alinea knowledge

Façades:
Do all-glass buildings make financial sense?

August 2016

Façades | Do all-glass buildings make financial sense?

All-glass commercial buildings are a common sight in large cities in particular and make a dramatic architectural statement. But do the numbers add up? Steve Mudie of alinea with Rachel Coleman and Steve Watts look at the costs and options for all-glass façades

01 / Evolution

All-glass commercial buildings have been part of the UK skyline for over 40 years. The 1970s collaboration between Foster + Partners and Pilkington at the Willis Faber and Dumas HQ in Ipswich, with its use of solar control, all-glass façades, provides a renowned and innovative early example of the genre. The 1980s saw the emergence of double-glazed body tinted and reflective coated all-glass façades before the high-tech, more transparent all-glass buildings of more recent years.

Up until the late 1980s, the design of an all-glass building – defined here as one with a homogeneous flat "skin", typically an aluminium framed curtain wall system with double-glazed, sealed units – would usually incorporate either body-tinted or reflective glass. Most would have glazed spandrel panels, the combination being highly efficient in reducing solar gain, albeit with reduced light transmittance, which at the time was considered acceptable. There was no Part L or energy conservation criteria as we know it today.

Modern-day buildings boast the latest facade and glass technologies, enabling the all-glass concept to be fully optimised, with maximum transparency allowing daylight in and views out. They sit alongside buildings where the approach responds to the same design criteria but in a different way, using both glass and solid detailing.

Particularly against the background of an inherent tension between glass and the environmental challenges of solar gain, a fundamental question is prompted: do all-glass buildings make financial sense?

02 / Design criteria

It is inevitable that the design concept for commercial office buildings will contain glass, not only to deliver optimal daylighting and views for wellbeing, but to reduce the need for artificial lighting and therefore, energy usage. Facade design will more often than not include an aluminium curtain wall, usually unitised (prefabricated) for large projects, but there are many sub-options and those considered should be judged against a number of criteria to determine which facade is "best" – while still making financial sense.

alinea's **"Five Criteria"** can be used as a framework to compare different systems through design development:

1. Architectural intent – the aesthetics of form and detailing

2. Performance – across every relevant aspect, from acoustics to weather-resistance

3. Buildability – ease of (safe, efficient) construction and longer-term maintenance

4. Procurement – getting best value from the right specialist contractor

5. Cost – matching price to design intent, and balancing capital and whole-life expenditure.

Facade performance criteria for a modern commercial building are still founded upon a necessity to accommodate project-specific dynamic wind loads, intrinsically linked with agreed structural movements and tolerances while achieving air and water tightness. Other key considerations include acoustic attenuation and flanking, often following British Council for Offices guidelines, fire and smoke stopping, as well as the interrelated requirements of safety, containment, impact, and security.

Technical aspects such as Part L and BREEAM will govern facade development, as will user comfort. These aspects, coupled with the aim of maximising the glazing area for a variety of reasons, form crucial drivers for facade design, often utilising the expertise of the designers, the wider professional team and, where required, the specialist contractor, to fully optimise facade performance and its contribution to the environmental performance of the building and its occupiers' comfort (and thus its impact on MEP systems).

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03 / Static or dynamic?

The building envelope should be assessed against all the Five Criteria detailed in section 2, no matter the material proposed or whether the concept is solid/glass or all-glass. Should the decision be made to follow the latter route then there are two fundamental approaches: static or dynamic systems. Dynamic systems effectively introduce active control of environmental factors.

Both often comprise an aluminium curtain wall chassis framing system, predominantly unitised, i.e. pre-assembled and glazed in controlled workshop conditions, thereafter delivered on a just-in-time basis and typically installed from the concrete slab, one floor at a time, as part of a co-ordinated installation sequence with the superstructure. However, each will have unique variations.

Static all-glass façades

By definition, static all-glass façades will typically entail double-glazed units with a neutral high performance solar control coating to key sun path impacted elevations. The paradox is that in order to withstand peak load solar gains, the facade would need to be relatively dark, impacting the levels of light transmittance. These user comfort issues (particularly the control of heat gain as measured by G values) sit alongside thermal loss measurements (U values): they are related and both must be taken into account.

It is not unusual for glass-faced spandrel panels to be incorporated at each floor, simply to mask the internal build-up of the concrete slab, raised floor, edge beam, MEP services and suspended ceiling. They also help achieve average U value criteria, acoustic flanking, and fire/smoke containment. This reduces the glazed area and thus the solar gain, but still risks a relatively dark coated glass appearance.

Static all-glass systems can make use of floor-to-floor glass units with bulkhead masking to the back face of the curtain wall chassis frame, at its interface with the primary structure and internal finishes. However, this would undoubtedly create the relatively dark coated glass appearance, or necessitate the introduction of vertical solid panels (which would be glass faced to maintain the aesthetic).

