatly, and make the specified stress and deflection control condition meaningless.

In general, the deflection of the metal plate is allowed to be 1/60 of the side length. For the aluminum plate with the section division side length 500mm and thickness 3mm, the allowed 8mm of the deflection value exceeds 2 times of the panel thickness. At this time, the calculated value of the deflection is 50 – 80 percent greater than the actual value. The control is stricter than the anticipated control value by letting the calculated deflection less than 1/60 of the side length. There is the similar situation for the calculation of the bearing capacity.

For above reason, the calculation of the metal plate should take appropriated reduction of the calculated result for the stress and deflection under current small deflection condition (Table 2).

The calculation of large deflection panels is a rather complicated non-linear elastic mechanic problem and it is hard to be expressed by a simple formula, so it is necessary to use the dedicated calculation method and software for the calculation on the concrete problem. Obviously, it is not convenient to be used in curtain walls engineering design generally.

Design of Curtain Wall Panel for Aluminum Composite Panels

General Requirement

Englisher B.Aalami and D.G.williams systematically calculate the rectangular thin plate with different borders and issue the Thin Plate Design for Transverse Loading. We appropriately simplify and merge the content according to a large number of calculated resulted for the convenience of the actual application, and select the parameter that is directly related to the deflection as the main variant, and compile with Table 3 of this specification. The dimension of the parameter is the ratio of the deflection to the thickness:

$$\theta = \frac{qa^4}{Et^4} \sim \frac{qa^4}{Et^3}/t \sim \frac{qa^4}{D}/t \sim d_f/t$$

Table 3: Reduced Coefficient η of Stress σ Calculated Result for Elastic Small Deflection Formula

$0=\frac{qa^4}{Et^4}$	*Calculated Result of B.Aalami and D.G.williams, Side Length Ratio*			*Value in Table 7.1.3 of This Specification*
	1.0	*1.5*	*2.0*	
≤1	*1.000*	*1.000*	*1.000*	*1.00*
10	*0.975*	*0.904*	*0.910*	*0.95*
20	*0.965*	*0.814*	*0.820*	*0.90*
40	*0.803*	*0.619*	*0.643*	*0.8l*
120	*0.480*	*0.333*	*0.363*	*0.6l*
200	*0.350*	*0.235*	*0.260*	*0.50*
300	*0.285*	*0.175*	*0.195*	*0.43*
≥400	*0.241*	*0.141*	*0.155*	*0.40*

As is shown in Table 2, the modified coefficient η will be reduced quickly with the . Namely, the stress and deflection calculated by the small deflection formula will be reduced much. For the sake of security, we get the value with large result in Table 3 to remain enough margin. At the same time, similar reduced coefficient η (Table 2) should be taken into account when we calculate the deflection d_f of panels.

For the effect of the Poisson ratio on the stress and deflection calculation of panels is limited, the reduced coefficient is applicable to calculate the stress and deflection of different metal plates in principle.

General Requirement

Table 4: Reduced Coefficient η of Stress σ Calculated Result for Elastic Small Deflection Formula

$0=\frac{qa^4}{Et^4}$	*Calculated Result of B.Aalami and D.G.williams, Side Length Ratio is*			*Value in Table 7.1.3 of This Specification*
	1.0	*1.5*	*2.0*	
≤1	*1.000*	*1.000*	*1.000*	*1.00*
10	*0.955*	*0.906*	*0.916*	*0.95*
20	*0.965*	*0.814*	*0.820*	*0.90*
40	*0.803*	*0.619*	*0.643*	*0.8l*
120	*0.482*	*0.394*	*0.417*	*0.6l*
200	*0.375*	*0.304*	*0.322*	*0.50*
300	*0.304*	*0.245*	*0.252*	*0.43*
≥400	*0.201*	*0.209*	*0.211*	*0.40*

Aluminum Composite Panels is the three-layer sandwich panel and the mechanic performance for various layers of materials is different, so the mechanical characteristics of panels is expressed by the equivalent section modulus We and the equivalent rigidity De for the calculation of the stress and deflection. The equivalent section modulus We and equivalent rigidity De are obtained from the bend test of sandwich panels.

When we calculate its parameter , the denominator in the formula 7.3-3 should use Et_e^4 or appropriately use $11.2D_et_e$ instead. Where, v gets 0.25.

■ 6. The calculation of deflection for curtain wall panels of Aluminum Composite Panels under the wind load:

The span center deflection of Aluminum Composite Panels can be calculated by the geometric non-linear finite element method or by the following formula:

$$d_{\mathrm{f}}=\frac{\mu w_{\mathrm{k}} l_{\mathrm{x}}^4}{D_{\mathrm{e}}}\eta$$

Where, D_{e} is the equivalent bending rigidity . $(\mathrm{Nmm}^2/\mathrm{mm})$

Under the action of the standard wind load value, the limit value of the panel deflection $d_{\mathrm{f,lim}}$ should use 1/60 of the side length for the section division calculation.

Design of Curtain Wall Panel for Aluminum Composite Panels

General Requirement

- III. Design of Reinforced Rib
- 1. The load applied to the curtain wall panel block of Aluminum Composite Panels can be transferred to the rib by the triangle or trapezoid distribution. It can be converted into the equivalent even distributed load by the equal moment rule for the calculation of ribs.
- 2. The side rib section size of Aluminum Composite Panels can be designed according to the structural requirement. The single span middle rib can be designed by the simply-supported beam. The multiple-span middle rib can be analyzed by the beam series of calculation software.
- 3. The reinforced middle rib should be equipped with enough rigidity, and it can use the metal square tube, slotted or angle material. The section thickness of the reinforce rib should not be less than 1.5mm. Furthermore, the maximal deflection value under the wind load standard value should not be greater than 1/120 of the distance for its supporting point.

Connection Design of Middle Ribs and Curtain Wall Panels

- IV. Connection Design of Middle Ribs and Curtain Wall Panels
- 1. The silicone structure sealant is used to carry out the bonding connection for middle ribs and curtain wall panels. The connection structure and calculation should meet the requirement for the use of silicone structure sealants.
- 2. The structural bonding tape is used to carry out the bonding connection for middle ribs and curtain wall panels. The connection structure and calculation should meet the requirement for the use of structural bond tapes.

Installation Design of Curtain Wall Panels

- V. Installation Design of Curtain Wall Panels
- 1. Curtain wall panels of Aluminum Composite Panels can use the bolt, flange or hook to fix in the beam or column. The diameter of fixing bolts should not be less than 4mm, and the quantity of bolts should be determined by the calculation according to the wind load and earthquake action undertaken by the curtain wall panels. The hook should be equipped with the anti-noise gasket.

  [Description] Curtain wall panels of Aluminum Composite Panels can take the bolt or flange connection method to fix in the beam or column along

Design of Curtain Wall Panel for Aluminum Composite Panels

Installation Design of Curtain Wall Panels

the perimeter, or take the hook connection method to fix in the beam or column along both sides. The diameter of fixing bolts should not be less than 4mm, and the quantity of bolts should be determined by the calculation according to the wind load and earthquake action undertaken by curtain wall panels. The hook should be equipped with the anti-noise gasket.

- 2. The thickness of hanging parts or angle rulers for curtain wall panels for Aluminum Composite Panels should not be less than 3mm, and the material can select the aluminum ally or steel that complies with current national standard. The rivet or anchor bolt for the connection of hanging parts or angle rulers with curtain wall panels should use the stainless steel material, and the diameter and quantity of the rivet, screw or bolt should be determined by the calculation. The distance from the center of the rivet, screw or bolt holes to the edge of the curtain wall panels should not be less than 2 times of the aperture, and the center distance of the hole should not be less than 3 times of the aperture.

Curtain Wall Panel Seam and Seal Design

- VI. Curtain Wall Panel Seam and Seal Design
- 1. The width of the connection panel seam for curtain walls block for Aluminum Composite Panels should meet the requirement of necessary spacing during the installation and construction. At the same time, it should be applicable to the deformation of curtain walls themselves and buildings under various forces. The width of the curtain wall panel seam should not be less than 8mm. The depth of the curtain wall panel seam should be determined according to the operability of the construction and the spacing required for the filling material.
- 2. The injected sealing panel seam and the sealing should meet the following requirements:

  1 The bottom of the curtain wall panel seam should be filled by the foam strip. The curtain wall panel seam should use the silicone sealant fillet for buildings, the thickness of the sealant should not be less than 3.5mm, and the width should not be less than 2 times of the thickness.

Curtain Wall Panel Seam and Seal Design

2. The silicone sealant for buildings of the coats surface should carry out the compatibility test, and paint the primer if necessary.

[Description] The injected sealing panel seam is a common used fillet format for it can provide reliable air tightness and water tightness. Various contractors are familiar with it and the construction quality can be ensured. The general project may take priority for the injected panel seam.

The bond performance of the silicone buildings sealant for the fluorocarbon coats of Aluminum Composite Panels is related to the manufacturer and brand name of sealants. Hence, the bonding performance should be tested in advance. Furthermore, the coating of primers is a measure to improve the seal bonding performance of some brand name. However, it is not necessary for each sealant and is not certain to play a role in each sealant. So it should be determined by the test.

■ 3. The embedded sealing panel seam and the sealing should meet the following requirements:

1 The contact of the sealing piece and sealing panel seam should be tight, or corresponding clamp is designed to prevent the peeling of the sealant strip. The crossing point of sealant strips should use sealants with special design to seal, or take other methods to ensure the reliability of the sealing.

2 Use the embedded sealing. It should carry out the multi-cavity and multi-channel sealing waterproof design according to the rain curtain principle, and set the drainage structure.

[Description] The water tightness of the embedded panel seam depends on the quality of the embedded panel seam and rational design of the equal pressure cavity. The embedded panel seam should provide enough elasticity and endurance. In general, we use two or three embedded panel seams to form one or two equal pressure cavities, sp as to prevent the rain penetration.

