

# **Architectural Precast Cladding: Advantages And Sustainability**

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## Abstract

Precast architectural cladding is a concrete building material that is produced off-site and shipped in prefabricated panels to a building site. Architectural Precast cladding have been rapidly increased worldwide especially in North America and Europe.

The manufactures recognizes that architectural precast cladding have inherent sustainable characteristics. Also, the manufacturers have an exceptional opportunities and responsibilities to participate in sustainable design and construction, including supporting durable and sustainable building practices and continual improved of their designs, plant production practices, and transportation and construction site activities to reduce environmental impact. In many countries, especially in Europe and the United States, using Architectural precast cladding is one of the best ways to use specially in tall buildings.

This research explains through five main sections the sustainability, durability, and advantages of the Architectural Precast cladding with the purpose of encouraging clients, contractors, and the architects to think and use Architectural precast cladding in their buildings.



## Introduction

Sustainability is an increasingly important issue in today's construction projects, whatever definition we choose to use, whether the focus is on the 'triple bottom line' or simply environmental protection. As a result, in many countries construction industry in and its customers now have higher expectations. For example, specifiers and designers are asking for greater clarity about environmental credentials, clients expect supply chains to be using responsible sourcing standards and others want to know how to achieve 'zero carbon' buildings.

Today's construction product manufacturers are responding to these calls and, in many instances, the precast concrete industry is leading the way by innovating in sustainable design, manufacture and construction. 'More from less' is an entirely appropriate motto for an industry moving towards more energy efficient, resource efficient, socially responsible and environmentally friendly ways of operating.

Architectural precast cladding is an excellent example of a building product that is made in a safe manufacturing environment, using predominantly abundant materials and locally available labor, and which contributes to energy efficient, healthy and long-lasting buildings.

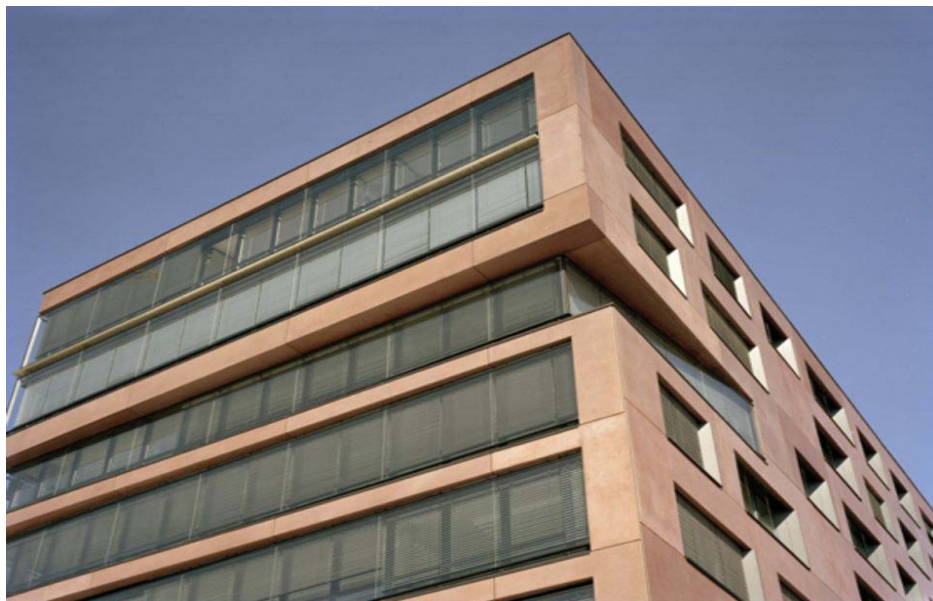
The term precast cladding describes a range of concrete products used to enclose a building; it includes load bearing, structural panels and non-load bearing elements, such as sills. Precast cladding is a concrete building material that is produced off-site and shipped in prefabricated panels to a building site. This is in contrast to standard concrete processes where the forms are built onsite and the concrete is allowed to form and cure in place. Precast cladding is formed in controlled conditions, meaning each piece should be nearly identical to any other. The forming and curing processes are tightly monitored, ensuring that each piece will have the exact same tolerances. On the building site, precast pieces speed construction, since workers don't need to wait for walls to dry. Concrete cladding dates back to the early 1900s and is well-established in Europe and elsewhere. Precast concrete cladding dates back to the early 1900s and is well-established in Europe and elsewhere.

