Principles of Curtain Walling
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All information contained herein E&OE.
1.0 Principles of Curtain Walling

Ever since Shreve, Lamb & Harmon specified aluminium curtain walling for the iconoclastic Empire State Building in 1929, this form of construction has helped redefine our built environment. Illuminated by a series of landmark projects including Pietro Belluschi’s Equitable Building, SOM’s Lever Building and Mies van der Rohe and Philip Johnson’s Seagram Building, leading architects have capitalised on the ability of curtain walling manufacturers to produce elegant solutions to complex design and engineering challenges. While not all curtain walling systems use aluminium framing, aluminium’s unique capability of being extruded into complex shapes to exact tolerances provides the unrivalled versatility which makes it the material of choice to this day. Literally thousands of unique profiles, each one able to perform a number of specific structural and aesthetic tasks, are now available to designers, as either off-the-peg or bespoke systems.

Curtain walling is currently experiencing an era of rapid and exciting development. The external glass box is disappearing as environmental issues take centre stage. As well as their accepted role in weatherproofing and external aesthetics, curtain walling systems are now being asked to perform an increasingly active role within the overall structure of the building. Natural light, ventilation and heat are increasingly controlled by building users, which necessitates adjustments to the envelope design. At the same time, demand for improved thermal insulation and solar control is affecting the design of curtain walling systems and their glazing elements; while new technologies, such as photovoltaics, are starting to be incorporated in building façades. These developments are causing architects to reappraise curtain walling and recognise the versatility and environmental advantages of today’s highly engineered systems.

1.01 What is Curtain Walling?

Put simply, curtain walling is a vertical building enclosure which supports no load other than its own weight and the environmental forces which act upon it. Curtain walls are not intended to assist in maintaining the structural integrity of a building. Dead loads and live loads are thus not intended to be transferred via the curtain wall to the foundations.

Curtain walling systems come in a variety of basic types. Off-the-peg systems, often referred to as ‘proprietary’ curtain walling, are constructed using a manufacturer’s standardised components. Bespoke or custom systems are purpose-designed for each particular project.

Increasingly popular are semi-bespoke systems which adapt a proprietary system to meet the specific challenges of a project. Over the past five years there has been considerable growth in this type of system, which has featured in some of the UK’s most prestigious contracts, such as Five Brindleyplace, Birmingham.

Curtain walling systems are presented to site in three basic ways. The first is as a framework of site-assembled components which is used to support pre-assembled infill panels, often known as ‘stick’ curtain walling. The second are sections of prefabricated wall which are transported to site as unitised frames, often pre-glazed. Finally, there are prefabricated unitised frames, often pre-glazed, which are hung on a site-assembled carrier framework.

The choice between stick and unitised systems is dependent on a number of factors, including cost, site access and construction timetabling, plus the overall design and structural requirements. (see Section 2.03)

1.02 Why Aluminium?

Aluminium framing is used for the vast majority of curtain walling applications, primarily for its excellent strength to weight ratio and its ability to be extruded in complex shapes. At 2.7g/cm$^2$, aluminium is 66% lighter than steel. It is also far less susceptible to brittle fractures.

The majority of aluminium curtain walling is constructed using 6000 series heat-treatable magnesium silicone alloys. They are highly extrudable and are thus ideal for the creation of complex shapes.

The properties of the alloy are amplified by the shape of the extruding die. Careful and knowledgeable die design can take advantage of the ability of the extrusion process to distribute the material across the section to exactly where it is needed for a particular performance requirement.

1.03 Coating Confidence

Although aluminium forms a protective layer of oxide as soon as it is exposed to air, most curtain walling components are treated or coated. Options include natural and coloured anodising, although most specifiers now choose an electrostatically-sprayed polyester powder coating. This provides a high quality surface with excellent adhesion, accurate colouration and very even film thickness.

The colour choice is vast. Kawneer, for instance, offers over 130 standard polyester colours and 31 metallic colours, with specials available for large contracts at no extra cost.
Specifiers can also take advantage of mechanical thermal-breaks to specify different colours on either side of a finished assembly.