■ 4 The open panel seam should comply with the following requirements:

1 The back of the open panel seam should prevent the water accumulation, and necessary drainage structure should be set to ensure the smooth drainage.

2 The insulating material of the buildings main body wall should take the waterproof and moisture proof measure, and it can take the zinc coated

Curtain Wall Panel Seam and Seal Design

steel plate or aluminum plate as the waterproof lining plate.

3 The back space of the decoration layer for Aluminum Composite Panels should keep ventilation to discharge the damp water vapor smoothly.

4 The supporting structure and metal connector should take effective anti-corrosive measure.

[Description] The open panel seam without sealing measure will make rain penetrate into the back space of the plate. Hence, it is necessary to take several measures to get rid of the effect. For instance, the drainage channel is used to discharge the accumulated water as soon as possible, increase the rear ventilation to make the remaining water content vapor and use the additional metal plate waterproof layer. For there is some water content and damp inevitably, the rear steel structure should take the anti-corrosive measure.

■ 5. Aluminum Composite Panels with the open panel seam should use the aluminum alloy folding edge, to prevent the core material exposes to the external atmosphere directly, or use the embedded Aluminum Composite Panel edge of the aluminum alloy frame, and take the flange to fix it in the beam and column.

Sealing Material

Sealing Material

■ Sealing Material

■ 1. The rubber product for curtain walls of Aluminum Composite Panels should use the EPDM, chloroprene rubber and silicone rubber.

[Description] At present, the sealing of domestic dry seam curtain wall mainly uses the rubber sealing strip to play the sealing role in the slotting depending on the elasticity of the rubber strip itself. The rubber strip is required to provide the characteristics of the ultraviolet resistance, degradation resistance and small permanent deformation and stain resistance. Several domestic large-scale projects use the rubber strip sealing and not any problem takes place up to now. However, if the quality of materials is not controlled strictly, some rubber interface may result in the quality problem within 1 or 2 years. For example, it may cause the degradation and cracking or even peeling to make the water and air leakage from curtain walls, and the panel may also peel and cause the hidden hazard for curtain walls. Hence, the unqualified sealing rubber strip is not allowed to use for curtain walls. Using the silicone rubber with excellent weather resistance and small permanent deformation as the sealing rubber strip is a development direction.

■ 2. The sealing rubber strip should comply with the regulation of current national standard Rubber Building Gaskets--Materials for Preformed Solid Vulcanized Structural Gaskets Specification HB/T 3099 and Industrial Rubber Sheet GB/T 5574.

The curtain walls of Aluminum Composite Panels should use the neutral weather resistance sealant, whose performance should comply with the regulation of current national standard Silicone Sealants for Building GB/T 14683.

[Description] The weather resistance sealant for curtain walls of Aluminum Composite Panels should use the neutral silicone weather resistance sealant for its super ultraviolet resistance performance and excellent compatibility with the silicone structural sealant. The acidic silicone sealant should not be used for it will release the acetic acid during the curing and play the corrosive role in the aluminum plate and film layer and react with the calcium carbonate in the neutral silicone structural sealant.

Sealing Material

Silicone Structural Sealant

■ Silicone Structural Sealant

■ 1. The performance of the neutral silicone structural sealant for curtain walls should comply with the regulation of current national standard Structural Silicone Sealants for Building GB 16776.
[Description] The silicone structural sealant is an important factor that will affect the safety of curtain walls. Our nation issued the national standard about the silicone structural sealant Structural Silicone Sealants for Building GB 16776 in 1997. GB 16776 is worked out on the basis of ASTM C1184 and specifies the most basic requirement of the silicone structural sealant. In 2002, GB 16776 was revised and the requirement of the elastic modulus and maximal extension ratio was added according to the use condition of the silicone structural sealant in recent years.

■ 2. Before the use of the silicone structural sealant, the compatibility with its contact material and adhesion-in-peel test should be carried out by the national recognized test institution.
[Description] Before the use of the silicone structural sealant, the adhesion-in-peel of Aluminum Composite Panels and metal frame test and the compatibility with the spacing strip, sealing gasket, positioning block and other contact sealant test should be carried out. It can be used only when the adhesion-in-peel and compatibility test is qualified. If the material used is not compatible with the structural sealant, it may cause the reduction or loss of the bonding strength and bonding performance for the structural sealant, and remain a large number of hidden hazards.
To ensure the performance of structural sealants meets the standard requirement and prevent the counterfeit product from entering into the field, this clause specifies to carry out the re-examination for partial performance of the structural sealant. The re-examination should be carried out after the material enters into the field by the test institution with corresponding qualification. Only the qualified product can be used.

■ 3. The silicone structural sealant manufacturer should provide the position change bearing capacity of the structural sealant and the quality certificate.
[Description] The position change bearing capacity of the silicone structural sealant is the assistant basis of its intensity index with the same importance, and is an important guarantee of the relative displacement

Sealing Material

Silicone Structural Sealant

■ Silicone Structural Sealant

capacity and reliability for curtain walls. Furthermore, it is also an important parameter for the calculation of the structural sealant seam thickness in this specification. In main domestic and foreign products, this index is usually greater than 0.15.

Other Materials

■ 1. Other materials used for curtain walls of Aluminum Composite Panels should comply with various requirements of JGJ 133 Technical Code for Metal and Stone Curtain Walls Engineering and related material standard. The bonding performance of the structural dual-side bonding tape should meet the design requirement.

[Description] This specification specifies the requirement of the main material for curtain walls of Aluminum Composite Panels. Other general materials of curtain walls, such as the aluminum material, steel, fittings, insulating material, should meet corresponding requirement in JGJ 133 Technical Code for Metal and Stone Curtain Walls Engineering.

Sealing Material

Connection Design of Curtain Wall Components and Main Body Structures

■ 1. The main body structure or structural component should be able to undertake the load and action transferred by curtain walls. The design value of the anchoring bearing capacity for the connection component and main body structure should be greater than the design value of the bearing capacity for the connection component itself.

[Description] The connection and anchoring of curtain walls should be reliable, and the bearing capacity should be determined by the calculation or the real test, and some margin should be maintained to prevent the sudden damage by the accidental factor. The anchoring bearing capacity of the connection component and main body structure should be greater than that of the connection component itself. In any case, the anchoring is not allowed to be damaged.

The main body structure for the curtain wall installation should provide the capacity to undertake various actions transferred from curtain walls, which should be taken into account fully for the design of the main body structure. If the main body structure is the concrete structure, the intensity of the concrete is related to the reliable work of the anchoring component. In addition to improve the management of the project quality for the concrete construction, it also puts forward for the minimal intensity level of the concrete. To ensure the connection reliability of the main body structure, the intensity of the main body structure concrete for connection parts should not be less than C20.

■ 2. The design of the connector, weld bead, bolt and rivet at the connection point of curtain wall components should comply with related regulation of current national standard Code for Design of Steel Structures GB50017, Technical Code for Design of Cold-formed Thin-wall Steel Structures GB50018 and Technical Specification for Steel Structure of Tall Buildings JGJ99. The bolt and rivet undertaken the force at the connection point should not be less than 2.

[Description] The connection between the beam and column of curtain walls and the connection between the column and anchoring component or the main body structure steel beam and steel material are usually implemented by the bolt, weld bead or rivet. At the same time, and the tension and shearing design should be carried out for the tensile and sheared bolt.

Connection Design of Curtain Wall Components and Main Body Structures

■ 5. For the stressed embedded parts that consist of the anchor plate and the anchoring steel bar in the symmetric position, it can be designed according to the regulation of JGJ133.

[Description] JGJ133 puts forward general regulation for the embedded part design of curtain walls. The requirement for the embedded parts mainly complies with related research outcomes and existing national standard Code for Design of Concretes GB50010.

1. The shearing bearing capacity of the shearing embedded parts is related to the intensity level, the strength, the arrangement method and diameter of steel bars.

2. For the embedded parts that suffer from the normal tensile force, the anchoring bar undertakes both the tensile force and the internal shearing force caused by the bending deformation of the steel plate, to make the anchoring bar be in the combined stress status when the steel plate bends and deforms. Hence, the reduced coefficient of the anchoring plate bending and deformation is introduced into the calculation formula.

3. For the embedded parts that undertake the bending moment, the test indicates that the resultant force point at the stressed area usually exceeds the edge bar at the stressed area. For the convenience and safety, the bending force arm gets the distance between the center lines of the external anchoring bars. Furthermore, the reduced coefficient of the anchoring plate bending and deformation is introduced into the calculation formula.

4. For the embedded parts that undertake the tensile force, shearing force, or tensile force and bending moment, their bearing capacities are supposed to be linear interrelated.

5. For the embedded parts that undertake the shearing force and bending moment, when $V/Vu0>0.7$, the shearing bearing capacity is linear interrelated with the bending bearing capacity, and when $V/Vu0\leqslant 0.7$, the shearing bearing capacity is not interrelated with the bending bearing capacity according to the test result. Where, Vu0 is the shearing bearing capacity when the embedded part undertakes the shearing action individually.

Connection Design of Curtain Wall Components and Main Body Structures

6. If the axial force ，$N < 0.5 f_c A$ appropriately get M-0.4NZ=0 as the boundary condition for the calculation of the shearing bearing capacity and the stressed bending bearing capacity.

For the embedded parts that undertake the normal tensile force and bending moment, the resistance in the tensile force item for the anchoring bar section area calculation formula should be multiplied by the coefficient 0.8, which is the reduced coefficient to improve the safety margin by taking the importance of the embedded parts and the complex of the force into account.

