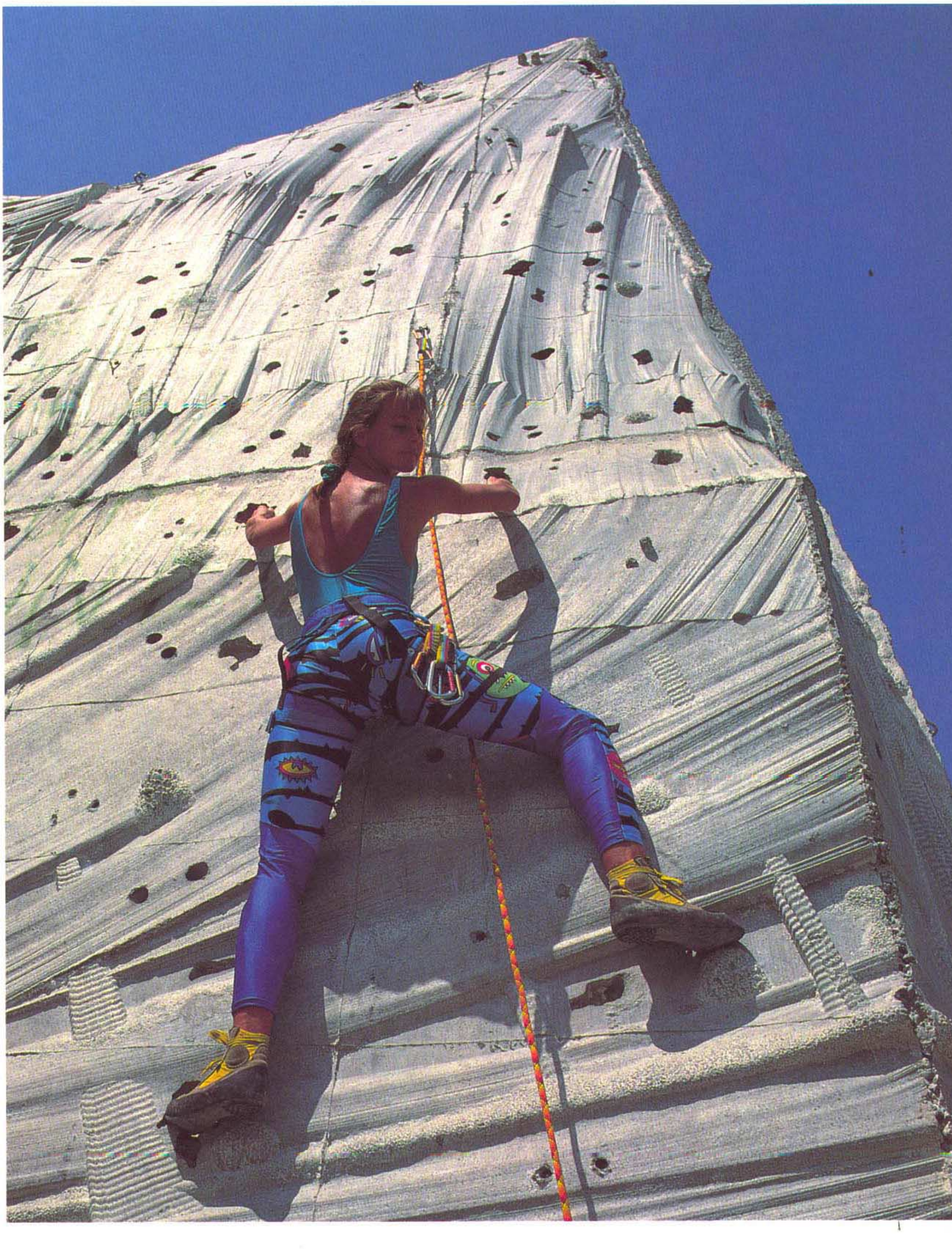