Coating longevity is not an issue. Polyester coated finishes have an anticipated service life of over 20 years, with leading manufacturers now offering 25 year guarantees on their coatings for normal applications.

1.04 Factory Finished for Fast Track Construction

One of the principal reasons for aluminium curtain wallings popularity is its suitability for fast track construction. The dimensional accuracy of factory-finished sections allows rapid erection on site and, in turn, permits internal finishing to proceed more quickly. The end result is earlier building occupancy and greater profit margins for the developer.

2.0 Design Principles

2.01 Weathertightness

It is the aim of every curtain walling installation to ensure total elimination of water ingress in accordance with the Building Regulations. This means that specifiers need a good awareness of the forces acting upon a building façade and the solutions available to ensure a weathertight exterior shell.

While the façade can be designed to reduce the exposure of the walling elements, it is obviously impossible to eliminate wetting of the façade. The primary reason for this wetting is the complex action of the wind as it strikes a building. When the flow of air impacts on a building, the air flow is deflected across the surface of the façade causing changes in pressure. Curtain wall designers have to pay particular attention to down draughts, which increase wind speed near the ground; vortices caused by air flow along the roof or the base of a building, which give rise to high suction at the edges of façades; separation, where high local suction pressures are created where façades changes direction such as parapets or corners, and funnelling, which increases wind speed between buildings or between separate elements of individual buildings.

The major consequence of these wind effects for designers is their impact on precipitation density. Vortices, separation and funnelling all cause water droplets to separate from the wind flow, concentrating wetting at these points in the façade. Where these façades are of impervious material, such as glazed curtain walling, large volumes of water will be shed to lower levels of the building. These forces place great stresses on the curtain walling, especially around expansion joints and glazing gaskets.

This is compounded by the fact that water flows down the façade until it hits any projections, such as the lips of individual panels, where it will tend to run into the corners where most joints and openings naturally occur. While factory finished systems can be manufactured to exacting tolerances, 100% sealing effectiveness cannot be guaranteed, which is why curtain walling manufacturers have developed a range of effective strategies to cope with water ingress and maintain the weathertightness of the façade.

As well as the wind, curtain walling systems also have to overcome a range of other localised forces including gravity, surface tension and capillary action. The effect of gravity, which causes water to run down a façade, can be counteracted by protecting horizontal joints with a drip detail and sloping them upwards. Kinetic energy which, if unchecked, would carry wind-driven raindrops through any opening, can be overcome by forming an upstand at the rear of joints. Surface tension, which can lead to water tracking through joints, can also be prevented by a drip detail. Capillary action, which can lead to water tracking inwards and upwards, can be countered by a capillary trap.

2.02 Design Solutions

There are three basic categories of curtain walling systems: front sealed, secondary sealed and pressure equalised.

Front sealed systems are designed to be totally impervious. They rely on exact positioning of the glazing panels and perfect mastic seals or glazing gaskets to provide a totally weathertight exterior shell. Front sealed systems have obvious limitations because their effectiveness is totally dependent upon the quality of the workmanship during installation and the longevity of the sealing mastics or glazing gaskets. Essentially, front sealed systems are only appropriate for use on low rise buildings in sheltered locations, where the façade is likely to be changed within 10 years. However, there are some proprietary systems on the market which combine continuous external gaskets with precautionary drainage, increasing the level of reassurance for specifiers.

Secondary sealed systems, as the name suggests, recognise that a 100% weathertight seal is unlikely to be achieved for the life of a façade. Thus, although designed to be weathertight, any water that does penetrate is collected and drained back to the outside through holes or slots. It is important that these drainage holes are large enough to overcome surface tension and winter icing. For hole drainage, minimum openings of 8mm to 10mm are recommended, while drainage slots of at least 20 by 5mm or 25 by 5mm are the recommended minimum. The current trend is
towards drainage slots, rather than holes. Drainage can be either through the transoms or mullions. (See Section 2.04)