When the straight anchoring bar and the bending anchoring bar take effect at the same time, take the total of shearing force subtracting the shearing of the straight anchoring bar as the shearing of the bending anchoring bar to calculate the section area:

$$A_{sb} \geq 1.4 \frac{V}{f_y} - 0.25 \alpha_r A_s \qquad (5.2)$$

Related foreign specification and domestic test research on the bending anchoring bar in the steel and concrete combined structure shows that the bending angle of the bending anchoring bar has not important effect on the shearing bearing capacity. At the same time, control the bending angle within 15° ~ 45° by taking the structure into account. When the straight anchoring bar is not set or only set by the structure, it will not be considered in the calculation, and we get As＝0.

The basic structure of embedded parts specified here requires take the meeting common embedded parts as the goal. The calculation formula is also established according to the requirement of these basic structures.

Upon calculating the anchoring area A, we suppose the anchoring bar plays its role fully, and the stress is up to its strength design value . To make the stress of the anchoring bar is up to and anchoring bar doesn’t slide or remove, the anchoring length should be enough, which is related to the model of the steel bar, the strength of the concrete and the type of the steel. The anchoring length can be calculated by the following formula:

$$l_a = a \frac{f_y}{f_t} d$$

Connection Design of Curtain Wall Components and Main Body Structures

■ 5. For the stressed embedded parts that consist of the anchor plate and the anchoring steel bar in the symmetric position, it can be designed according to the regulation of JGJ133.

[Description] JGJ133 puts forward general regulation for the embedded part design of curtain walls. The requirement for the embedded parts mainly complies with related research outcomes and existing national standard Code for Design of Concretes GB50010.

1. The shearing bearing capacity of the shearing embedded parts is related to the intensity level, the strength, the arrangement method and diameter of steel bars.

2. For the embedded parts that suffer from the normal tensile force, the anchoring bar undertakes both the tensile force and the internal shearing force caused by the bending deformation of the steel plate, to make the anchoring bar be in the combined stress status when the steel plate bends and deforms. Hence, the reduced coefficient of the anchoring plate bending and deformation is introduced into the calculation formula.

3. For the embedded parts that undertake the bending moment, the test indicates that the resultant force point at the stressed area usually exceeds the edge bar at the stressed area. For the convenience and safety, the bending force arm gets the distance between the center lines of the external anchoring bars. Furthermore, the reduced coefficient of the anchoring plate bending and deformation is introduced into the calculation formula.

4. For the embedded parts that undertake the tensile force, shearing force, or tensile force and bending moment, their bearing capacities are supposed to be linear interrelated.

5. For the embedded parts that undertake the shearing force and bending moment, when $V/Vu0>0.7$, the shearing bearing capacity is linear interrelated with the bending bearing capacity, and when $V/Vu0\leqslant 0.7$, the shearing bearing capacity is not interrelated with the bending bearing capacity according to the test result. Where, Vu0 is the shearing bearing capacity when the embedded part undertakes the shearing action individually.

Connection Design of Curtain Wall Components and Main Body Structures

Where, l_a is the anchoring length of the tensile steel bar (mm).

f_t is the design value of the tensile strength for the concrete axis center, it gets the value according to existing national standard Code for Design of Concretes 50010. When the strength of concretes is higher than C40, we get C40.

d is the nominal diameter of anchoring bars (mm).

a is the shape coefficient of anchoring bars. We get 0.16 for the round steel bar and 0.14 for the steel bar with ribs.

Sometimes, it is hard to use curtain wall embedded parts for the value is too large. Hence, we use the low stress design method, namely, increase the area of the anchoring bar and reduce the actual stress of the anchoring bar, to shorten the anchoring length. However, the anchoring length should not be less than 15 times of the steel bar diameter.

■ 6. The embedded steel plate of the slotted embedded parts and other connection measures should be designed according to related regulation of existing national standard Code for Design of Steel Structures GB50017.

■ 7. The anchor bolt connection for curtain walls frame and main body structure should comply with the following regulation:

1 The products should be equipped with the leave-factory certificate.

2 The anti-corrosion processing should be carried out for the anchoring bolt of the carbon steel.

3 The field test of the bearing capacity should be carried out, and the pull-out test should be carried out, if required.

4 Each connection node should not be equipped with the anchor bolts less than 2.

5 The diameter of anchor bolts should be determined by the calculation of the bearing capacity and should not be less than 10mm.

6 The welding operation should not be carried out on the connector that contacts with the chemical anchor bolts.

7 The design value of the bearing capacity for anchor bolts should not be greater than 50 percent of its limit bearing capacity.

[Description] If no embedded part is set and the embedded part is missed in civil engineering, or the embedded part offsets the design position too

much, or the design is changed, or the old building is added with curtain walls, it is usually necessary to be connected by the post anchor bolt. When the post anchor bolt (mechanical or chemical anchor bolt) is used, several measures should be taken to ensure the reliability of connection.

■ 8. When curtain walls are connected with the masonry structure, the steel bar concrete or steel structural beam and column should be set on the main body structure of connection parts. The light filling wall should not be taken as the supporting structure of curtain walls.

[Description] The bearing capacity outside of the masonry structure plane is low and it is hard to be connected directly. Hence, the concrete structure or steel structure connection component should be added. The bearing capacity and deformation capacity of the light partition wall is low and should not be taken as the supporting structure of curtain walls.

Endurance and Safety Performance

Endurance and Safety Performance

- 1. The color of the paint baking for Aluminum Composite Panels is allowed to change with the time, and it will show slight and even change in the same facade. However, the long term performance test should be carried out according to the nation standard of the fluorocarbon paint and customers should be provided with 10 years or more quality assurance (For the details on the test method and index requirement, refer to the clause 3.2.3 in athis specification).
  [Description] The surface endurance performance of curtain walls for Aluminum Composite Panels mainly depends on the color of products, the use location, environment and direction. The variation of effect factors causes the slight difference of the degradation speed of curtain wall panels. However, the degradation condition should be same under the same factor, and the change condition (such as fading) should be even.
- 2. The fireproof design of curtain walls for Aluminum Composite Panels should comply with related regulation of existing national standard Code of Design on Building Fire Protection and Prevention GB50016, and the curtain wall fireproof of tall buildings should comply with related regulation of existing national standard Code for Fire Protection Design of Tall Buildings GB 50045.
  [Description] The curtain wall fireproof of Aluminum Composite Panels is not specified in the Code of Design on Building Fire Protection and Prevention GB 50016 definitely. However, it puts forward some fireproof regulation for the building material and different parts of the building. When curtain walls are in these parts, related requirement should be met.
  It specified the building curtain wall in the Code for Fire Protection Design of Tall Buildings GB 50045 definitely, and it should be complied with.
- 3. The fireproof sealing design should be designed for the seam between the curtain wall and surrounding fireproof partition members, the seam between the curtain wall panel or partition wall outer space and the seam between the real wall surface opening edges.
  [Description] Although curtain walls of Aluminum Composite Panels themselves don’t provide special fireproof capacity, it is a part of the whole building as the external envelope structure. Some important parts should provide a certain fire resistance, and comply with the whole fireproof requirement of the building.

Endurance and Safety Performance

Endurance and Safety Performance

The fireproof sealing is a fire protection and smoke isolated method with broad application for current building design, which is formed by filling the material that is not inflammable or fire resistant in the seam, to reach the goal that prevents the flame and high temperature flue gas and noxious gas from spreading in buildings.

■ 4. The smoke protection and fireproof sealing structural system of curtain walls should provide the sealing and endurance. If it catches fire, the integrity should be maintained within the specified fire resistance limit.

[Description] The endurance, adaptable capacity of the deformation and stability is the basic requirement of the fireproof sealing material or system, which should be integrated considered and rationally selected according to the width amd property of the seam (for example, whether the extension/contraction deformation takes place), material quality of adjacent members, other surrounding environment factors and design requirements. In general, the larger of the seam, the larger of the extension/contraction and the higher the fireproof level, the higher the requirement of the fireproof sealing material or system is.

■ 5. The fireproof sealing system should use the non-inflammable or fire retardant material that complies with the requirement.

[Description] The fireproof sealing structural system of curtain walls provides several effective fabrication methods. Regardless of any methods, the material made of the system should provide the fire resistance performance specified in the design.

■ 6. The seam between the curtain wall and floor slab compartment can use the rock wool or mineral wool sealing. The thickness of the rock wool and mineral wool should not be less than 100mm, and should be filled tightly. The thickness of the rock wool and mineral wool between the floors should use the zinc coated steel sheet with the thickness no less than 1,5mm, and the seam between the bearing board and other structures should be filled with the fireproof sealing material.

[Description] The bearing board of the fireproof sealing should use the anti-corrosive processing steel plate with the thickness no less than 1.5mm, but not use the single aluminum plate or Aluminum Composite Panels.

Endurance and Safety Performance

7. The lightning protection design of curtain walls for Aluminum Composite Panels should comply with related regulation of existing national standard Code for Protection of Structures against Lightning GB 50057 and Code for Electrical Design of Civil Buildings JGJ/T 16. The member as the lightning protection network in the metal frame of curtain walls should be connected with the lightning protection system of the main body structure reliably. For the building with the requirement of the electromagnetic shield or using the common grounding protection, the lightning design of its curtain walls should comply with related requirement of Protection against Lightning Electromagnetic Impulse - Part 1: General principles GB/T 19271.1.

[Description] Existing national standard Code for Protection of Structures against Lightning GB 50057 doesn't put forward the regulation on the curtain wall lightning protection concretely and definitely.

The curtain wall of Aluminum Composite Panels is the envelope structure that is attached to the main building. The metal frame of curtain walls is usually not taken as the lightning protection grounding, but makes use of the lightning protection system of the main body structure and combines with the lightning protection design of the building itself. Hence, it is required to be connected with the lightning protection system of the main body structure reliably, and keep the conduction smooth.