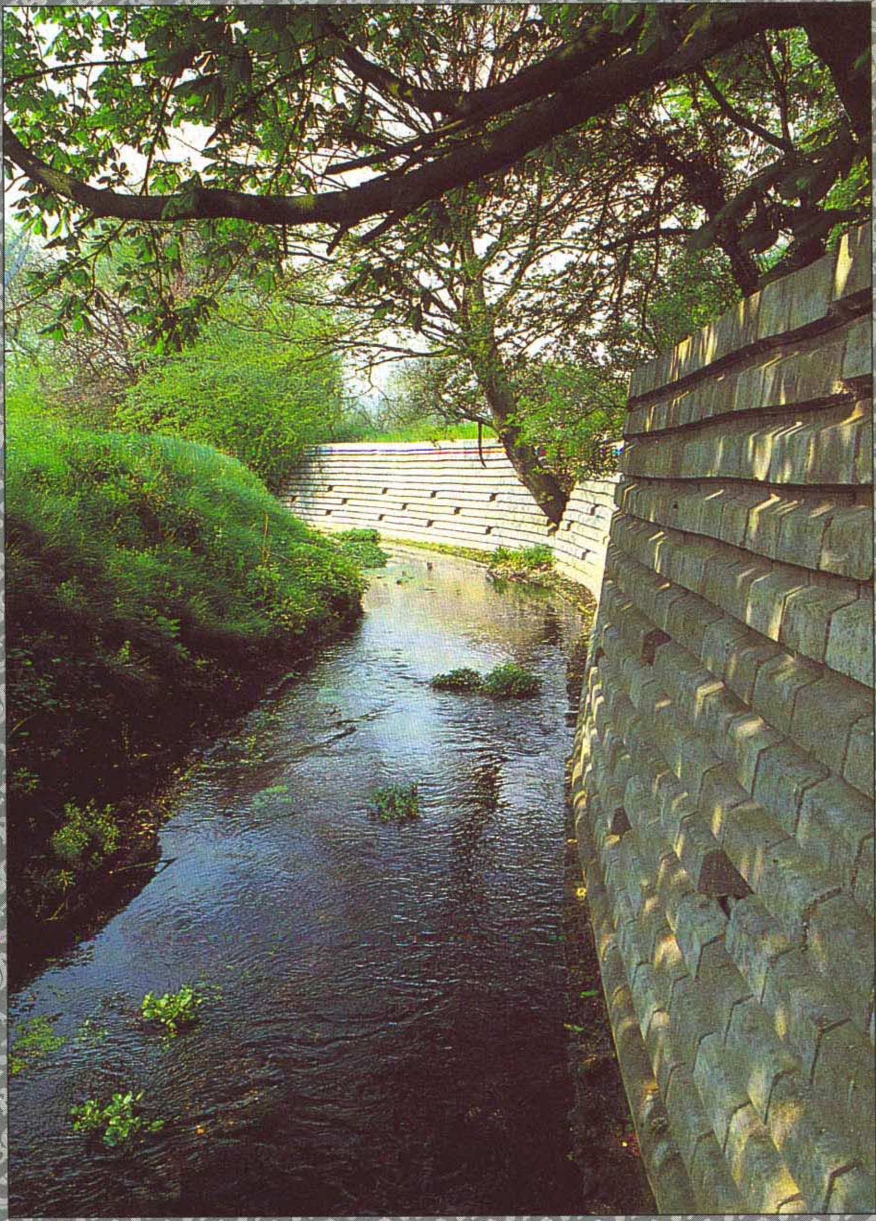
SUMMER 1992

