

# **SOLID ALUMINIUM PANELS FOR EXTERIOR WALL CLADDING**

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## **ABSTRACT**

Basic designs are presented of different methods for wall cladding with aluminium panels. Recent developments in aluminium alloys and coil finishing procedures are described, which improve the durability and the economy of solid aluminium panels.

A technical and economical comparison is made between different technologies and materials for panel production: a) starting from precoated (PVDF, polyester powder, or anodized) metal, b) painting or anodizing after fabrication, c) welded or unwelded corners, d) multilayer and composite panels.

## **SCOPE**

Our purpose is to illustrate how a system based on recent improvements in aluminium coil coating can cut costs and improve quality in exterior wall cladding.

The system, here designated for short as PAC (Prefinished Aluminium Cassette), has 3 basic features: 1) Cladding panels fabricated from solid aluminium sheet high-stress leveled for perfect flatness; 2) Sheet produced from precoated metal with an exceptionally thick and tough polyester powder finish which withstands deformation without exposing the metal, so that panels require no further finishing after fabrication; 3) Panels of a 'cassette' or 'tray' design, produced by bending and working the borders for rigidity and for anchoring to the structure.

The relevance of this subject can be better appreciated when one considers that the use of solid aluminium sheet as an exterior cladding is far from being an old and accepted practice: on the contrary, it had been all but abandoned for about 30 years and its comeback 10 years ago required a good amount of new technology.

## **THE COMEBACK OF SOLID ALUMINIUM**

### **Why solid aluminium went out of the picture**

In principle, aluminium sheet should have been the most widely used cladding material for the past 50 years, in consideration of its lightness, formability, and corrosion resistance. In fact it has not been so, in spite of the excellent demonstration offered in 1953 by the Alcoa Building in Pittsburg (Fig. 1) which was the first case of a high-rise building using aluminium as a cladding material. However, the market didn't follow suit. The reason was that the good results of the Alcoa Building had been obtained by using a

special alloy and procedures that made the cost prohibitive for anybody except an aluminium producer wishing to enhance its image.

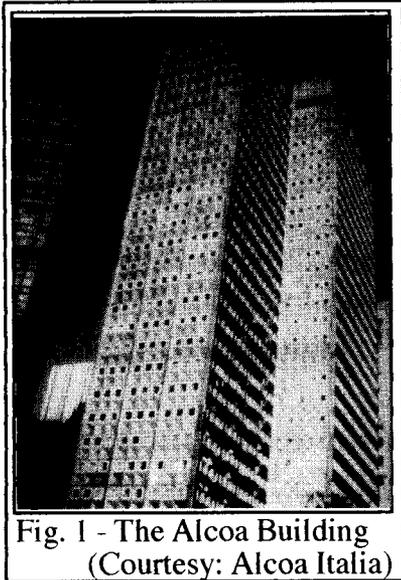


Fig. 1 - The Alcoa Building  
(Courtesy: Alcoa Italia)

In common practice at the time a) the rolling mills were not able to stress-level economically the thick (>1,5 mm) and wide grades of sheet required for the solid panels; and b) anodizing -the only high-performance finish available at the time- was not able to produce a perfectly uniform aspect on a series of panels.

Both designers and constructors, therefore, quickly learned to steer away from solid aluminium panels, fearing that their wavy surfaces and 'checkered' effects would totally spoil the impression of a 'well-made object' that is such an essential requirement of modern architecture.

### **Substitutes for aluminium sheet**

During the long eclipse of solid aluminium panel sheet, it was mostly replaced by multilayer sheet composed of a 3-5 mm plastic core faced with coilcoated thin (0.5 mm) aluminium, where new high-performance paint did away with the uniformity problem and the plastic core ensured perfect flatness. To a lesser extent, thin coilcoated aluminium was also used as a facing of foamed or honeycomb panels, which was more expensive and created some complications in panel joints and attachment to the structure.

In conclusion, these multilayer and composite products caused aluminium surfaces to reappear on facades in the first half of the Seventies. When solid aluminium overcame its problems and came back on the market, its comeback was made easier because it could use -with some adaptmets and improvements- the designs and systems that had been widely used with multilayer sheet during the 'eclipse' of solid sheet.