## Sustainable performance in Use

The most important aspect of any discussion about the sustainability of buildings must be the actual performance of a completed building during its life. This encompasses a broad range of issues such as energy use, water consumption, maintenance cycles, fitness for purpose and even fire safety. It is really important to approach the design of sustainable buildings with their whole life performance in mind; a short term attitude simply will not deliver on long term sustainability objectives. Building should be robust, energy efficient, healthy and comfortable for their occupants, whether for commercials, domestics or industrial use.



Precast cladding panels needs no packaging and so reduces transport costs



Façade of the House on Sandtor quay: Red colored precast concrete cladding panels

### ***Long Life, loose Fit***

It is critical that buildings are designed with their future in mind so that they can offer outstanding performance standards in use and even outlast their intended service life. They should be long-lasting and adaptable to change, where needed-this is called 'long life, loose fit' and it is a term that is well-matched to precast concrete cladding which provides a long-lasting enclosure to a building without restricting future adaption inside. In fact, where desirable, concrete cladding panels can be removed safely (deconstructed) and re-installed after works to extend the footprint of a building. This is very resource-efficient and reduces unnecessary waste from refurbishment projects.

Furthermore, the proven durability and low maintenance credentials of this type of construction are evidenced in the number of early 20<sup>th</sup> century precast clad buildings in existence today, many of which still look brand new. The high quality surface finishes achieved in the factory will remain an extremely robust face to the weather for many decades, even hundreds of years, and are therefore easy to maintain.

The typical 60+ years design life reduces the frequency of maintenance cycles and also lessons costs and inconvenience for the owner, where pollution is a particular problem, manufacturers can provide surface finishes and coating that will help prevent the buildup of dirt from exhaust fumes. These photo catalytic treatments to cladding panels help keep facades clean; the nano-particles simply do not allow dirt particles to stick to the surface and they are washed away by rain.

### ***Life Safety and Resilience***

Precast concrete increases its strength for many years after it is cast, but even immediately after installation it is durable and robust and resists rain penetration, wind-blown debris and in some cases, blasts and chemical attack. The fire resistance properties of concrete are also important. Precast concrete cladding does not catch fire, burn, melt, or drop molten particles and can prevent the spread of fire, usually only minor repairs are required to make good after a fire.

### *Moving Toward Zero Carbon*

Specifiers are frequently asking about the carbon footprints of building products, but it is definitely more important to remember the life time carbon footprint of a building; that is the more significant sustainability issue, in most cases, by an order of magnitude. About 90% of a building's environmental impacts will arise during its operation or use, much of which is from the energy used for heating, lighting and, in some cases, cooling of the spaces inside.