CONCRETE QUARTERLY





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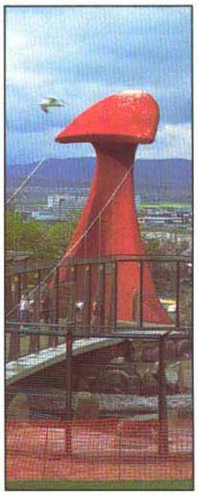
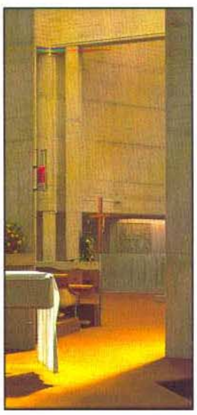
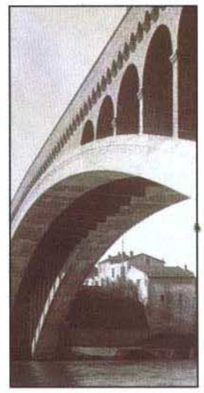



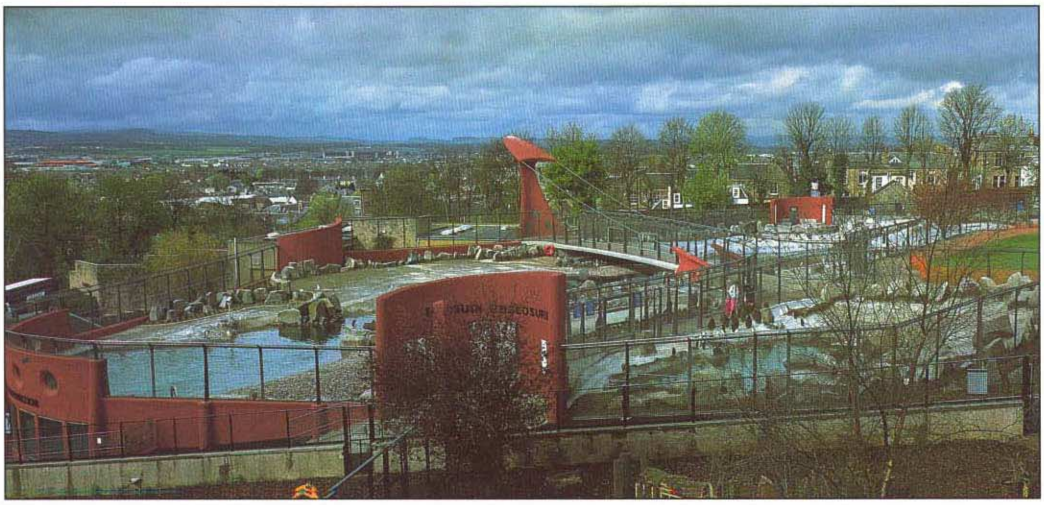

Invited contributors to *Concrete Quarterly* are encouraged to express their own opinions; these do not, of course, always reflect the views of the British Cement Association.

Frontispiece
Bank erosion on a Cambridgeshire stream has been successfully overcome with 'Porcupine' interlocking precast concrete retaining wall units.
Photograph – MMG Civil Engineering

Front cover
Form follows function: the sculptural qualities and strength of concrete have been harnessed in a climbing wall at Constance University, southern Germany.
Photograph – Rudolf Menk, Beton-Verlag

BCA

HOME  FROM HOME



Kim Jervis
BEd, FRSA

Kim Jervis is a freelance designer, engaged principally in architecture and interior design. His work has largely involved restoration and refurbishment of historic buildings, as well as designing animal enclosures.

Photographs – Eric Howard and Terry Donovan

Designers often complain about their patrons – indeed it has often been said that architecture would be a fine job if it were not for the clients. If, on top of this, the clients are supremely indifferent to one's finest efforts, smell of fish and have little purpose in life other than to procreate, then one can begin to grasp the problems of designing for penguins.

Penguin pools were elevated to an art form in the 1930s when Berthold Lubetkin created, with Ove Arup, his seminal design for the pool, recently restored, at London's Regent's Park Zoo. The shade of Lubetkin loomed over all participants in the design competition, run by the Royal Zoological Society of Scotland in conjunction with The Royal Incorporation of Architects in Scotland, to find a designer for its new penguin enclosure.