### **Why solid aluminium is back**

Solid aluminium came back when perfectly flat, thick sheet with a uniform high-performance finish became available. 'Panel quality' flatness was produced when the rolling mills installed high-power stress-leveling equipment for gauges up to 3 mm. Uniformity of aspect was obtained by : a) Painting the panels, after fabrication, with liquid PVDF or polyester powder; b) Fabricating the panels from sheet previously coilcoated with the same paint products (Fig. 2); and c) Using coil anodized sheet (Fig. 3). Particularly, the latter coil finishing processes were determinant in lowering both finishing and working costs. As a consequence, solid aluminium sheet reappeared on the market as an entirely new product, characterized by high performance at lower cost.

We shall now examine the developments and adaptations introduced by the "new" material in the different branches of light panel technology.

## SCREEN PANELS AND WATERPROOF PANELS



Fig. 2 (above): PCC (Powder Coil Coated) Mirawall panels on the Gemini Towers in Milan (Seralwall)

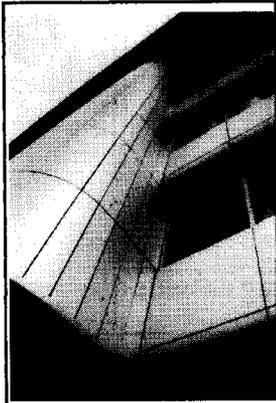


Fig. 3 (left): Preanodized screen panels on a ventilated wall in Naples (Fenzi)

Cladding systems using solid aluminium can be divided into screen systems and waterproof systems. Screen systems are typically applied for ventilated walls, whilst waterproof systems are used for curtainwalls. Table I sets out the main panel designs in the two instances. Solid aluminium screen panel systems have an air space behind, are not waterproof, don't contribute to structural resistance of the wall, can use relatively thin metal (down to 1,5 mm), and their panel technology (PAC) is by and large an adaptation of designs introduced by multilayer PMC (Fig. 4). Similarly to the latter, PAC panels are fabricated from precoated metal, which considerably reduces their cost and improves colour uniformity in comparison with panels finished after fabrication. The simplest and most popular screen systems for ventilated walls embody, as in Fig. 4, "cassette" (or "tray") panels, hung to

**TABLE I - PANEL TYPES**

SCREEN PANELS		CURTAINWALL PANELS	
Symbol	Description	Symbol	Description
PAC	Prefinished Aluminium Cassette Coil coated or coil anodized	WAC	Welded Aluminium Cassette Painted after fabrication
PMC	Prefinished Multilayer Cassette Coil coated	SAC	Sealed Aluminium Cassette Coil coated or coil anodized

vertical structures that were previously aligned. An improved version, permitting easier alignment and installation, is shown in Fig. 5.

Welded aluminium waterproof systems (Fig. 6), instead, have been conceived as curtainwall components. As such, their WAC panels do not have a "primary" watertight wall on the back and they must play the role of a watertight barrier themselves. WAC

panels are expensively made by border bending and working to some "cassette" design, followed by welding at the 4 corners and painting (risking flatness deterioration in the curing oven) with 3-coat PVDF or 1-coat polyester powder. However, the costly WAC technique can be frequently replaced by the simpler SAC technique exploiting precoated metal (Fig. 6) to produce waterproof panels. Here, corners are sealed rather than welded (welding of course would damage the finish), and corner design features 45° riveted joints according to traditional multilayer technology. This permits the application of sealants which make the wall waterproof with the aid of rubber gaskets.

Screen panel systems have much wider applications than WAC or SAC, ranging from the refurbishing of old buildings to ventilated walls for high rise buildings as in fig. 3.

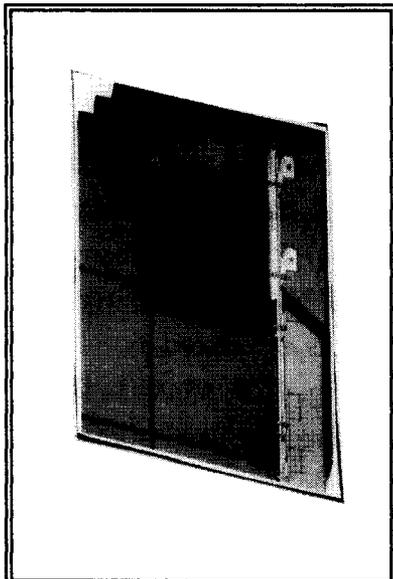


Fig. 4 - A basic design of hung cassette screen, using the PMC or the PAC panel technology (Bicro by Alcom)