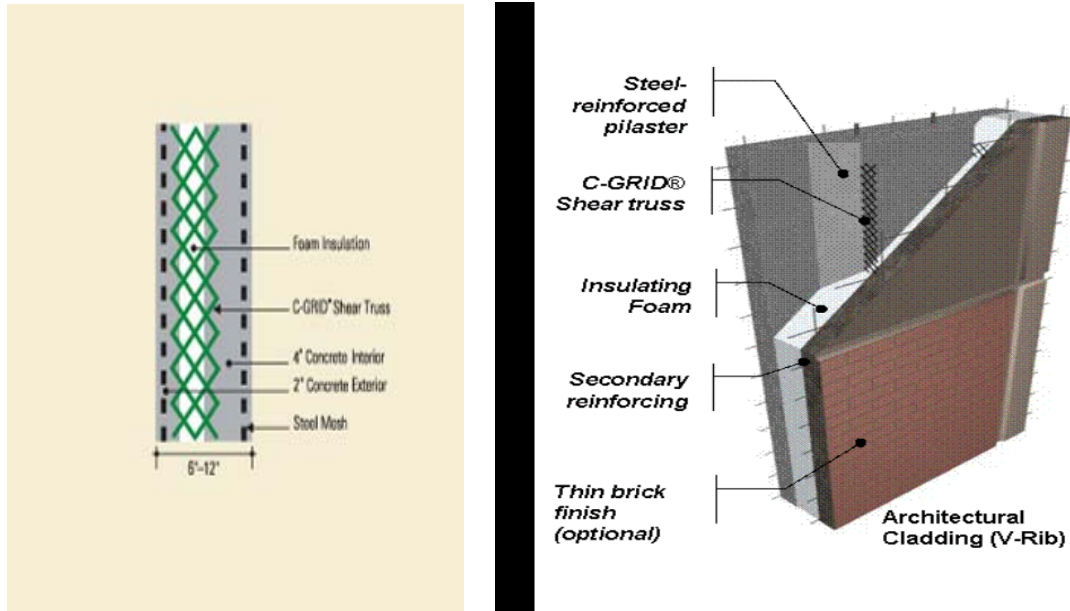
By contrast, just 10% of impacts arise from the manufacture and construction of the building's structure. This is another very good reason to think long term about buildings and to not simply focus on capital costs. In the precast factory, energy consumption can be as low as 150-200 MJ/tonne of product, and normally batching and mixing processes add no more than 3-5 kgCO<sub>2e</sub>/tonne of finished product. Using fly ash and GGBS will reduce carbon emissions even further.

Research has shown that concrete building can pay back their initial carbon 'investment' in just over 10 years, and then continue to provide savings by having an in-built ability to moderate extremes of temperature, particularly during the summer months. Essentially, the use of precast concrete cladding in a building contributes to its thermal mass which helps to even out daily and seasonal temperature swings, making indoor spaces more comfortable without having to resort to air conditioning. This saves energy and money in the long term and, in the short term, saves on capital investment and maintenance bills for air conditioning plant.

That said, in the countries with a lengthy winter season, certain levels of insulation must also be provided in the building envelope to ensure that heat is not lost through the façade. There is no problem in combining precast concrete cladding with insulation products either in the factory, or on site.

Precast concrete insulated sandwich cladding panels offer a very efficient and practical solution, achieving a U value of 0.25 W/m<sup>2</sup>K or better. Insulation sits within two precast concrete layers; the external leaf provides protection against the elements and the internal layer provides thermal mass 'in the right place', i.e. facing internal heat sources such as people and computers. The vulnerable insulation layer is thus protected effectively and the building envelope is doing all that can be asked of it by moderating extremes, whether these arise from cold winter temperatures

or internal heat gains. The occupants remain comfortable and the building owner saves energy and money. What's more, precast concrete is inert, so it doesn't give off any gases, toxic compounds or volatile organic compounds in use.



## Planning For a Sustainable Project

The importance of thinking long-term about sustainability in building is well-known. But there are, of course, practical challenges in achieving this. For instance, the building project team may be under time and cost pressures or be unsure about a client's needs. Indeed, the early stages of a building project can be particularly fraught or problematic. However, decisions made at that time can affect not only the build program, but also long-term building performance, so it is important to get them right.

It is for these reasons that teams trying to address sustainability from the outset need help to ensure that their decisions and subsequent actions do produce the intended results in practice. The early appointment of a precast cladding manufacturer can pay dividends because they will bring expertise, experience and insight to the process.



This section describes the benefits of planning for a sustainable building by working with a manufacturer as early as possible to best deliver specific project sustainability objectives, such as:

- Low energy consumption in use.
- Minimal transport emissions.
- Minimal water use on site.
- Delivering ongoing training for workers.
- Use of environmental management standards.
- Use of responsible sourcing standards.

### ***Confidence Built-in***

Selecting precast cladding early in a project's development provides a much better chance of achieving key sustainability objectives (such as those for energy use, resource efficiency, and waste management and transport emissions). Early decisions between the project team and the manufacturer enable good practice to be designed in; this builds confidence, is much more cost objective than trying to do so later and ensures that opportunities are not missed as the project progress.