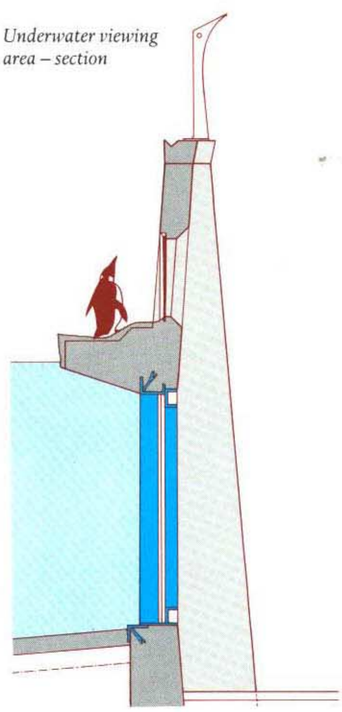
We were fortunate to win that competition in February 1990, and the enclosure – the world's largest – was opened by HRH The Princess Royal in April of this year.

New approach

When Lubetkin designed the Regent's Park Pool, the perceived needs of zoos were very different from those that prevail now. Zoos were seen as places of entertainment, animals formed a 'collection', and as they died they were simply replaced.

The Edinburgh colony was established by the Zoo and Christian Salvesen, through the company's whaling activities, in 1914. From the beginning, it was intended that the colony should be self-sustaining through breeding; this thinking is today central to the philosophy of any responsible zoo.

Underwater viewing area – section



Although the penguin itself is not threatened in the wild, its natural habitat, the Antarctic, clearly is. At the outset of the project we felt that this enclosure should be read as a metaphor of the threat to the Antarctic. The considerable efforts made to create this new enclosure can be seen as a microcosm of the efforts needed in the southern oceans.

In essence, the principal aims of our design were:

- to ensure that all elements of the design should focus on the well-being of the birds
- to provide a significant improvement, in terms of both visitor understanding and enjoyment, over the old enclosure
- to provide a centrepiece for the zoo and
- to combine the dual functions of education and enjoyment.

To quote the competition brief, 'the new enclosure should restore the penguin enclosure and collection as the crowning glory of the Scottish Zoological Park'.

The enclosure

The enclosure takes the form of a large pool, approximately 70 m long and 3.5 m deep, surrounded by beaches and landscaped areas formed from rock, pebbles and grasslands. It was our intention to try to create a natural environment similar to that, say, in the Falkland Islands. A separate, smaller enclosure is provided for younger birds being reared by hand before going to collections all over the world.

The enclosure is surrounded by fencing and large retaining walls. The centrepiece of the design is a 20 m span single-column cantilever suspension bridge.

A variety of viewing 'experiences' are positioned around the pool, culminating in the underwater viewing area at the south west of the site. Penguins, while comic and ungainly on land, are supremely elegant underwater as they effectively 'fly' through the water using their wings as flippers.

The viewing area and the filtration plant form the major core elements of the design; nearly half the total budget is allocated to these two items.

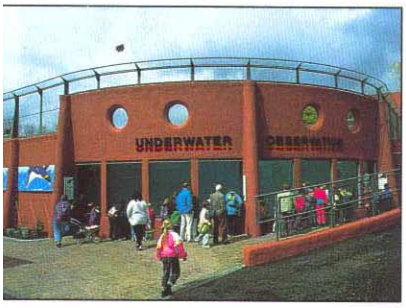
The penguin is very effective at converting fish to 'waste matter' and this, added to the fact that guano is a fine medium for encouraging the growth of algae, creates major problems in cleaning the water.

In such circumstances, filtration is usually based on addition of chlorine to the water. However, this was not permitted by the Zoo, and the system has to rely on ozone forced into the water to make it inert. This novel process is supplemented by biological, sand and UV filters.