In general, the column of curtain walls should use the flexible cable to connect with each other. For the floor whose main building has the horizontal grading ring, the embedded parts or fittings of the column should use the circular steel or flat steel to connect with the horizontal grading ring welding, to form the conduction path. The welding seam and the connection cable should be coated with the antirust paint. The section area of the flat steel should not be less than 5mm×40mm, and the diameter of the circular steel should not be less than 12mm.

The curtain wall key roof stratum with the lightning protection function should be made by using the aluminum alloy plate with the thickness no less than 3mm, the section area of the key roof stratum should not be too small. The curtain wall key roof stratum system should be effectively connected with the lightning protection system of the main body structure roof.

Endurance and Safety Performance

For the building with the electromagnetic protection requirement, the Protection against Lightning Electromagnetic Impulse - Part 1: General principles GB/T 19271.1 requires the metal members with large size, such as the metal window, carry out the equi-potential connection with the lightning protection system (LPS), and the protection network formed by the metal member should not be too large. For the equi-potential connection, this standard puts forward a certain requirement that should be met for the lightning protection design of curtain walls.

- 8. For the endurance of curtain walls for open Aluminum Composite Panels, in addition to above-mentioned whole endurance performance, it should be noted to take the long-term surface treatment quality, the matching with the surface paint baking of Aluminum Composite Panels and preventing the rust from affecting the performance into account. Furthermore, it should also be noted to consider the endurance of the internal fixation for the curtain walls, connection and installation of assistant fittings. If the surrounding environment of buildings is special, such as the seaside and corrosive air (such as the building within the industrial pollution area), it is necessary to use the material with superior endurance.

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Wind Load Mpa	Allowed Panel Length (mm)	Center Deflection (mm)	Rivet Hole Distance (mm)
Width of Panel: 1000mm：			
500	8000	26	500
600	8000	32	500
700	8000	37	500
800	3700	37	500
900	3300	35	500
1000	3000	34	500
1100	2700	33	500
1200	2400	31	500
1400	2100	30	500
1600	1700	25	500
1800	1400	22	500
2000	1200	20	500
2200	1100	18	500
2400	1000	17	500
2600	900	16	500
2800	800	15	400
3000	750	15	400
Width of Panel: 1250mm			
500	3800	35	500
600	3300	38	500
700	3000	38	500
800	2800	37	500
900	2500	36	500
1000	2300	35	500
1100	2000	31	500
1200	1800	28	500
1400	1500	25	500
1600	1300	23	500
1800	1100	21	500
2000	1000	20	500
2200	900	19	500
2400	800	18	400
2600	750	18	400
2800	700	17	300
3000	650	16	300

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Wind Load Mpa	Allowed Panel Length (mm)	Center Deflection (mm)	Rivet Hole Distance (mm)
Width of Panel: 1500mm：			
500	3400	43	500
600	3000	42	500
700	2700	41	500
800	2300	36	500
900	2000	32	500
1000	1800	30	500
1100	1600	28	500
1200	1500	27	500
1400	1250	25	500
1600	1100	24	500
1800	1000	23	500
2000	900	22	400
2200	800	21	400
2400	750	20	300
2600	700	19	300
2800	350	18	300
3000	600	15	300

Above data is obtained on the basis of the following data:

1. The allowed design stress of the surface aluminum composite panel is 51MPa (evaluate 2.5 times of safety factors for the failure and 1.75 times of the permanent deformation).
2. The EI equivalent rigidity value of the panel is 0.24kNm2m-1.
3. The allowed design strength of rivets (the safety factor is 3) is the shearing strength Rc=720N and tensile strength Rt=680N.
4. The interaction between the shear and tensile stress is given as Fc/Rc+Ft/Rt《1, where, Fc and Ft are the application load of the shear and tensile respectively.
5. The fixing space is the diameter of the drilling hole subtracting the diameter of rivets, which is equal to 0.3mm.
6. The allowed frame deformation is less than 1/200 of the vertical spans between wall frames.

Description of Auxiliary Materials for Curtain Walls of Aluminum Composite Panels

Description of Auxiliary Materials for Curtain Walls of Aluminum Composite Panels

The following is the common specification:

Main Body Connection: For Aluminum composite panel : M12X10 Chemical Bolt
For Glass: M12X160 Flat-head Bolt

Connection Bolt: M12X160

Aluminum Plate: Vertical Main Channel 100X50X3 Aluminum Square Tube or Zinc Coated Square Tube
60X60X3
Horizontal Channel 25X38X3

Aluminum Angle Ruler: 25X20X3

Self-tapping Screw: M5X12

Foam Bar: ¢6XL

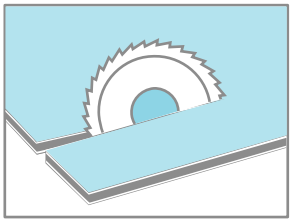
Al Screws: ¢5X16

Slotting Process Schematics of Aluminum Composite Panels

Processing Method Diagram

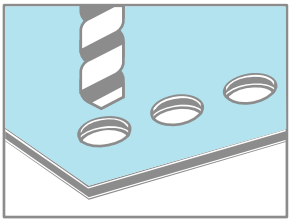
Gluing

Use standard metal and aluminium adhesives. Ensure you avoid contact with the polyethylene centre, some adhesives will attack and decay the core. The use of conventional double faced tapes is acceptable.



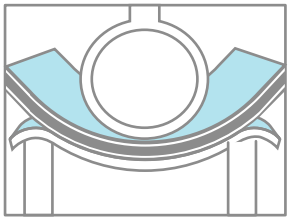
Sawing

Circular Saw: trapezoidal/flat tooth blade. Flat teeth chamfered at 45° carbide tipped.



Drilling

IBOND is easily drilled-we suggest for best results, the use of bits designed for drilling aluminium and plastic are used.

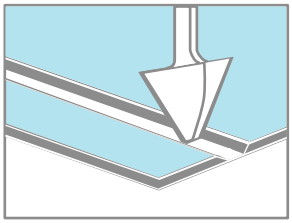


Bending

Use a folding table.
Min inside radius r=15xt (t=panel thickness).

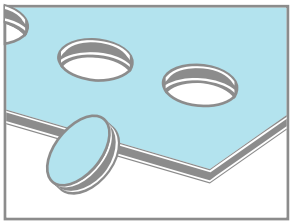
Digital printing

There have been numerous inks tested for compatibility and adherence to IBOND. The company has the large-scale digital printing machine for the customers.



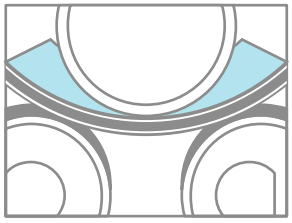
Slotting

Grooves can also be easily cut using a special cutting machine that comes complete with a guide. The "V" shaped groove is automatically cut into IBOND, which can then be easily fold by hand. A minimum thickness of 0.3mm of the polyethylene must be left on the bottom of back of the decorative face.



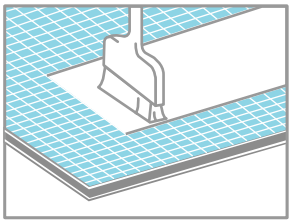
Punching

Use a steel band tool on a punching base for 2mm and 3mm thickness. Conventional punching machines are excellent for this process.



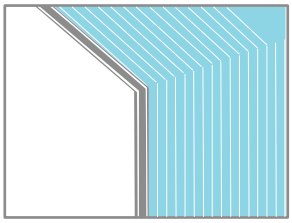
Roll bending

3-roller panel bender is preferable for bending large internal diameters.



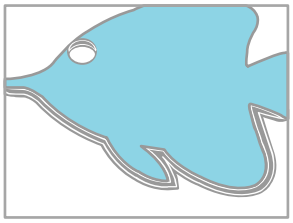
Silk-screen

There have been numerous inks tested for compatibility and adherence to IBOND.



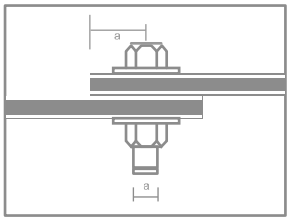
Folding

IBOND can easily be folded by slotting or routing a groove on the rear of the product, as describes in the slotting and routing section.



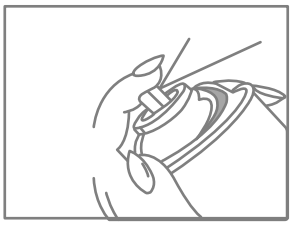
Contour cutting

IBOND can be laminated manually or by machine using cast or calendared self adhesive foil. The quality of polyester finish ensures it does not come off if the foil is changed. Photographs can be applied with adhesive film or wet dispersion adhesive. Panel must be clean and free from grease.



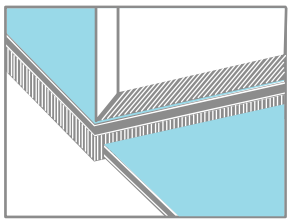
Clamping and bolting

Can be clamped with a serrated corner joint and butt sections for IBOND thickness of 3mm and 4mm.
When bolting, e=2D is the formula to use to calculate the distance of fixing to the end of the panel



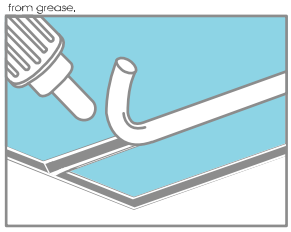
Spray painting and coating

Standard air drying painting acrylic or two part polyurethane coatings are suitable.



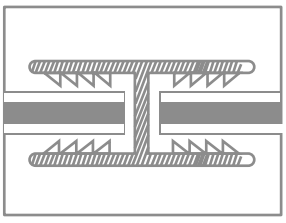
Cutting

Use a standard guillotine for this purpose. Ensure the top cover sheet is inserted properly



Hot air welding

A polyethylene welding rod is available for use with an electric hot air welding set.



Fastened installation

When link two panels, you could use the fastened settings.