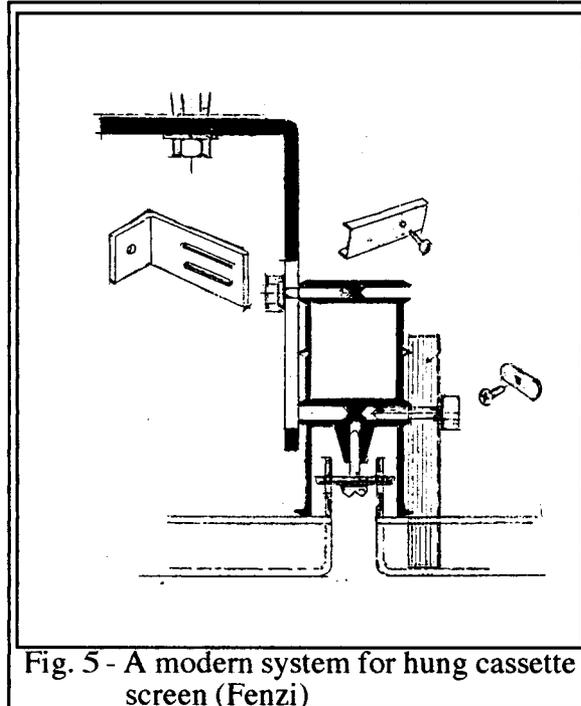


Fig. 5 - A modern system for hung cassette screen (Fenzi)

Some confusion is sometimes made when specifications ask for WAC panels not for curtainwalls but for ventilated walls. This is contradictory, and unnecessarily introduces the additional costs of waterproof panels in ventilated wall projects where simpler screen panels could be used. To give a rough idea of the difference, a screen panel may cost

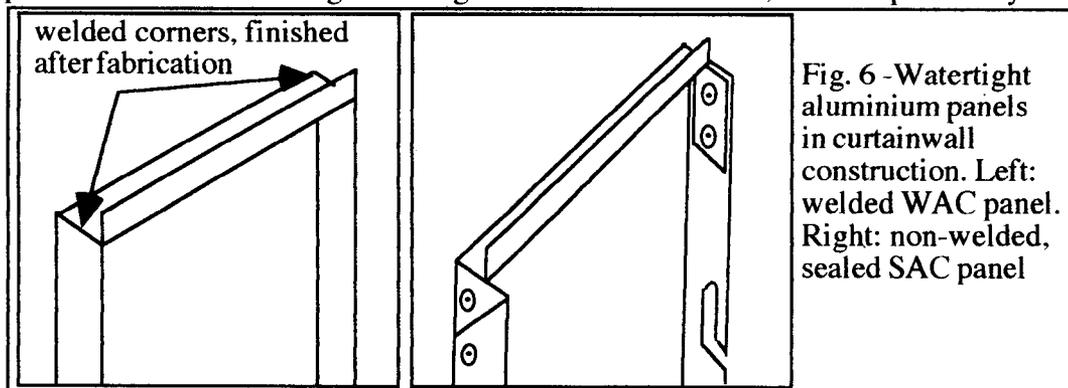


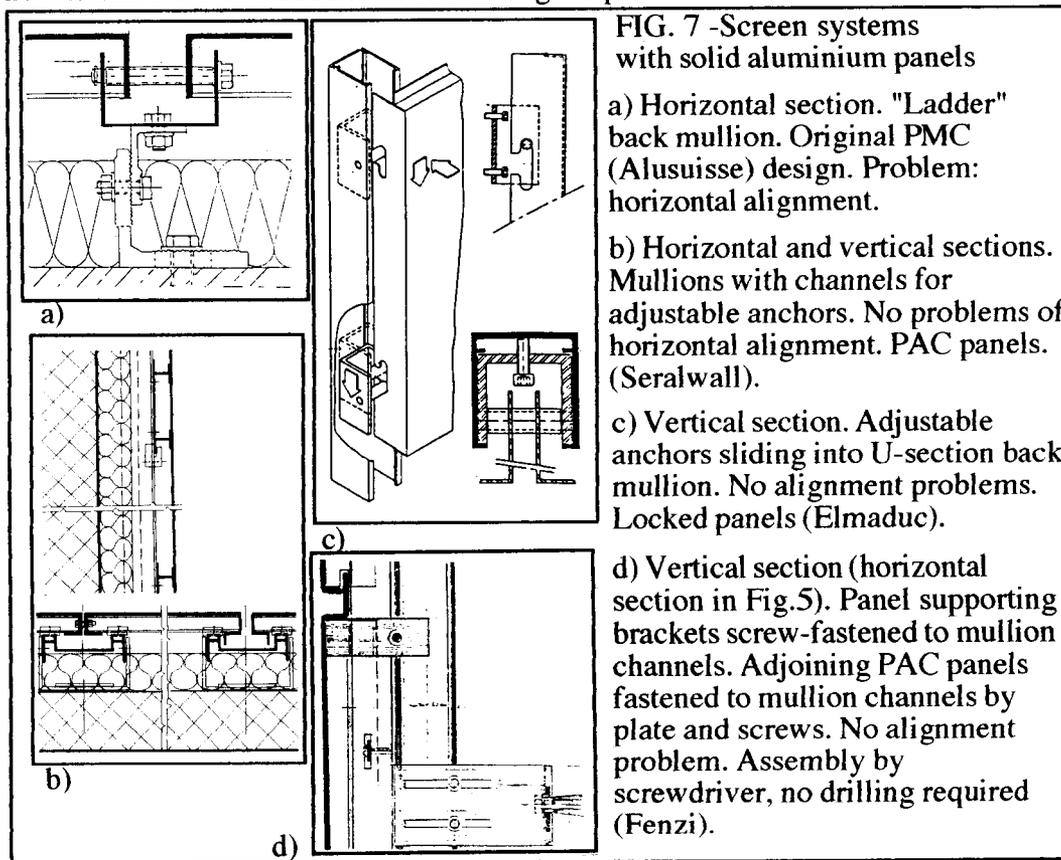
Fig. 6 - Watertight aluminium panels in curtainwall construction. Left: welded WAC panel. Right: non-welded, sealed SAC panel