The final option is a pressure equalised curtain wall. In these systems an outer rainscreen provides a protective barrier. Protected Openings allow air ingress to a compartmentalised central cavity, which facilitates pressure equalisation. The inner leaf is designed to be air tight, and may be either curtain walling, traditional masonry or, in refurbishment projects, the existing building façade. The principle of the system is that the air pressure in the cavity changes in sympathy with the external wind pressure, thus eliminating the pressure differential across the external seal which would otherwise tend to draw moisture into the cavity. The size of the slots generally ranges from 25 by 6mm up to 50 by 8mm, depending upon the size of the cavity and the effectiveness of the inner airtight seal. Effective compartmentalisation is required to cope with differential air pressures across the façade caused by vortices, separation and funnelling. For curtain walling systems with transom drainage, compartmentalisation can be simply achieved by closing off the cavity at every mullion/transom joint.

2.03 Stick or Unitised Curtain Walling?

There are two basic types of curtain walling installations: stick and unitised.

Stick systems are installed on site, component by component, after being prepared and machined in the factory and supplied in knock down form. They get their name from the fact that the vertical structural mullions (sticks) are fixed first. After the mullions are secure, the horizontal transoms are added and then the glazing panels, spandrels and vents installed in the completed grid; normally using a pressure plate and facecap. This means that a building has to be unoccupied during refurbishment. Stick systems allow on site adjustment, but the performance of the systems is dependent upon the quality of the installation in what are often uncontrolled conditions.

In conclusion, stick systems are economical and, if correctly designed, detailed and installed, extremely reliable. They are, however, slow to assemble, which may not suit certain fast track projects.

Unitised curtain walling systems are installed as a series of factory-assembled frames, usually with interlocking mullions and transoms. The glazing panels and spandrels are usually factory-glazed and seals are also applied or prepared in the factory. Unitised systems are used where the movement or deflections in a building are such that a stick system is inappropriate. Their principal benefits are speed of installation, minimal on site labour, and lower installation costs. However, these are obviated to an extent by the increased storage and shipping costs, the need for very careful site handling, and the requirement for expensive lifting equipment on site. Unitised systems are popular because they eliminate, or reduce, the need for on site sealing, therefore making them less reliant on the standard of site workmanship. However, for unitised systems to perform to their full potential, it is critical that the brackets to which the components are fixed are accurately installed. Unitised systems do not require decanting during refurbishment contracts.

In conclusion, unitised systems offer the benefits of factory fabrication in controlled environment, and very rapid assembly on site. However, they are generally more expensive than stick systems and require longer lead times.

2.04 Zone or Mullion Drainage?

There are two basic drainage options for curtain walling systems, zone drainage and mullion drainage.

Zone drainage systems feature simple butt jointed mullions and transoms, with each panel acting as an individual unit. The benefit of this configuration is that each panel is individually drained via its transom, and areas of leakage are thus highlighted. Zone drained systems are more responsive to pressure changes as they facilitate pressure equalisation. The use of square cut mullions and transoms also requires less fabrication, reducing manufacturing costs. Zone drainage, as an established technology allows specifiers to draw on the accumulated expertise of system manufacturers. However, zone drainage does have its negative points. The visible drainage slots can mar the appearance of the façade, and leakage from these slots may cause streaking on lower panels. The use of zone drainage also calls for more fabrication on the pressure plates, which offsets some of the benefits of the simple square cut mullions and transoms.

Mullion or point drainage appeals to specifiers because it obviates the need for visible drainage slots. Sealing is also less critical with mullion drained systems since they feature overlapping joints. Pressure plate fabrication is also simpler, and thus cheaper, with this type of system. However, mullion drainage also has its negative points. Mullion cills must be detailed to allow drainage, and the head of the mullion must be detailed to let in air. Unlike zone drainage systems, it is hard to determine the source of a leak, since water can track further before draining away. Mullion drained curtain walling is also less responsive to pressure changes, since
There are really two segments of the roof ventilation and natural light. Individually controlled environments utilising natural centralised building management systems towards the move away from air conditioned buildings with environmental reasons. This has been fuelled by the move away from air conditioned buildings with centralised building management systems towards individually controlled environments utilising natural ventilation and natural light.

There are really two segments of the roof glazing market: slope glazing and patent glazing.