Slotting Process Schematics of Aluminum Composite Panels

Slotting Process Schematics of Aluminum Composite Panels

During the folding construction, Aluminum Composite Panels should be slotted at the folding. According to the folding requirement, it may be the V-shaped or U-shaped slot. Several typical slotting methods are shown as in the figure A. The slotting mechanics dedicated for Aluminum Composite Panels should be used to ensure the slotting depth doesn't damage the opposite Al material and reserve the plastics layer with 0.3mm thickness. It can take such reinforced measure at the slotting according to the requirement, such as the addition of side ribs.

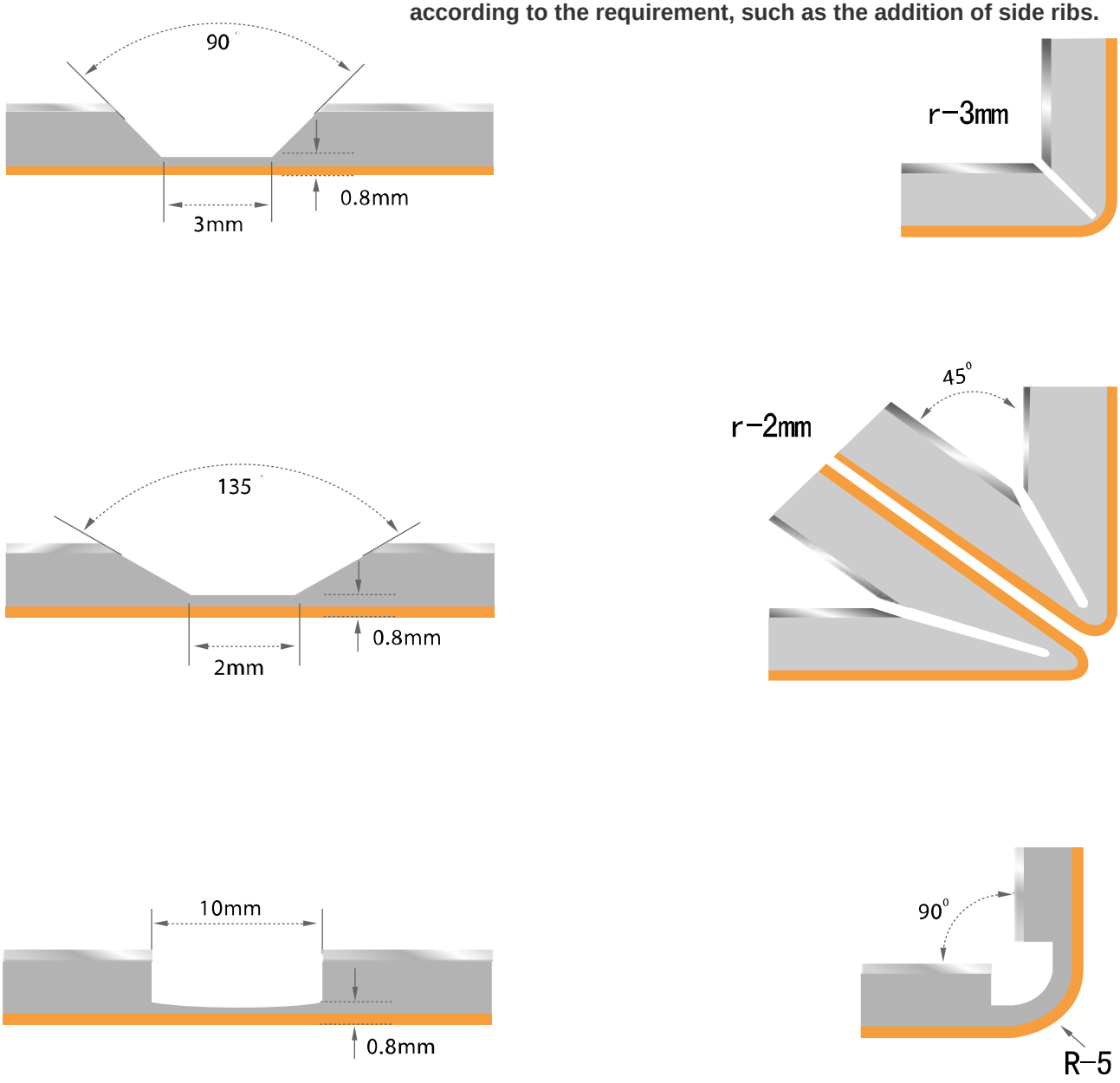


Fig. 1 Several Typical Processing slotting Schematics Connection

Slotting Process Schematics of Aluminum Composite Panels

Slotting Process Schematics of Aluminum Composite Panels

■ **Connection**

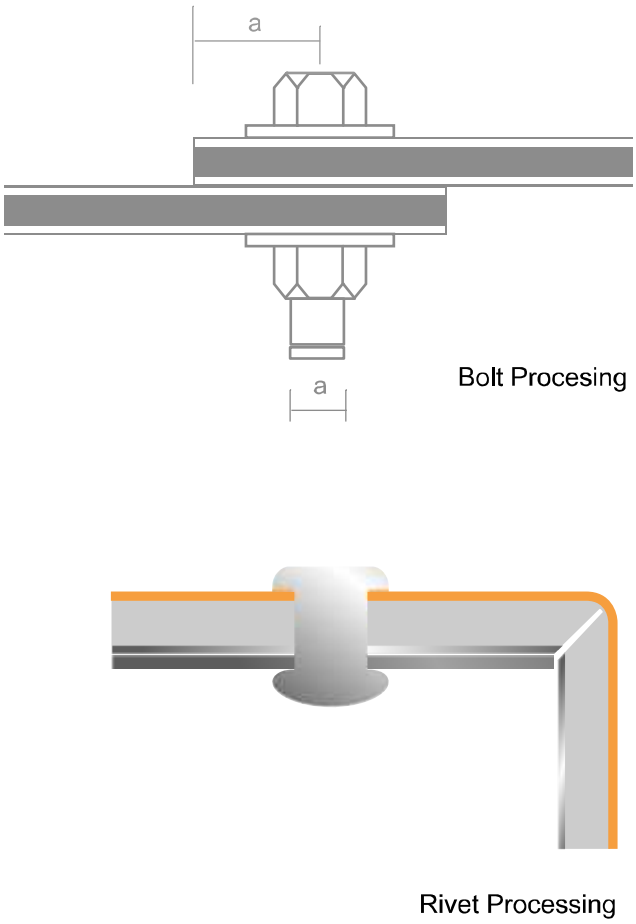
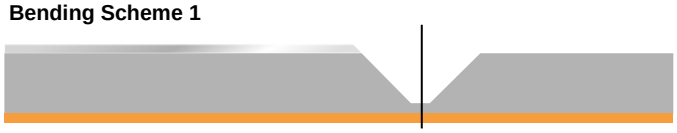


Fig.2 Schematics of Two Common Connection Methods

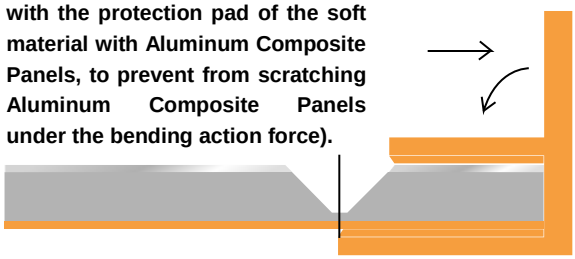
Slotting Process Schematics of Aluminum Composite Panels

Bending Processing of Aluminum Composite Panels

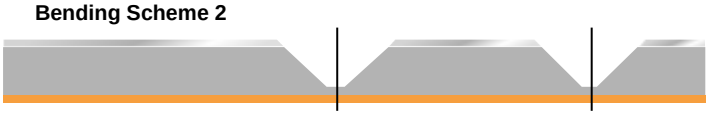
Right Concave Bending Scheme 1

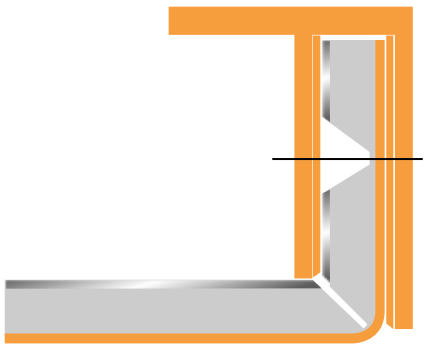


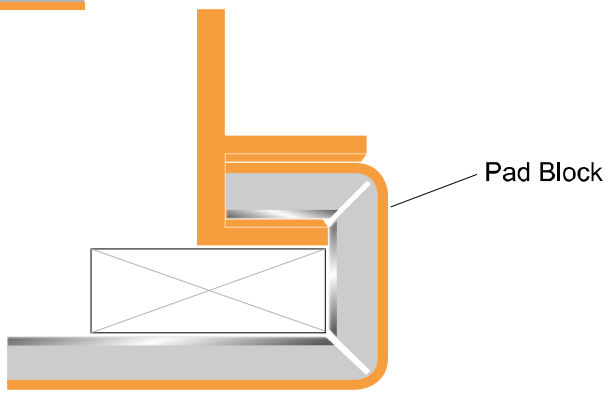
Bending Ruler (the bending ruler with handles should be provided with the protection pad of the soft material with Aluminum Composite Panels, to prevent from scratching Aluminum Composite Panels under the bending action force).