There are numerous examples of all-glass façades, both fully glazed and those combining glass faced vertical solid panels. Examples include the Scalpel (52 Lime Street) and One Angel Court. The “path to lightness” led to the development of dynamic systems.

Dynamic all-glass façades

Arguably the benchmark standard of an all-glass concept, where the overall facade zone depth is comparable to that of a static system (250-300mm). Double-glazed units, with a low emissivity (low E) coating form the rear line of the curtain wall chassis, with a single glass pane to the outside, creating a cavity within which motorised blinds are located for solar control optimisation, delivering best-in-class light transmission.

There is still a spandrel zone within a dynamic system; however, it is set back on the thermal line and masked to some extent by the external single glass pane, if adopting a full storey height glass aesthetic. These types of system are now much more common and are installed in a number of completed commercial buildings such as the Shard at London Bridge, comprising a double skin ventilated cavity which, with the automated blinds drawn uses convection to assist in removing solar heat gain though unobtrusive air vents at each floor level.

Understanding by the industry of slim cavity double skin facade performance has evolved, allowing development of the closed cavity facade (CCF) concept. This minimises access to the cavity, unlike double skin ventilated cavity façades, which use vents to draw air in from outside, making it necessary to access the cavity for cleaning the cavity facing glass and blinds. CCF technology can be seen at the International Quarter London, Stratford and will form the principal external walls of 22 Bishopsgate in the City, the superstructure of which is currently under construction.

There are of course a variety of pros and cons between the two generic approaches, as well as across the many sub options, all seek to create all-glass façades with the greatest views while addressing environmental challenges – and will perform against the Five Criteria in different ways.

The Scalpel, currently under construction in the City, is one of several prominent all-glass commercial towers in London

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04 / What constitutes 'financial sense'?

The budget for a building and its constituent parts is, above all, a function of commercial viability: put simply, the relationship between value and cost. Both are driven by a range of metrics that go beyond capital cost (though that is a substantial input), from net to gross floor area efficiencies to ongoing operating costs. Façades have a significant part to play in the assessment of all these factors.

In addition, increasingly, the wellbeing of the building occupants is an important consideration. A building's envelope must deliver optimal levels of daylight and allow a connectedness with the outside world while creating a protective barrier to enable a controlled internal environment. Either all-glass facade system will help to achieve wellbeing aims, albeit to differing levels. Static façades will not provide the same flexible light transmittance and solar control levels as the dynamic solution, creating implications for energy usage (although there will still be codes to which the building must conform). The impact of any glare blinds must be considered, particularly in-use, as manual fit-out blinds in static façades are, more often than not, left in the down position (in a dynamic system, the cavity blinds can be programmed and adjusted to suit different tenants' needs at different points in the building and can feed into the overall building management system).

While there is an upward trend in capital costs from static to dynamic solutions, there are overlaps in cost ranges caused by a number of sub-options, detailing and material choices.

There are a variety of generic facade solution combinations for achieving project-specific "glass and solid" architectural intent. For example, a particular project might entail the use of precast concrete to solid areas, either as reconstituted stone finish or perhaps pre-clad with bricks, stone or ceramic tiles. This would necessitate separate precast and glazing packages, irrespective of whether the glazing system is installed in panels at the precaster's works or as a retrofit on site. Cost impacts include managing the two separate trades, design and co-ordination, interfaces, programme, and impact upon the structure design. There is also a need to ensure that drylining is included to mask any insulation applied to the rear face of the precast concrete elements.

A facade that combines glass and solid detailing is often perceived to be more cost effective than an all-glass facade. However, an all-glass facade provides the opportunity for a single specialist contractor to design, fabricate and install the entire building envelope (or the vast majority of it). This manages risk in terms of design co-ordination, programme, quality and delivery under contract. Efficiency with the static chassis framing system is achieved as it is capable of accommodating glass and glass faced solid panels; however, it can also accommodate a diverse range of rain screen materials. For smaller developments, the all-glass static concept, including glass-fronted solid panels can be achieved using proprietary curtain wall systems, both stick and, where possible, unitised. The dynamic approach is better suited to larger projects, and relies on the use of a unitised curtain wall chassis system, produced in controlled factory conditions for quality control, planning, programming and economies of scale. In-use costs for a static facade are limited to glass cleaning and replacing items such as the glass units, gaskets, and seals over the 60-year design life of the facade. Dynamic façades, however, will attract additional maintenance costs within the cavity including the replacement of blinds and motors.

To maximise building efficiency and opening up net internal areas, the facade zone depth should be optimised, while taking account of architectural intent and performance criteria.

The optimal position for a curtain wall chassis system is outside of the slab, maximising net internal area (NIA). It is possible to design a facade solution (static or dynamic) with a minimum 250mm zone depth. As regards NIA measurement for a dynamic facade solution, the inner glass line is in-plane with the chassis framework, therefore the NIA measurements is to the rear of the frame. Conservative NIA measurement for a static facade is likewise to the rear of chassis framework; however, it is possible for a raised floor to be cut in and around the mullions up to the glazing area only (but not floor-to-ceiling solid panel locations). Capital costs must be taken account of, if such a detail is to be used to maximise NIA. This option is not possible with a dynamic / double skin concept.