Slope glazing is a logical extension to modern vertically-hung curtain walling systems. It is now gaining wider specification, especially for commercial, retail and leisure projects. Slope glazing utilises the pressure equalisation principles and insulating thermal breaks of zone drained curtain walling. Panels are supported by purlins that drop into pre-prepared recesses in the main structural rafters. Drainage is via rafters, with each glazed panel self-drained. The use of standardised components should allow slope glazing to be completely compatible with vertical curtain walling, allowing the creation of fully glazed structures. This is facilitated by special details, such as adjustable eaves, which provide fully engineered solutions to common construction requirements. As with curtain walling systems, both light and heavy duty options are available from manufacturers to cope with the particular requirements of high rise structures and large spans.

The current trend in slope glazing further echoes that in curtain walling, with a growth in bespoke and semi-bespoke systems, complementing the use of standard proprietary systems. Indeed it is rare now for standard slope glazing or curtain walling systems to be considered for major projects without some degree of customisation. Many of these systems eventually find their way into manufacturers’ standard portfolios, increasing the choice of proven systems available to specifiers. These bespoke and semi-bespoke systems are now being used in increasingly complex shapes, from pyramidal rooflights to domes, glazed atria and barrel vaults.

Patent glazing is a more simplified form of glazing system featuring an interior structural glazing bar and exterior profile between which the glazing panels are clamped. Enhanced thermal performance can be achieved by the use of standard double glazed units. Patent glazing systems are predominantly suited to projects with relatively simple roof structures requiring narrow modules and lightweight glazing bars. While the aesthetic appearance, and thermal and acoustic properties of patent glazing systems are limited, their low cost makes these systems ideal for budget conscious projects such as factory roof glazing, covered walkways and canopies.

Rainscreens are another development from curtain walling. They are essentially a cold façade formed from flat structural panels fixed to a fully adjustable aluminium sub-frame which sits in front of an airtight building structure. The rainscreen, as its name suggests, is designed to deflect rainwater from the building’s façade. Any rainwater that does penetrate the rainscreen either drains away or...
evaporates, thus providing total weather protection for the inner envelope. Fully air-sealed at the internal junction, with special gaskets used externally, rainscreens are engineered to cope with the massive pressure differentials experienced in large structures, such as shopping malls, despite the use of individual glazing panels up to 900 by 1,200mm. The secret is transoms designed to allow thermal and structural movement, while integral drainage channels discharge into interconnected sloping glazing bars. With mullion and transom framing, thermal movement can be simply accommodated by a sleeve and spigot assembly at the head and foot of each panel, often in tandem with a compression gasket to the junctions to maintain the weather tightness of the overall assembly.

Equally suitable for new build or refurbishment projects, rainscreen systems are modular in design and thus compatible with modular glazing systems, allowing the rapid construction of composite façades. The use of open baffled joints and back ventilation means that rainscreens can use the same principle of pressure equalisation as curtain walling systems to control potential rainwater penetration.

3.0 Performance and Testing

3.01 Test Classifications

There are two essential sources for information about the performance and testing of curtain walling systems: BS 8200: Code of Practice for the design of non-loadbearing external vertical enclosures of buildings; and Standard for Curtain Walling by the Centre for Window and Cladding Technology (CWCT).

Essentially systems are tested against three criteria: air tightness, water penetration resistance and wind resistance. Many proprietary systems have already been extensively tested. Testing is more critical when it comes to bespoke systems.

The CWCT has developed a Test Classification which expresses a system’s test results in terms of the pressures achieved (in Pascals) in the air permeability, water penetration and wind resistance serviceability tests. Thus an Air 300 / Water 600 / Wind 2000 rating represents a system satisfactorily tested to 300 Pascals air permeability, 600 Pascals water resistance and 2000 Pascals for wind resistance.

3.02 Wind Resistance and Structural Loading

Knowledge of anticipated wind pressures is fundamental in curtain walling design. Wind pressure calculations should be undertaken with the help of a qualified structural engineer, and full allowance should be made for the effects of vortices, separation and funnelling. Guidance on wind loads, and also for the structural calculation of dead loads and live loads in curtain walling installations, can be found in the CWCT’s Standard for Curtain Walling.