Bight Concave Bending Scheme 2







Slotting Process Schematics of Aluminum Composite Panels

Bending Processing of Aluminum Composite Panels

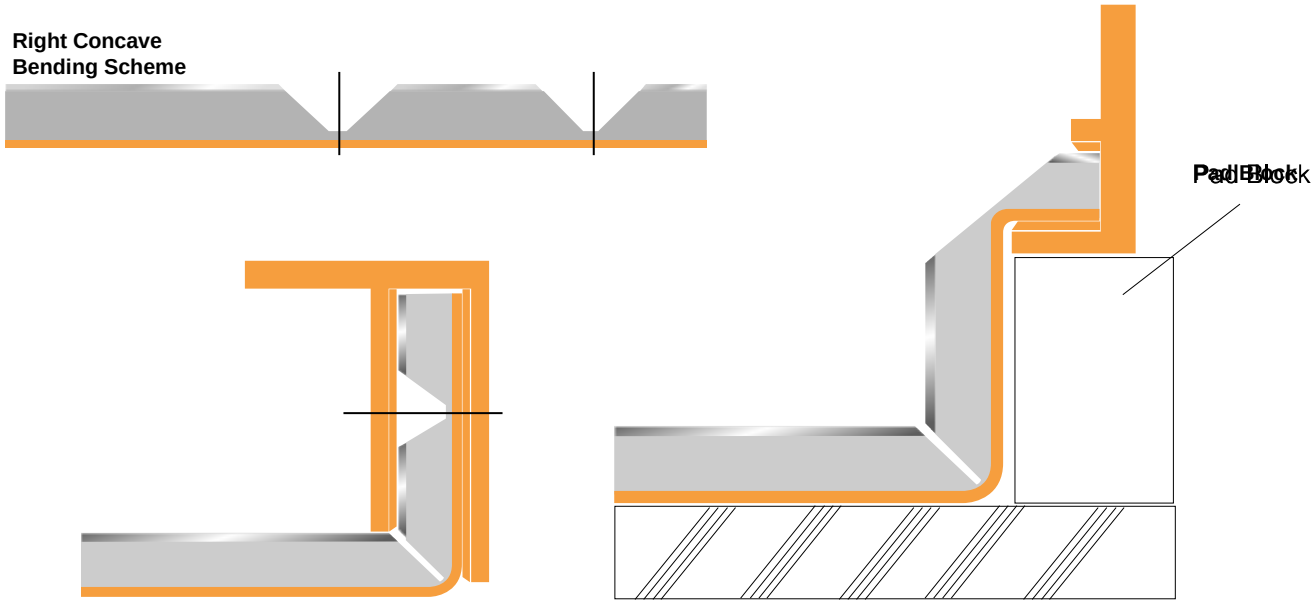


Fig.3 Right Concave Bending Diagram

Slotting, Shearing and Arcing Process and Equipments

I. Slotting

Portable Slotting Equipments

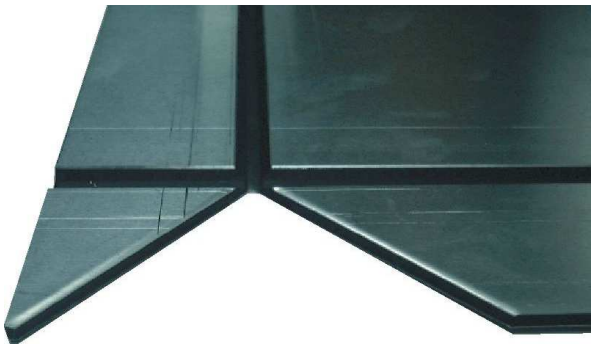
PC Desktop Slotting Machine

PortableArcing Slotting Machine

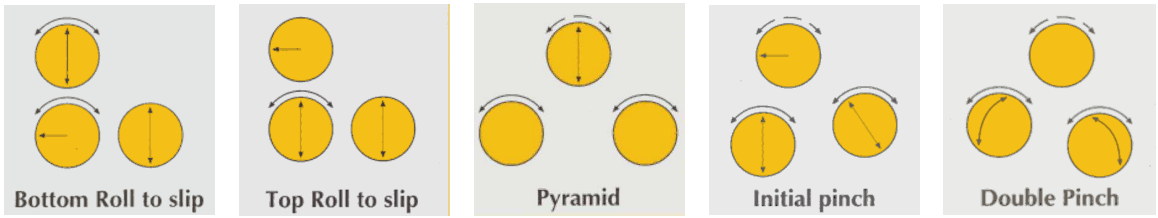
Slotting Blade

Vertical Slotting Machine

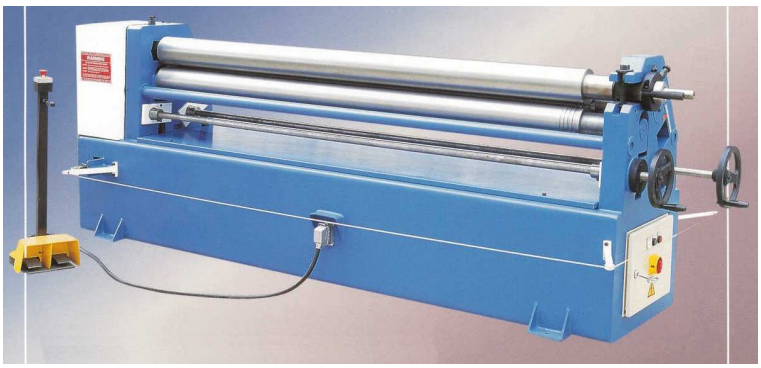
II. Shearing

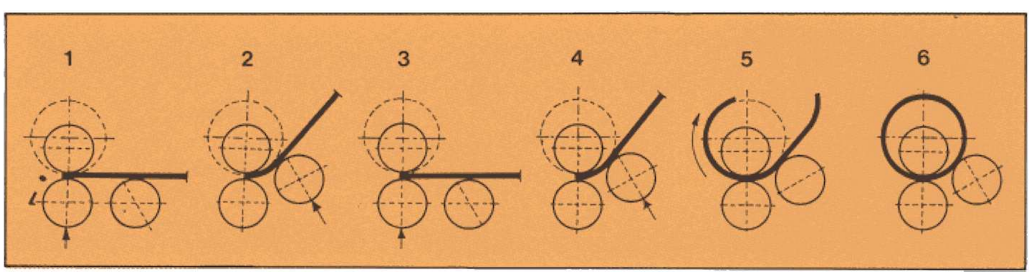


III. Arcing



Three-rollerArc Machine



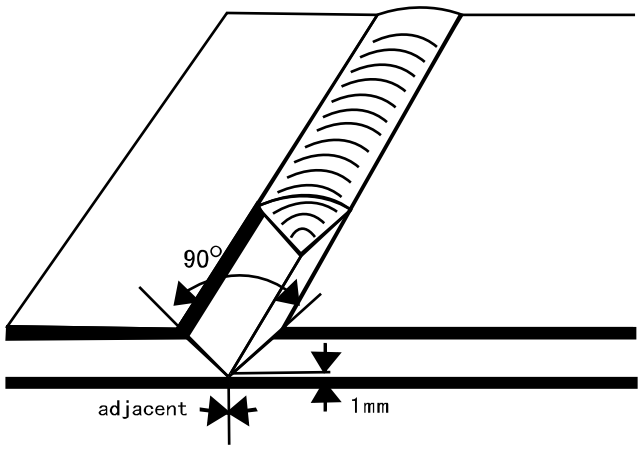


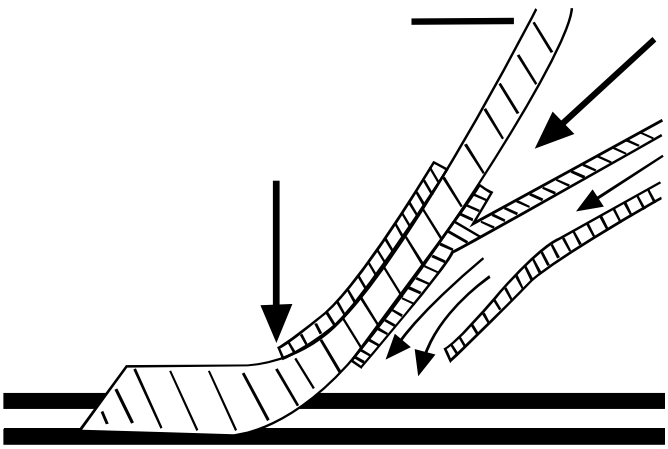
Hot Air Welding

Hot Air Welding

Hot Air Boiler

Welding Head





Note: Temperature of hot air required for the welding: 265 ± 5°

Transportation, Storage and Process Considerations

Transportation, Storage and Process Considerations

■ (1) It should be prevented from installing in the abnormal environment such as the flue dust, dust storm, radiation, noxious gas and chemicals.

■ (2) The products should be placed horizontally regardless during the transportation or in the warehouse. If it is necessary to be placed vertically, the panel should be placed vertical to the plane. The panels should be placed compactly with each other, and the storage limit should not exceed 6 months. When single or multiple panel materials are transported, four sides of the panel should be raised up. Don't drag and pull the single side of the panel.

■ (3) The sawing, trimming, edge cutting, riveting, slotting, bending and lacquering can be carried out for this product.

■ (4) The slotting should use the flat header V-shaped cutting tools. The width of the slotting bottom is 2.5-4mm, and the blade should be sharp, the rotation speed is 2000-3000 rpm and the feeding speed is 3-5m/min, to prevent from peeling of the Aluminum Composite Panels by the melting of the bonding agent for too high temperature during the slotting. The plastic core material with the thickness 0.2-0.4 mm should be reserved between the lowest point of the slotting and the Al plate. The distance between the slotting central line and the edge of the Aluminum Composite Panels should be greater than 20 mm.
If the slotting is too shallow, it is hard for the folding process, and if the slotting is too deep, the paint crack phenomenon will take place for the panel surface coating after the folding process, and the whole strength of the Aluminum Composite Panels can not be ensured. Only the standardized slotting construction can meet the processing requirement.

■ (5) It is necessary to apply the force evenly during the folding for the primary molding. Don't apply the force suddenly or bend it repeatedly. It had better fabricate simple folding calipers for the field operation, to ensure the requirement of the processing quality and improve the process rate.