Manufacturing members regularly get involved in project discussions. They are accustomed to explaining to designers and clients how they can get the best out of precast cladding products, for example, by utilizing the benefits of an efficient factory environment and the performance attributes of the material. This might include presentations or a factory visit, for example to see environmental management systems at work, and perhaps a visit to a completed cladding project, to hear about the precast advantages first-hand. In any case, the approachability of the precast cladding manufacturers will make this a helpful and constructive dialogue.



## *Sustainability Management*

Many of the good practices that precast manufacturers put into place everyday can be seen in section of Sustainable Manufacture in this research, ranging from efficient use of raw materials to water conservation strategies.

That said, overarching these practical aspects are the management systems and procedures that are used to ensure that precast factories are exemplars of good practice in the way that sustainability is managed, for example, through good environmental, health, and safety practices. Architectural cladding factories are easily able to demonstrate their achievements in these areas via quality and environmental procedures, such as BS EN ISO 9001 and BS EN ISO 14001. The formation of third-party accredited systems enables manufacturers to provide robust evidence of their procedure, both in the factory and administratively. Clients can thus be clear that precast cladding companies go ‘beyond compliance’ and are demonstrating effective product stewardship.

For example, working with The Carbon Trust, one company has put into place several new energy reduction initiatives including additional insulation to the factory envelope, new heating controls and better use of day lighting to save lighting energy. Ongoing monitoring systems are now in place and lessons learned have been applied in a new manufacturing facility.

In addition, manufacturers have sustainability policies in place and are contributing to the development of sector sustainability initiatives in the broader concrete industry. An effective exchange of ideas and knowledge transfer is well-established in the precast industry, principally via particular association; this allows best practices to be shared between companies, regardless of the product being manufactured.

## **Designing Responsibly**

In practical terms, project teams will often need to liaise closely with precast cladding manufacturers to ensure that sustainability objectives are met in the long term. It is important to understand that this involvement starts early in the design process, but to be truly effective; it must continue throughout the detailed design, production information and construction processes.

This section explains how benefits are accrued all the way through a precast cladding project, but also notes how an over-reliance on the results from project/environmental rating systems can limit potential long-term benefits.

### ***Benefits All The Way***

Effective early decision-making can help improve sustainability, but time is of the essence if a team is to ensure that all possibilities to reduce impacts and maximize value are utilized.

For example, early planning with the precast manufacturer means that:

1. Materials can be sourced locally, so reducing transport emissions and supporting regional economies.
2. Panels can be designed to be manufactured efficiently and installed easily.
3. Production in the factory can be made more efficient in terms of raw material use, mold reuse and finishing.
4. Automation of production is more likely to be feasible.
5. Energy use can be reduced by using self-compacting concrete and natural curing.
6. Deliveries to site can be coordinated to make best use of truck journeys.
7. Waste and other impacts can be reduced by coordinating with other trades to eliminate unnecessary waste in site.
8. Thermal mass benefits can be utilized in the building.

### ***Responsible Sourcing***

A recent development is the use of responsible sourcing of standards within construction as a means of assessing the sustainability credentials of the parties within the supply chain. This is pertinent because it offers clients greater confidence in the provenance of the products and services being specified and is also a project-long activity. Although individual manufacturers are taking action (for example by insisting their suppliers have ISO 14001), a pan-industry framework standards (known as BES 60010) for this now exists, and the concrete industry launched a certification scheme in December 2008 that allows concrete products to be recognized as 'responsibly sourced'. Architectural precast cladding manufacturers support the ethos of this

initiative and are keen to ensure that the environmental, economic, social and ethical credentials of the cladding industry are made clear to clients.

### ***Precast Cladding And The Guides***

In most countries guides have been established to rate environment for many precast elements, including precast concrete cladding. The aim is to provide a simple-to-use rating system so that specifiers can easily compare alternatives for a particular element, such as roofing or flooring. Indeed, it has proved popular and has recently been updated and extended.