3.03 Fabrication Advances

The introduction of advanced computer controlled machining stations has had a significant impact on curtain walling design and fabrication. Previously extrusions had to be measured and machined by hand. Now, using CAD CAM technology, complex shapes can be cut, routed and drilled in a single pass, to exact tolerances. Complex mitres can also be cut with ease to ensure exact jointing. These systems can also optimise the use of individual extrusions, minimising wastage.

A major benefit of CAD CAM is its exacting operating tolerances. This means that the machine will automatically reject any extrusions that do not conform to its pre-set parameters. The result is that only perfect components are delivered to site, preventing unnecessary delays due to the replacement of substandard components. With any possibility of manual error excluded from the manufacturing process, site installation is simplified and the overall quality of the completed curtain walling installation improved.

Specifiers are just starting to explore the greater design freedom opened up by the current generation of curtain walling systems. It is, for instance, quite possible to incorporate fixing slots in the internal face of systems to support radiators, or to incorporate complex curved fins for schemes where the designer wishes to emphasise the vertical lines of the curtain walling.

3.04 Technological Integration

One of the benefits of specifying a precision-engineered system, like contemporary curtain walling, is the ability to benefit from the experience gained on previous projects. Extruders have developed their own industry standards, such as glazing bars at 622mm centres to accommodate 600mm wide glazing panels. However, as bespoke systems are developed to cope with unique design challenges, so the vocabulary of systems manufacturers is constantly expanding. Die libraries containing several thousand proven extrusions are now held by major extruders, and many existing designs can be simply modified to facilitate the introduction of new technologies, such as photovoltaic panels or triple glazing.

Since Bernd Melchior developed his Solar House at Remschaid, Germany in the 1980s, building-integrated photovoltaics (PV) has emerged as one of the most exciting additions to
the architect’s arsenal. Sir Norman Foster, Renzo Piano and Thomas Herzog are among the many high profile designers who have appreciated the advantages of an attractive energy source that is completely in harmony with both hi-tech architecture and green issues.

PV modules are easy to integrate, being simply clamped in place of a standard DGU and sealed by a gasket. Integrating PV modules into the cladding of a building has many advantages. No additional infrastructure is required for the electricity generation. Sub-construction costs are eliminated and the electricity generated can be used directly on site. The façade itself becomes multi-functional, with weather and acoustic protection combined with electricity generation.

Roof mounting remains the preferred option, largely because a 30° slope optimises operating efficiency. PV systems can be mounted over an existing roof; integrated with an aluminium slope-glazing system or take the form of PV roof files.

Recent development has concentrated on façade applications. Typical uses include the spandrels of vertical skylights, with PV modules used to replace the traditional opaque elements. Glazed staircases and entrance halls are also suitable, with transparent modules maximising daylight utilisation. Large developments, such as shopping centres, are also suitable since PV modules can replace the skylights over floors and access areas. PV modules are also ideal for glazed roofs in galleries and conservatories, where insulating glazing can be used; or as projecting sun blinds which naturally offer a highly efficient angle to harvest the sun’s rays.

The energy generated by PV modules can be used in different ways. One option is direct connection to a building management process, such as ventilation. Another possibility is an accumulator, such as connection to the public mains. Such network-related plants offer many advantages: good energy exploitation, ease of installation, use of standard components, security of supply, ability to match output with demand, low technical costs, reduced space requirements and elimination of maintenance costs.

The use of PV elements in curtain walling and slope glazing will become more and more attractive as development work increases and costs decline. The technology has already moved from the futuristic to the marketable. PV façades have become easier for the architect and the fabricator to handle. Comprehensive standardisation of the components and the modular construction system offer enough space for various ideas concerning the application in buildings, setting the architect free to explore the creative potential of this exciting, aesthetically-pleasing, and environmentally-friendly technology.

### 3.05 Design Development

One of the reasons for aluminium’s popularity with designers is the relatively low cost of die development. This means that bespoke solutions can be cost-effective even on small projects, although most specifiers prefer to work with or adapt, existing, proven solutions which have been fully tested in the laboratory and on site.