Transportation, Storage and Process Considerations

■ (6) Don't fill in the silicone gels in rain. During injecting the silicone gel, pay attention to prevent the bubble and the coating of the silicone gels should be even. After the silicone gel is coated at the seam, use the knife with the arc surface to scratch the seam into the arc surface.

■ (7) For the arc surface decoration, the bending equipment should be used for the processing, gently apply force to make the bending of the Aluminum Composite Panels up to required curved surface, and the curvature radius should not be less than 20cm.

■ (8) The installation should be carried out according to the arrow direction. Prevent the visual color difference caused by the ray reflection, especially for the Aluminum Composite Panels with the metal particles.

■ (9) Don't remove the protective film before the construction is completed, to prevent from scratching the surface painting film. The protective film should be removed within 45 days after the construction is completed.

■ (10) The resin or hardened glue should not be used for the installation of the internal wall board. Otherwise, it will not be flat. It had better take the plywood or other related materials as the floor of Aluminum Composite Panels for the installation of the internal wall. Don't paste the Aluminum Composite Panels in the cement wall directly.

■ (11) After the folding for Aluminum Composite Panels, the channel dimension of corresponding lining dimension should not be greater than 600mm*600mm, to ensure the requirement of the panel strength is met.

From the above mentioned, it is necessary to improve the field management, pay attention to the field environmental sanitation and carry out the standardized construction by the standard, to meet the quality requirement and achieve the installation effect.

Protection and Cleaning of Curtain Walls for Aluminum Composite Panels

■ 1. The protective measure should be taken for curtain wall members and panels of Aluminum Composite Panels, and such phenomena as the deformation, discoloration and pollution should not take place.

■ 2. The sealants on the curtain wall surface should be cleaned in time during the curtain wall construction.

■ 3. After the curtain wall engineering is completed, the protective film should be removed within the specified date on the protective film. The cleaning solution should be worked out to prevent from damaging the surface for the cleaning.
[Description] The protective film of Aluminum Composite Panels plays the role in preventing the panel surface from damaging during the construction. After the construction is completed, the protective film should be removed in time, to reduce the probability that causes it hard to remove the protective film for the degradation, serious sealant missing or pollution of the Aluminum Composite Panels surface.

■ 4. The flexible cleaning shoul be carried out for curtain walls of Aluminum Composite Panels by the neutral cleaner without the corrosion and pollution of the plate surface. Before the cleaning, consult the plate manufacturers for related considerations. The Aluminum Composite Panels should be cleaned and serviced for one time every year at least and the surface defect and hazardous substances should be removed, to maintain the surface clean and ensure the normal service life of products.
[Description] The surface paint baking of Aluminum Composite Panels should be carried out with professional cleaning and maintenance periodically, and the hazardous filth for the paint baking on its surface should be removed, to ensure long-term quality of the paint baking. When the curtain wall is cleaned, it is suggested to clean the external wall of buildings one time every year at least. The surface cleaning should be carried out for the indoor wall depending on the actual dirt degree.

Protection and Cleaning of Curtain Walls for Aluminum Composite Panels

The cleaning of the building walls should be carried out by manual or appropriate cleaning equipment from the top to bottom. Don't use any goods with corrosion to wipe and clean the surface of the paint baking.

The concrete cleaning steps are shown as follows:

1. Use a large amount of clean water to rinse the surface of panel firstly.
2. Use the soft cloth dipped with the detergent diluted by water to wipe the surface of panel gently.
3. Then use a large amount of clean water to rinse the surface of panel again to remove the dirt.
4. Check the surface of panel, and pay attention to clean the place at which is not cleaned completely by the detergent.
5. Use the clean water to rinse the surface of panel until all of the detergents are removed.

Note: Don't clean the hot surface (when the temperature exceeds 40 ¡ãC) for it is harm to the paint baking of the panel surface if the water content is volatilized too quickly. Special attention should be paid to select appropriate detergents. One basic principle is to select the neutral detergents. Don't use the detergents with strong alkali, such as potassium hydrate, sodium hydroxide or sodium carbonate, the detergents with strong acid, the detergents with corrosion or the detergents with soluble paint baking.

Furthermore, you had better select a small area to clean before cleaning for a large area, and then begin the formal cleaning after it is confirmed to be safe.

Recycling of Aluminum Composite Panels

Recycling of Aluminum Composite Panels

■ The Aluminum Composite Panels are the complex of the PE core material and the dual-side aluminum panel. In general, the aluminum material in the panel is about 50 percent of the weight for the plate. Hence, the Aluminum Composite Panels provide superior rigidity and light weight, and it is easy to process and install in buildings.

For various components of Aluminum Composite Panels are the recyclable resources, the waste material generated during the manufacturing should be recycled fully. In general, we use the aluminum panel heating method to carry out the separation and recycling.

■ Heating Recycling Method

The waste panel generated during the manufacturing is cut into the strip by the cutter, and the small-sized waste material may not be cut. The side strip is placed into the heating furnace to heat up and bake, to melt the hot-melt sealant for the bonding, and then peel the surface aluminum and plastics. In general, the heating of Aluminum Composite Panels takes the electric furnace or steam heating method.

1. The recycling reprocessing will be carried out for the aluminum panel after the separation by the aluminum processing plant.
2. The reprocessing will be carried out for the plastic core plate after the separation. And it can be used for other aspects of the plastic processing.

Connection Design of Curtain Wall Components and Main Body Structures

6. If the axial force ，$N < 0.5 f_c A$ appropriately get M-0.4NZ=0 as the boundary condition for the calculation of the shearing bearing capacity and the stressed bending bearing capacity.

For the embedded parts that undertake the normal tensile force and bending moment, the resistance in the tensile force item for the anchoring bar section area calculation formula should be multiplied by the coefficient 0.8, which is the reduced coefficient to improve the safety margin by taking the importance of the embedded parts and the complex of the force into account.

When the straight anchoring bar and the bending anchoring bar take effect at the same time, take the total of shearing force subtracting the shearing of the straight anchoring bar as the shearing of the bending anchoring bar to calculate the section area:

$$A_{sb} \geq 1.4 \frac{V}{f_y} - 0.25 \alpha_r A_S \qquad (5.2)$$

Related foreign specification and domestic test research on the bending anchoring bar in the steel and concrete combined structure shows that the bending angle of the bending anchoring bar has not important effect on the shearing bearing capacity. At the same time, control the bending angle within 15° ~ 45° by taking the structure into account. When the straight anchoring bar is not set or only set by the structure, it will not be considered in the calculation, and we get As＝0.

The basic structure of embedded parts specified here requires take the meeting common embedded parts as the goal. The calculation formula is also established according to the requirement of these basic structures.

Upon calculating the anchoring area A, we suppose the anchoring bar plays its role fully, and the stress is up to its strength design value . To make the stress of the anchoring bar is up to and anchoring bar doesn’t slide or remove, the anchoring length should be enough, which is related to the model of the steel bar, the strength of the concrete and the type of the steel. The anchoring length can be calculated by the following formula:

$$l_a = a \frac{f_y}{f_t} d$$

Connection Design of Curtain Wall Components and Main Body Structures

■ 5. For the stressed embedded parts that consist of the anchor plate and the anchoring steel bar in the symmetric position, it can be designed according to the regulation of JGJ133.

[Description] JGJ133 puts forward general regulation for the embedded part design of curtain walls. The requirement for the embedded parts mainly complies with related research outcomes and existing national standard Code for Design of Concretes GB50010.

1. The shearing bearing capacity of the shearing embedded parts is related to the intensity level, the strength, the arrangement method and diameter of steel bars.

2. For the embedded parts that suffer from the normal tensile force, the anchoring bar undertakes both the tensile force and the internal shearing force caused by the bending deformation of the steel plate, to make the anchoring bar be in the combined stress status when the steel plate bends and deforms. Hence, the reduced coefficient of the anchoring plate bending and deformation is introduced into the calculation formula.

3. For the embedded parts that undertake the bending moment, the test indicates that the resultant force point at the stressed area usually exceeds the edge bar at the stressed area. For the convenience and safety, the bending force arm gets the distance between the center lines of the external anchoring bars. Furthermore, the reduced coefficient of the anchoring plate bending and deformation is introduced into the calculation formula.

4. For the embedded parts that undertake the tensile force, shearing force, or tensile force and bending moment, their bearing capacities are supposed to be linear interrelated.

5. For the embedded parts that undertake the shearing force and bending moment, when $V/Vu0>0.7$, the shearing bearing capacity is linear interrelated with the bending bearing capacity, and when $V/Vu0\leqslant 0.7$, the shearing bearing capacity is not interrelated with the bending bearing capacity according to the test result. Where, Vu0 is the shearing bearing capacity when the embedded part undertakes the shearing action individually.

Connection Design of Curtain Wall Components and Main Body Structures

Where, l_a is the anchoring length of the tensile steel bar (mm).

f_t is the design value of the tensile strength for the concrete axis center, it gets the value according to existing national standard Code for Design of Concretes 50010. When the strength of concretes is higher than C40, we get C40.

d is the nominal diameter of anchoring bars (mm).

a is the shape coefficient of anchoring bars. We get 0.16 for the round steel bar and 0.14 for the steel bar with ribs.

Sometimes, it is hard to use curtain wall embedded parts for the value is too large. Hence, we use the low stress design method, namely, increase the area of the anchoring bar and reduce the actual stress of the anchoring bar, to shorten the anchoring length. However, the anchoring length should not be less than 15 times of the steel bar diameter.

■ 6. The embedded steel plate of the slotted embedded parts and other connection measures should be designed according to related regulation of existing national standard Code for Design of Steel Structures GB50017.

■ 7. The anchor bolt connection for curtain walls frame and main body structure should comply with the following regulation:

1 The products should be equipped with the leave-factory certificate.

2 The anti-corrosion processing should be carried out for the anchoring bolt of the carbon steel.

3 The field test of the bearing capacity should be carried out, and the pull-out test should be carried out, if required.