The ratings are categorized, for example from A+ to E (with A+ being the best over a range of indicators), based on a certain year design life and can be selected according to building type. Importantly, the rating is for all of the products which make up an element (i.e. cladding, insulation, facing, etc).

Unlike other types of production, concrete cladding produces very little or no waste on site, but this is not accounted for. Indeed, the constraints of the methodology adopted by precast guides disadvantage all methods off-site construction. Moreover, the series of weightings used within the calculation method may be disadvantageous to any concrete product (because it is comprised of virgin materials, cement or water). In fact, mineral extraction is giving a higher weighting than lifetime carbon emissions.

### ***Looking At It Holistically***

While the guides do offer a helpful yardstick to compare building elements, concern about the breadth of issues addressed is important-an environmental focus is important, but not sufficiently holistic to represent a true sustainability assessment. After all, “a good building is more than the sum of its parts”.

The architectural cladding associations are keen to help specifiers understand the full spectrum of sustainability issues associated with building construction. For instance, the benefits of thermal mass are not reflected in the UK Green Guide ratings, which is unfortunate, but the guide explains how choosing precast cladding is critically important to improve the operational performance of a building over its lifetime by utilizing thermal mass.

## Sustainable Manufacture

The manufacture of precast concrete cladding takes place in safe, efficient and well-managed factories. The protected environment in these facilities ensures high quality products, but it also makes environmental protection and sustainable manufacture easier to achieve. The extensive use of quality management standards and procedures ensures that this happens day in, day out. In this respect, customers can feel confident that manufacturers are acting responsibly within and outside the factory gate. This section outlines a range of innovative approaches that are commonly used in precast cladding factories to conserve resources, prevent pollution and enhance safety, and also describes ways in which companies liaise with local communities.

### *Materials And Waste Management*

The way in which precast cladding is produced is inherently resources efficient. Furthermore, the process relies on mainly local supply chains, is well-established and understood. Factory scheduling is highly efficient, with repetition being a good key to achieving the greatest economy. This description is common for most precast concrete products, but is worth emphasizing here. Cladding manufacturers are experts in managing and conserving natural resources, taking great care to design concrete mixes so that cements, aggregates and other materials are combined to produce high quality products. In addition, companies are taking further steps to reduce primary resource extraction, minimize waste or reduce production energy, by using:

- Cement replacement materials such as ground granulated blast furnace slag, fly ash and silica, which are by-products from other industries and would otherwise go to waste.
- Self compacting concrete, this removes the need for vibration (saving energy, reducing noise and preventing hearing loss in workers) and uses less primary aggregates.
- Locally quarried stone, this saves transport emissions and fuel.
- Reconstructed stone, this uses small pieces of aggregate and stone which may otherwise be classified as waste and so saves tones of natural stone from being quarried.
- Up to 100% recycled steel reinforcement. In fact, many produced steel rebar is composed of recycled steel, saving significant amounts of energy and reducing waste. It can be cut and bent to shape on demand in the factory.

- Recycled water from finishing processes. This reduces the burden on boreholes and mains water supplies; some factories also capture rainwater from their roofs.
- Approved timber for molds and forms and minimal use of hardwoods.
- Reusing molds and tables. Steel molds can be reused many times and, if well designed, timber molds can be reused successfully.
- Recycling and waste minimization initiatives, segregation of waste happens at source.
- Zero packaging, precast products require no package for transport.
- Closed curing chambers and energy, efficient curing techniques.
- Sealed chambers for grit-blasting, producing virtually no waste as grit recaptured and reused.

### ***Socially Responsible Employers and neighbors***

Precast factories provide tens thousands jobs worldwide. Some workers are from families with long histories of working in concrete manufacture. Indeed, the train and skilled workforce is an important part of the life of a cladding factory especially where highly bespoke specialist cladding panels are made. Experienced stone masons, skilled joiners and pattern makers are all part of the tea; job satisfaction is high and employees buy-in to the concept of sustainability. Labor efficiency is correspondingly very high, close to 100%, and staff turnover is low. Above all, the small size of most precast cladding factories makes for a close-knit team that takes health and safety very seriously. Most factories will also extend a hand of friendship to local community groups, schools and charities and are keen to welcome visitors.