40-70 \$/m<sup>2</sup> with the solid PAC version in the lower range and the PMC in the upper range, whilst WAC panels may cost from 100 \$/m<sup>2</sup> upwards.

### Screen panel design

Fig.7 presents some typical examples of screen systems for ventilated walls. The PMC system in 7a is the basic design employed for multilayer panels. Several modern PAC systems using solid aluminium sheet have been developed from this traditional PMC design, with improvements made possible by the strength of solid aluminium and by the new 'bendproof' thick prepainted finishes like PCC (Powder Coil Coating).

Technical and economical points arising from introduction of solid aluminium with the new finishes are discussed at the following chapter.



### ADVANTAGES OF PREPAINTED SOLID ALUMINIUM PANELS

The use of PAC panels produced from coil coated thick aluminium sheet has an obvious advantage in the lower cost of the material. At 1996 prices, the metal needed for small panels (e.g. 1,0 x 1,2 m) would be 1,5 mm thick and cost ≈ 16 \$/m<sup>2</sup>. Larger panels (e.g. 1,5 x 1,5 m) would use 2,0-2,5 mm thickness with a metal cost between 21 and 27 \$/m<sup>2</sup>. And with very large panels (e.g. 2,0 x 1,5 m) made from 3 mm sheet metal the cost would go up to 30-32 \$/m<sup>2</sup>, still nicely competitive with traditional materials.

But price is not the only asset of PAC panels: solid sheet with a thick PPC finish can also be shaped into panels more economically than multilayer sheet, because it does not need welding or scoring on the back before bending, neither does it need riveting of the corners, except in some special cases such as the SAC waterproof system, or when a slight scoring on the back may be required to guarantee perfect border alignment along ranges of panels exposed to close lateral observation. A simpler shape of the corner joint is also possible, as shown in fig. 8. As a consequence of such simplifications, approximately an additional 7 \$/m<sup>2</sup> can be spared by using the PAC technique.

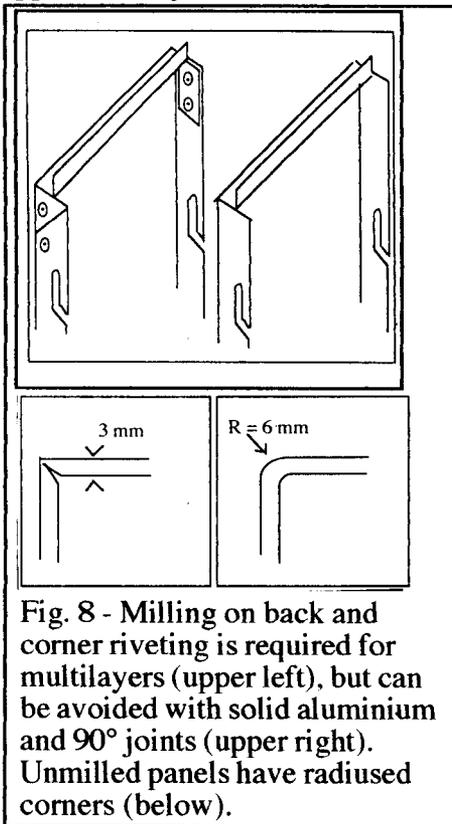


Fig. 8 - Milling on back and corner riveting is required for multilayers (upper left), but can be avoided with solid aluminium and 90° joints (upper right). Unmilled panels have radiused corners (below).