4 Each connection node should not be equipped with the anchor bolts less than 2.

5 The diameter of anchor bolts should be determined by the calculation of the bearing capacity and should not be less than 10mm.

6 The welding operation should not be carried out on the connector that contacts with the chemical anchor bolts.

7 The design value of the bearing capacity for anchor bolts should not be greater than 50 percent of its limit bearing capacity.

[Description] If no embedded part is set and the embedded part is missed in civil engineering, or the embedded part offsets the design position too

much, or the design is changed, or the old building is added with curtain walls, it is usually necessary to be connected by the post anchor bolt. When the post anchor bolt (mechanical or chemical anchor bolt) is used, several measures should be taken to ensure the reliability of connection.

■ 8. When curtain walls are connected with the masonry structure, the steel bar concrete or steel structural beam and column should be set on the main body structure of connection parts. The light filling wall should not be taken as the supporting structure of curtain walls.

[Description] The bearing capacity outside of the masonry structure plane is low and it is hard to be connected directly. Hence, the concrete structure or steel structure connection component should be added. The bearing capacity and deformation capacity of the light partition wall is low and should not be taken as the supporting structure of curtain walls.

Endurance and Safety Performance

Endurance and Safety Performance

■ 1. The color of the paint baking for Aluminum Composite Panels is allowed to change with the time, and it will show slight and even change in the same facade. However, the long term performance test should be carried out according to the nation standard of the fluorocarbon paint and customers should be provided with 10 years or more quality assurance (For the details on the test method and index requirement, refer to the clause 3.2.3 in athis specification).
[Description] The surface endurance performance of curtain walls for Aluminum Composite Panels mainly depends on the color of products, the use location, environment and direction. The variation of effect factors causes the slight difference of the degradation speed of curtain wall panels. However, the degradation condition should be same under the same factor, and the change condition (such as fading) should be even.

■ 2. The fireproof design of curtain walls for Aluminum Composite Panels should comply with related regulation of existing national standard Code of Design on Building Fire Protection and Prevention GB50016, and the curtain wall fireproof of tall buildings should comply with related regulation of existing national standard Code for Fire Protection Design of Tall Buildings GB 50045.
[Description] The curtain wall fireproof of Aluminum Composite Panels is not specified in the Code of Design on Building Fire Protection and Prevention GB 50016 definitely. However, it puts forward some fireproof regulation for the building material and different parts of the building. When curtain walls are in these parts, related requirement should be met.
It specified the building curtain wall in the Code for Fire Protection Design of Tall Buildings GB 50045 definitely, and it should be complied with.

■ 3. The fireproof sealing design should be designed for the seam between the curtain wall and surrounding fireproof partition members, the seam between the curtain wall panel or partition wall outer space and the seam between the real wall surface opening edges.
[Description] Although curtain walls of Aluminum Composite Panels themselves don’t provide special fireproof capacity, it is a part of the whole building as the external envelope structure. Some important parts should provide a certain fire resistance, and comply with the whole fireproof requirement of the building.

Endurance and Safety Performance

Endurance and Safety Performance

The fireproof sealing is a fire protection and smoke isolated method with broad application for current building design, which is formed by filling the material that is not inflammable or fire resistant in the seam, to reach the goal that prevents the flame and high temperature flue gas and noxious gas from spreading in buildings.

- 4. The smoke protection and fireproof sealing structural system of curtain walls should provide the sealing and endurance. If it catches fire, the integrity should be maintained within the specified fire resistance limit.

  [Description] The endurance, adaptable capacity of the deformation and stability is the basic requirement of the fireproof sealing material or system, which should be integrated considered and rationally selected according to the width amd property of the seam (for example, whether the extension/contraction deformation takes place), material quality of adjacent members, other surrounding environment factors and design requirements. In general, the larger of the seam, the larger of the extension/contraction and the higher the fireproof level, the higher the requirement of the fireproof sealing material or system is.

- 5. The fireproof sealing system should use the non-inflammable or fire retardant material that complies with the requirement.

  [Description] The fireproof sealing structural system of curtain walls provides several effective fabrication methods. Regardless of any methods, the material made of the system should provide the fire resistance performance specified in the design.

- 6. The seam between the curtain wall and floor slab compartment can use the rock wool or mineral wool sealing. The thickness of the rock wool and mineral wool should not be less than 100mm, and should be filled tightly. The thickness of the rock wool and mineral wool between the floors should use the zinc coated steel sheet with the thickness no less than 1,5mm, and the seam between the bearing board and other structures should be filled with the fireproof sealing material.

  [Description] The bearing board of the fireproof sealing should use the anti-corrosive processing steel plate with the thickness no less than 1.5mm, but not use the single aluminum plate or Aluminum Composite Panels.

Endurance and Safety Performance

7. The lightning protection design of curtain walls for Aluminum Composite Panels should comply with related regulation of existing national standard Code for Protection of Structures against Lightning GB 50057 and Code for Electrical Design of Civil Buildings JGJ/T 16. The member as the lightning protection network in the metal frame of curtain walls should be connected with the lightning protection system of the main body structure reliably. For the building with the requirement of the electromagnetic shield or using the common grounding protection, the lightning design of its curtain walls should comply with related requirement of Protection against Lightning Electromagnetic Impulse - Part 1: General principles GB/T 19271.1.

[Description] Existing national standard Code for Protection of Structures against Lightning GB 50057 doesn't put forward the regulation on the curtain wall lightning protection concretely and definitely.

The curtain wall of Aluminum Composite Panels is the envelope structure that is attached to the main building. The metal frame of curtain walls is usually not taken as the lightning protection grounding, but makes use of the lightning protection system of the main body structure and combines with the lightning protection design of the building itself. Hence, it is required to be connected with the lightning protection system of the main body structure reliably, and keep the conduction smooth.

In general, the column of curtain walls should use the flexible cable to connect with each other. For the floor whose main building has the horizontal grading ring, the embedded parts or fittings of the column should use the circular steel or flat steel to connect with the horizontal grading ring welding, to form the conduction path. The welding seam and the connection cable should be coated with the antirust paint. The section area of the flat steel should not be less than 5mm×40mm, and the diameter of the circular steel should not be less than 12mm.

The curtain wall key roof stratum with the lightning protection function should be made by using the aluminum alloy plate with the thickness no less than 3mm, the section area of the key roof stratum should not be too small. The curtain wall key roof stratum system should be effectively connected with the lightning protection system of the main body structure roof.

Endurance and Safety Performance

For the building with the electromagnetic protection requirement, the Protection against Lightning Electromagnetic Impulse - Part 1: General principles GB/T 19271.1 requires the metal members with large size, such as the metal window, carry out the equi-potential connection with the lightning protection system (LPS), and the protection network formed by the metal member should not be too large. For the equi-potential connection, this standard puts forward a certain requirement that should be met for the lightning protection design of curtain walls.

- 8. For the endurance of curtain walls for open Aluminum Composite Panels, in addition to above-mentioned whole endurance performance, it should be noted to take the long-term surface treatment quality, the matching with the surface paint baking of Aluminum Composite Panels and preventing the rust from affecting the performance into account. Furthermore, it should also be noted to consider the endurance of the internal fixation for the curtain walls, connection and installation of assistant fittings. If the surrounding environment of buildings is special, such as the seaside and corrosive air (such as the building within the industrial pollution area), it is necessary to use the material with superior endurance.

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Wind Load Mpa	Allowed Panel Length (mm)	Center Deflection (mm)	Rivet Hole Distance (mm)
Width of Panel: 1000mm：			
500	8000	26	500
600	8000	32	500
700	8000	37	500
800	3700	37	500
900	3300	35	500
1000	3000	34	500
1100	2700	33	500
1200	2400	31	500
1400	2100	30	500
1600	1700	25	500
1800	1400	22	500
2000	1200	20	500
2200	1100	18	500
2400	1000	17	500
2600	900	16	500
2800	800	15	400
3000	750	15	400
Width of Panel: 1250mm			
500	3800	35	500
600	3300	38	500
700	3000	38	500
800	2800	37	500
900	2500	36	500
1000	2300	35	500
1100	2000	31	500
1200	1800	28	500
1400	1500	25	500
1600	1300	23	500
1800	1100	21	500
2000	1000	20	500
2200	900	19	500
2400	800	18	400
2600	750	18	400
2800	700	17	300
3000	650	16	300

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Relationship between Bending Deflection and Panel Dimension (Setting of Reinforced Rib) of Aluminum Composite Panels for Curtain Walls

Wind Load Mpa	Allowed Panel Length (mm)	Center Deflection (mm)	Rivet Hole Distance (mm)
Width of Panel: 1500mm：			
500	3400	43	500
600	3000	42	500
700	2700	41	500
800	2300	36	500
900	2000	32	500
1000	1800	30	500
1100	1600	28	500
1200	1500	27	500
1400	1250	25	500
1600	1100	24	500
1800	1000	23	500
2000	900	22	400
2200	800	21	400
2400	750	20	300
2600	700	19	300
2800	350	18	300
3000	600	15	300

Above data is obtained on the basis of the following data:

1. The allowed design stress of the surface aluminum composite panel is 51MPa (evaluate 2.5 times of safety factors for the failure and 1.75 times of the permanent deformation).
2. The EI equivalent rigidity value of the panel is 0.24kNm2m-1.
3. The allowed design strength of rivets (the safety factor is 3) is the shearing strength Rc=720N and tensile strength Rt=680N.
4. The interaction between the shear and tensile stress is given as Fc/Rc+Ft/Rt《1, where, Fc and Ft are the application load of the shear and tensile respectively.
5. The fixing space is the diameter of the drilling hole subtracting the diameter of rivets, which is equal to 0.3mm.
6. The allowed frame deformation is less than 1/200 of the vertical spans between wall frames.