### ***Good Practice In Precast Cladding Factories***

There are many specific sustainability and environmental improvement initiatives that can be seen in precast cladding manufacturing, but not all are readily visible to the naked eye. Sustainability within the factory means implementing an effective combination of both physical features (such as rainwater harvesting and storage pond) and work practices (e.g. ensuring full delivery loads and using energy management systems). All factories will implement a range of these initiatives, but in reality the choice will depend on factory size, nature of production techniques and the cladding products being manufactured.

## Safe, Sustainable Construction On-Site

The sustainability advantages of precast cladding are accrued not only during production, but continue to emerge after products leave the factory. Significant attention to detail regarding delivery arrangements and on-site construction operations means that there are further benefits to be gained through the just-in-time, zero waste approach which characterizes precast cladding projects.

Many clients and contractors are now asking material suppliers for clear statements on responsible sourcing, sustainable practices and environmental credentials, both on and off site. Precast cladding manufacturers are accustomed to these requests and will work closely with the contractor to substantiate this by delivering safe, just-in-time and zero waste construction.

Using precast cladding from a precast association member gives project teams confidence that deliveries on-site handling and erection processes go smoothly. This section explains how manufacturers and specialist erectors work together, offering additional benefits such as fully-glazed, insulated in a matter of minutes, saving energy, time, labor and materials.

### *Delivering The Goods*

Although a significant amount of energy uses (and carbon emissions) are associated with transport, only a small proportion of this is related to the transportation of construction products. It is still important to reduce this as far as possible. Precast manufacturers invest great effort in devising efficient delivery patterns and load planning with their haulers. Essentially, this means making each load count, ensuring that trucks are full and that return journeys are stocked with deliveries of other products wherever possible. Loads are maximized on fuel-efficient trucks; deliveries are arranged for off-peak hours. In addition, with most cladding products destined for the external facades of buildings, they are extremely robust and can travel safely with little or no packaging which means zero waste burden and landfill tax for the receiving site.

### ***Handling Safely***

During production precast manufacturers achieve exceptional safety targets and have reduced accidents significantly in the last years. This reduction of accidents continues on site, where, once panels have arrived, they are scheduled for lifting and installation as soon as possible, if not immediately (i.e. just-in-time). This is organized and undertaken by specialist teams of precast concrete erectors, who are dedicated to the safe and accurate installation of precast cladding panels-safety is paramount.

### ***Installation-Energy-Efficient, Simple And Safe***

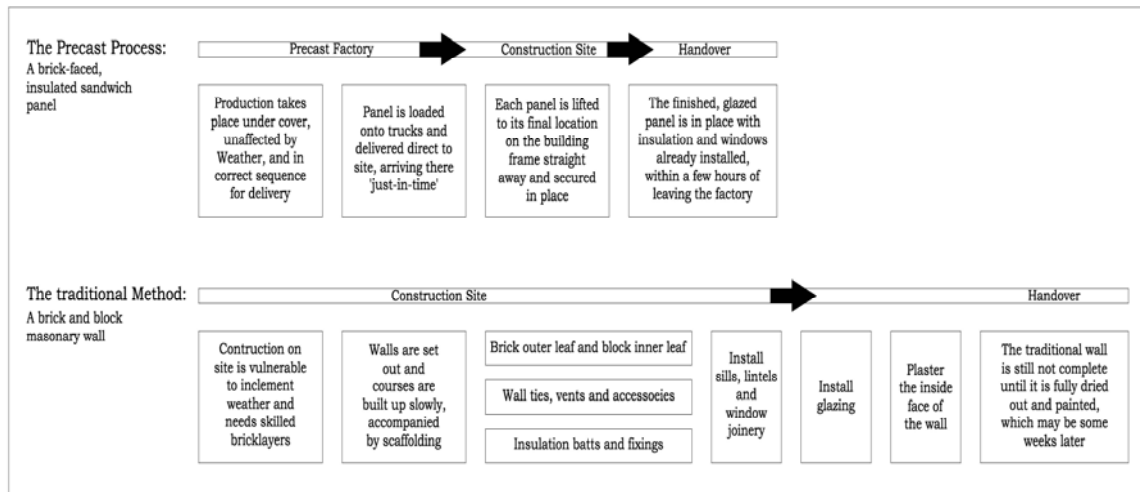
The energy used during the construction of a building can easily be overlooked. To some extent, this is sensible because most of a building's energy is consumed during its operation, but with energy prices rising steadily, there is growing pressure to account for the sustainability of on-site operations.