The recent development of specific CAD CAC engineering and calculation software packages, such as Kawneer's KaluCAD, has enabled designers, fabricators and installers to create complex curtain wall and rainscreen systems with authority and confidence. These systems also aid inter-office communications, unifying the estimating, design and production functions: essential if fabricators are to offer the best possible service to fast track contracts.

Typical end products include special framing elements and external profiles designed to provide blast-proof curtain walling solutions, new ‘stalk’ slope glazing systems, structural members which accommodate tracks for cleaning cradles and integrated curtain walling and rainscreen systems.

### 3.06 Contracting

Post Latham, the key word in construction has become partnering, and nowhere is this concept more relevant than in curtain walling. The success of a project requires an active cooperation between client, designer, main contractor, system manufacturer and installer. Schemes such as Five Brindleyplace, now cited as a case study in the UK Construction Industry Board’s report ‘Partnering in the Team’, have proved the benefits of early involvement of the manufacturer and installer in major curtain walling contracts. This is particularly true when the contract calls for bespoke or semi-bespoke systems, as it is vital that sufficient time is allocated for design engineering, prototype development and system testing so that the actual site installation will proceed smoothly, on time and to budget.

Curtain walling manufacturers are at the leading edge of this partnering process, working closely with a small band of specialist installers who have the expertise, financial strength and trained workforce to cope with the demands of curtain walling on fast track construction projects. Both manufacturers and installers are greatly helped in this regard by the CWCT, which not only provides a reliable source of technical expertise but also recognised training courses for specialist sub-contractors.
4.0 Case Studies

4.01 Commercial/Office

**Project**
Oterprise Square, 26 Nathan Road, Hong Kong, China

**Architect**
Rocco Design Ltd

**System**
Custom semi-unitized curtain wall with louvres, operable windows, curved feature covers and horizontal sunscreens. (Sunscreens are the exterior horizontal feature located at the rectangular shaped area of the curtain wall.)

**Contract value**
$1,400,000

**Specification**
Progressive, 27-storey office tower and podium with splayed glass skin

**Detail**
5200m² of custom, semi-unitized, structural silicone glazed framing with aluminium sunshades, operable windows and curved aluminium feature cover profiles.

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4.02 Commercial/Office

**Project**
Five Brindleyplace, Birmingham

**Architect**
Sidell Gibson

**Installer**
Glamalco Ltd

**System**
Kawneer Series 1200 curtain walling, Kawneer Series 1200 slope glazing system, Kawneer framing system and Kawneer Series Tilturn windows.

**Contract value**
£1,400,000

**Specification**
Complex six-storey curtain walling structure with glazed atrium designed to offer natural internal environment with minimal solar gain through use of automatic blinds and vents.

**Detail**
Atrium glazing featuring Kawneer Series 1200 slope glazing system.

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4.03 Industrial

**Project**
Motorola’s new Mobile Telecommunications Manufacturing HQ, Swindon

**Architect**
Sheppard Robson

**Installer**
Exterior Profiles Ltd

**System**
Kawneer Series 1200S curtain walling system, bespoke semi-structurally glazed, low pitch roof and Kawneer Series Designer 53 swing doors.

**Contract value**
£3,300,000

**Specification**
Bespoke semi-structurally glazed, low pitch roof, and new curtain walling system providing a four-sided, structurally glazed, structure.

**Detail**
Flush finish to curtain walling panels and glass.
4.04  **Commercial/Office**

*Project*  Calakmul, Santa Fe (near Mexico City), Mexico

*Architect*  Agustin Hernandez

*System*  Custom four-sided Structural Silicone Glazed (SSG) Stick System Curtain Wall and custom skylights.

*Contract value*  $1,600,000

*Specification*  Ornate office building and exhibition centre with award-winning design.

*Detail*  Custom structural silicone glazed framing and aluminium panels for 6-storey office, pyramidal skylights and pedestrian tunnel.