Fig. 01 Design evolution of all-glass façades

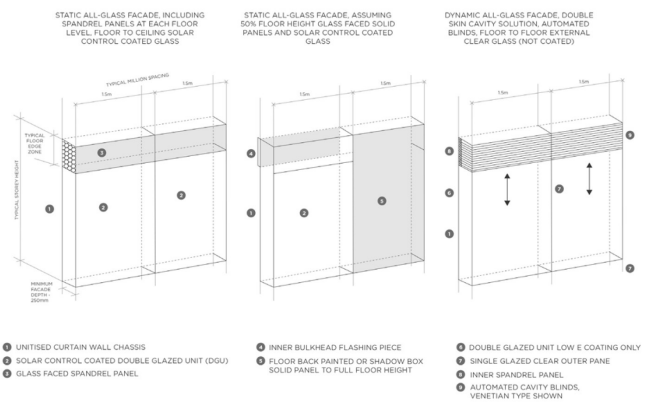

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Fig. 02 All-glass capital cost ranges (£m² facade area)

Fig. 03 Cost premiums (above and beyond the base option of an all-glass relatively dark solution)

	+£/m2
Static: 50% solid panels	50-100
Dynamic: double-skin, ventilated cavity facade or closed cavity facade (CCF)	150-200
Electrical supply, connections and control system, necessary for dynamic facade	40-50

Notes:

i. Based on a Grade A commercial offi ce scheme in London with reasonable scale / repetition
ii. Costs relate to primary façades above ground floor
iii. Sterling / euro exchange rates / payment strategy to be considered

A complete economic comparison would have to factor in whole-life cost assessments. This is less straightforward due to a relative lack of reliable data for maintenance and operating costs of dynamic façades.

22 Bishopsgate has a dynamic all-glass facade, closed cavity technology and automated Venetian blinds

05 / Summary

Can all-glass commercial buildings make financial sense? Yes, on the basis that:

- The facade design concept satisfies the client brief and can be bought cost effectively within budget, subject to any project specific "abnormals", such as currency fluctuation risks if the facade is procured from a non-UK based specialist contractor.
- The facade entails a curtain wall chassis solution throughout, either static or dynamic, unitised/ prefabricated for dynamic façades and for large projects, enabling a single specialist contractor procurement approach for the facade package, possibly via a pre-contract services agreement process, which drives a fully co-ordinated design, interfaces and project delivery, maximising quality, minimising risk and providing clear early budget and design certainty.
- The curtain wall chassis solution maximises commercial efficiency, in terms of NIA (reduced facade zone).
- The facade is required to provide optimal levels of daylight, including best-in-class daylight levels.
- The facade achieves or surpasses minimum performance criteria, including BREEAM, building Regulations Part L, specific Centre for Walling and Cladding Technology requirements, and any other relevant references.
- The external walls contribute to the value of the commercial development, both externally (aesthetics, quality) and internally (views, comfort, control).
- In the case of the dynamic facade solution, building performance can be future-proofed, maximising commercial value.
- The client is made fully aware of building-in-use costs, and these are balanced with other factors such as user comfort and wellbeing.

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05 / Summary (continued)

Both solid/glass and all-glass façades can provide high-quality solutions for the envelope of a commercial building, and the choice will depend upon weighted performance against the Five Criteria.

The economics of glass façades are largely driven by the inherent tension between transparency and solar gain, with control exerted by the “darkness” and solidity of static solutions, or by the automated blinds and cavities of dynamic façades.

Should all-glass be the preferred solution then the base option is the simplest static system, which uses relatively dark, high-performance coated glass, likely to include spandrel panels. To avoid such a dark glass look, solid glass faced panels can be introduced. The cost premium for an all-glass facade with up to 50% glass-faced solid panels could add £50-£100/m2 on to the total facade area. The cost range will be influenced by the design solution, for example the use of back-painted glass units or more expensive shadow box detailing. Other non-glass rain screen materials could also be bought within this cost range, depending upon specification and detailing.

The cost uplift from the base option for a dynamic double skin cavity facade, including motors and blinds would be £150-£200/m2 plus allowance for electrical supply, connections and control system, which would add approximately a further £40-£50/m2 onto the facade area. While this is often bought in an M&E package, it is specific to the double-skin facade and thus must to be accounted for when comparing costs between static and dynamic façades.

Specific projects might benefi t from a CCF approach, which can be bought for a similar price range to a ventilated double-skin facade, particularly where there is the benefit of scale and repetition. However, with limited procurement opportunities, it could be perceived as a commercial risk by some (though this can be mitigated).

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