Precast cladding panels can be produced with all the necessary elements of wall construction included. An example is shown in the diagram in which internal and external finishes, insulation and fully-glazed windows have all been fitted in the precast factory, with no need for anything else to happen on site but jointing and sealing operations. This is a highly cost-efficient way of facing a building because it is fast, uses virtually no labor, minimal equipment and produces no waste. All of which is beneficial to the contractor in developing and implementing a site waste management plan.

The installation process is also energy efficient, because with precast cladding:

- Crane time and number of lifts are optimized and so electrical energy is reduced.
- Site cranes are used, without the need to bring in additional specialist equipment.
- There is no need to double handle the panels.
- There are no wet trades.
- Little energy is needed and power tools are not required.
- Small teams of specialist erection workers travel to sit together, saving on fuel emissions.





Installation process for precast sandwich panel and brick and block wall

## Aftercare

Precast concrete cladding is an efficient, clean and modern method of construction, which means that contractors achieve a tidy, safe site that remains clean and dry. Moreover, the early and fast enclosure of a building that uses precast cladding gives workers safe edge protection and a sheltered working environment, ready for fit-out. There is no waste produced in the installation, no packaging to recycle or dispose off. Lifters are cast in to panels, thus further avoiding waste. Finally, a simple wash down of the panels is all that is required, which uses only water and no harmful chemicals.

Subsequent maintenance of precast cladding is infrequent and minor, with most manufacturers espousing a sensible principle of 'repair, not replace'. The existence of so many precast buildings that remain in excellent condition is good evidence of the robustness, durability and longevity of the product. Although 100% recycling of concrete products is possible at end of life, the added value that cladding panels bring means that most remain in service.

## Conclusion

There is no doubt that the early decision to use precast concrete cladding can have design and construction benefits, but it is also clear that many sustainability advantages can also be gained by using precast cladding. Member companies of different precast associations have a lengthy track record of successful liaison with customers to ensure that environmental, economic and social objectives can be best met in the long term. Approachable manufacturers make it easy to discuss and decide an appropriate strategy for the building's design and construction.

Safe, low energy and responsible manufacturing processes produce impressive results-savings in energy and materials, and reductions in waste are all possible in well-managed precast factories which use state-of-the-art sustainable technologies such as ground-source heat pumps, self-compacting concrete and water recycling. Importantly, precast manufacture produces very little waste and is classified as low risk in terms of environmental hazards.

Construction with precast cladding is safe, well-planned and efficient. Contractors can be confident that their project schedule will benefit from just-in-time deliveries and a specialist team to ensure fast and accurate installation. Energy, materials and labor on site are all reduced by specifying precast cladding, which means valuable cost savings for the contractor and the client. But the benefits do not stop accruing after construction; using concrete cladding products ensures that clients gain long term advantages throughout the life of building.

The results speak for themselves, precast cladding products already adorn many of the best building projects in the world, but, increasingly, specifiers are selecting cladding because of its sustainability and performance attributes as well as its attractive appearance. The judicious selection of high quality, robust and durable construction products like precast cladding results in added value for clients, such as lifetime carbon savings via the energy efficiency achieved through the use of thermal mass. The main sustainability advantages from using are:

- Precast concrete cladding is resilient, energy efficient, low maintenance, attractive and durable.
- Manufacture takes place in low energy, resource efficient and low waste production facilities, managed and staffed by trained and innovative workforce.
- Precast concrete cladding has significant sustainability benefits to offer.

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