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4.05  **University**

*Project*  Centre for Environmental Science and Technology Management, State University of New York, Albany

*Architect*  Cannon & Associates

*System*  Kawneer’s photovoltaic curtain walling system, 1600 PowerWall™ and Series 1600 Curtain Walling.

*Contract value*  $1,300,000

*Specification*  A complex 3 storey spherical shaped building with PV power panels installed into 1600 slope glazing to provide and demonstrate the energy/technology available with PV power cells.

*Detail*  Kawneer’s 1600 PowerWall Slope Glazed System is located on the southern façade above the windows. Installed on a flat insulated metal panel, the PV system captures renewable energy while controlling solar heat gain and substantially reducing the cooling load for the building.

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4.06  **Leisure**

*Project*  Warner Village Multiplex Cinema, Inverness

*Architect*  Halliday Fraser Munro

*Installer*  Charles Henshaw & Sons Ltd

*System*  Kawneer Series 190 doors, Kawneer Series 1200 curtain walling and Kawneer Series 503 Tiltum windows.

*Contract value*  £80,000

*Specification*  Full-height glazed entrance area with maximum sized glazing panels needing no intermediary transoms or mullions.

*Detail*  Series 1200 Curtain Walling System with silver anodised finish and 6mm clear double-glazed units; Series 503 Tiltum windows have Kawneer Permacover polyester powder paint finish.
### 4.07 Commercial/Office
- **Project**: Cheng Loong Plaza, Taipei, Taiwan
- **Architect**: Three Men Architects
- **System**: Custom pre-glazed Unitized Curtain Wall with concealed vents.
- **Contract value**: $3,000,000
- **Specification**: 29-storey office building requiring a full curtainwall envelope with concealed operable vents and balcony doors.
- **Detail**: Custom, fully unitized curtainwall glazed with high-performance glass and aluminium panels.

### 4.08 Industrial
- **Project**: Newport Wafer-Fab Ltd, Gwent
- **Architect & Project Management**: M&W Pearce Ltd
- **Installer**: Glamalco Ltd
- **System**: Kawneer Series 190 doors, Kawneer Series 1200 curtain walling and Kawneer Casement Windows.
- **Contract value**: £350,000
- **Specification**: Three-storey panel-clad building to provide ultra-clean manufacturing area. Fast-track construction.
- **Detail**: Kawneer Series 1200 Curtain Walling System; Kawneer casement windows running in a ribbon around the building; Kawneer Series 190 Doors.

### 4.09 Commercial/Office
- **Project**: Lippo Centre, Hong Kong, China
- **Architect**: Wong & Ouyang (HK) Ltd
- **System**: Custom 1600 Wall System® with concealed vents.
- **Contract value**: $4,500,000
- **Specification**: Twin 46 and 44 storey office towers with multiple glazing planes.
- **Detail**: Custom, stick curtainwall with concealed vents.
5.0 Acknowledgement

5.01 The Author

Joe Simpson, 42, has been a construction journalist for twenty years. He started his career at RCI, and later edited both Building Products and Building Refurbishment before founding his own publishing company of which he is still a director. In recent years Joe has been freelance Technical Editor of Building Design, and founder Editor and Publisher of ECO magazine.

Joe currently works as a freelance journalist, as well as editing Tile UK and a number of industry reports. He also lectures to the RIBA, local authorities and other professional bodies on a range of subjects from sustainable construction to new roofing technology.

6.0 Sources of Information

6.01 Trade Associations and Research Bodies

Centre for Window and Cladding Technology
University of Bath, Claverton Down, Bath BA2 7AY Tel: 01225 826541

Aluminium Federation
Broadway House, Calthorpe Road, Five Ways, Birmingham B15 1TN Tel: 0121 456 1103

Council for Aluminium in Building
(Architectural Aluminium Association, Aluminium Windows Association, Patent Glazing Contractors Association)
191 Cirencester Road, Charlton Kings, Cheltenham, Gloucestershire GL53 8DF Tel: 01242 578278

Glass & Glazing Federation
44-48 Borough High Street, London SE1 1XB Tel: 0207 403 7177