### Objections to solid aluminium

As every innovation, PAC technology must face criticism by designers and constructors who got to feel comfortable with previous technology and are cautious about hidden dangers in new technologies. The main points raised in this connection are listed as follows:

- 1) **Bare borders.** PAC panels obviously have bare borders where the sheet has been cut. However, 50 years' experience has proven that bare aluminium self-passivates in a matter of months.
- 2) **Radiused bends.** When back milling is omitted, bends are radiused ( $R=2 \times$  thickness, see fig8). This is seldom objectionable for facades which are always seen from a distance. And no milling means a stronger panel.
- 3) **Open joints.** The most usual PAC panel design has 90° joints (fig. 8) which are not waterproof.

This should not be considered a problem for ventilated walls, which can be designed to collect, flush away, or evaporate from their airspace any small amounts of water that may have succeeded in passing through the external screen.

4) **Weathering.** Many specifications prescribe PVDF finishes, so that the thick polyester powder finishes used for most PAC panels risk to be disqualified. Advocates of PAC point out that powder coatings have been successfully used on architectural aluminium frames for over 20 years, and the new polyester products used in PCC finishing are further improved upon the conventional types, so they certainly are fully architectural finishes. The PPC film is 60-70  $\mu\text{m}$ , 3 times thicker than common coilcoating.

5) **Filiform corrosion.** Filiform corrosion (wormlike swelling of the paint) has been sometimes observed on powder painted extrusions, and is sometimes feared as a possible defect of powder coil coated PAC panels. However, this problem is only typical

of 6060 alloy extruded sections, and has not been observed on rolled 3003 or 5754 alloys used for powder coil coating. A possible explanation is that filiform corrosion starts from metal surface defects that may arise when sections are extruded without respecting the procedures required to prevent surfacing of inner billet impurities. Such metallurgical defects are not observed on sheet metal because of the different deformation pattern in the rolling process.

6) Expansion and deformation. PACs have no special problems in comparison with other light panels. Depending on wind forces, they may also require back stiffening bars, which can be applied in the conventional way by means of bi-adhesive tapes or

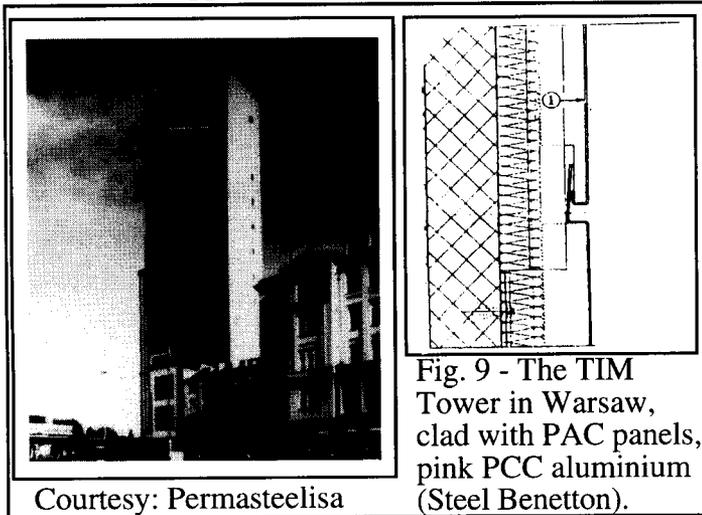


Fig. 9 - The TIM Tower in Warsaw, clad with PAC panels, pink PCC aluminium (Steel Benetton).

Courtesy: Permasteelisa

silicone adhesive.

Expansion must be taken care of by the usual means, involving some clearance at fixing or anchoring points.

7) Fire. Fire resistance of PACS is certainly better than multilayers, because PACS contain no plastic.

## CONCLUSION

As always in the architectural field, every new material, every new treatment, or every new application of conventional materials stimulates our imagination to produce new design ideas. The case of pre-coated aluminium panels is a typical, albeit small, example of such a process. And the objections raised to this innovation bring up another point that is worth stressing in the present "Standard & Specification Rush". Standards and specifications should never become a hindrance to creativity.