6.02 Relevant Standards

BS EN 755 Aluminium Alloy Extrusion
BS EN 485 Aluminium Alloy Sheet
BS 1161 Specification for aluminium alloy sections for structural purposes
CF 118 The structural use of aluminium
BS 8118 Design Code for structural uses of aluminium
BS 5286 Specification for aluminium-framed sliding glass doors
BS 4873 Specification for aluminium alloy windows
BS 5516 Code of Practice for designing and installing of sloping and vertical patent glazing
BS 1615 Method for specifying anodic oxidation coatings on aluminium and its alloys
BS 3987 Specification for anodic oxide coatings on wrought aluminium for external architectural applications
BS 6496 Specification for powder organic coatings on aluminium
BS 4842 Specification for liquid organic coatings on aluminium
BS EN 12373 Aluminium and aluminium alloys. Anodizing
prEN 12152 Curtain Walling. Air permeability. Performance requirements and classifications
prEN 12153 Curtain Walling. Air permeability test methods
prEN 12365 Building Hardware. Gaskets and weatherstripping for doors, windows shutters and curtain walling
BS EN ISO 10077-1 Thermal performance of windows, doors and shutters simplified method
BS EN ISO 10077-2 Thermal performance of windows, doors and shutters numerical method
prEN 12412 Windows, doors and shutters. Determining thermal transmittance by the hot box method
BS EN 1026 Windows and doors. Air permeability test methods
BS EN ISO 14683 Thermal bridges in building construction. Linear thermal transmittance
BS EN 673 Glass in building. Determination of thermal transmittance Calculation method
BS EN 674 Glass in building. Determination of thermal transmittance Guarded hot plate method
BS EN 675 Glass in building. Determination of thermal transmittance Heat flow meter method
BS EN ISO 8990 Thermal insulation. Determination of steady state transmission properties
BS EN ISO 12567-1 Thermal performance of windows and doors - Determination of thermal transmittance
BS EN ISO 6946 Building components and building elements - Thermal resistance and thermal transmittance
prEN 13947 Thermal performance of curtain walling
BS EN ISO 10211-1 Thermal bridges in building construction
BS EN 1027 Windows and doors. Watertightness test method
BS EN 12211 Windows and doors. Resistance to windload test method
prEN 2207 Windows and doors. Air permeability classification
prEN 12208 Windows and doors. Watertightness classification
prEN 12210 Windows and doors. Resistance to windload classification

6.03 Further Reading

Standard for Curtain Walling CWCT
Guide to Good Practice for Façades CWCT
Test Methods for Curtain Walling CWCT
The Properties of Aluminium & Its Alloys Aluminium Federation
Guide to the Specification of Windows Aluminium Window Association
Fundamentals of Building Construction: Materials and Methodology Author: Edward Allen
ISBN: 0-471-18349-0
Aluminium Extrusions: A technical design guide Author: Howard Spencer, AEA
Advanced Uses of Aluminium Extrusions in Commercial Fenestration Aluminium Extruders Association
Aluminium Structures: a guide to their specification and design Authors: J Randolph Kissel & Robert L Ferry
ISBN: 0-471-05385-6
The Practical Design of Structural Elements in Aluminium Author John W Bull
ISBN: 0-291-39798-0
Aluminium in Building Author: John Lane
Architectural Metals: a guide to selection, specification and performance Author L William Zahner
6.04 Kawneer Contact File

Main Office:

Kawneer UK Limited
Astmoor Industrial Estate
Runcorn, Cheshire WA7 1QQ
Tel: 01928 502500
Fax: 01928 502501
E-mail: enquiries@eu.kawneer.com
www.kawneer-europe.com

London Office
Tel: 0207 409 1422
Fax: 0207 409 1466

Technical Literature

- Finishes & Services
- Shopfronts & Framing Systems
- Non Thermal and Thermal Framing Systems
- Door Systems
- 505 Swing Door
- 1200 Series Curtain Wall Systems
- RS-100 Rainscreen System
- Patent Glazing Systems
- 1600 Curtain Wall
- Sliding Windows
- 500 Series Windows
- Econ Windows
- Econ 75 TS Top Swing Window
- Patio Doors