The filtration system, designed by Dryden Aquaculture, is central to the project. It has been described by Heriot-Watt University, who checked the design, as 'the finest available with current technology'.

Having provided clear water, the next problem was glass through which visitors can see the penguins underwater. Sealife Centres now have a contracting division which, in conjunction with Pilkingtons, provides considerable expertise in the design of glass for underwater viewing. The penguin enclosure was the first project carried out by the new company.

The eight panels forming the viewing windows set in a concrete wall are made from laminated glass with a total thickness of 38 mm. Considerable research was carried out to ensure the glass was vandal-proof; these panels are, after all, a glass dam, retaining a quarter of a million gallons of water.



The bridge

The focal point of the enclosure is the bridge which provides spectacular views across the pool and of the penguins swimming below. From the outset, its design had layered meanings, symbolic nautical images that conjure ideas of ships and ice. It is appropriate, therefore, that it has been named the Salvesen Bridge in honour of the family which was its principal sponsor.

The mast and abutments supporting the bridge have few straight lines and could not be formed using conventional formwork. Whilst at college I had studied yacht design for a year, and this contributed to the decision to use fibreglass moulds for these elements. In truth, only boatbuilders could supply the expertise required to create such complex shapes.

Following a conventional tender process, Moody's of Southampton were chosen to create the moulds. As is usual, a male 'plug' constructed from timber and fibreglass was made first. The mould was formed in eight pieces over this and, appropriately, travelled to site on a yacht transporter.

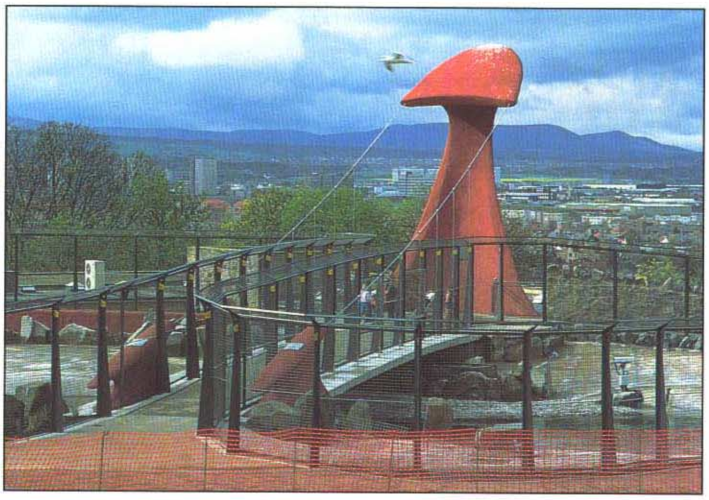
Following erection of the moulds, the mast, which has a steel core, was cast in no-fines concrete and subsequently finished with a layer of sprayed concrete. During its construction a chimpanzee escaped from its keepers and many happy hours were spent retrieving it from the scaffolding. We are still trying to fathom how to explain the delay on the day-work sheet!

Concrete construction of the remainder of the enclosure was carried out using conventional steel and timber formwork, despite the fact that nearly all the shapes of the structure were curved. Again, all exposed areas were given a sprayed concrete finish.

Animals, as I suggested earlier, have a habit of cutting one down to size – our beautiful mast top is now a fine latrine for dozens of the seabirds that flock to the site in search of spare fish.

Year of the penguin?

It seems to have become fashionable to adopt an 'animal of the year'. The shark would not have been totally unrepresentative of the 1980s. The whale has come to symbolize our efforts to save the planet, whilst the elephant symbolizes the growing conflict between man and animals for a place to live. Maybe this will be the year of the penguin. We could do far worse than recognize a bird that combines humour and some elegance with an unquestioning affection for man. ■



The Salvesen Bridge – appropriately reminiscent of a whale's tail

CLIENT
- The Royal Zoological Society of Scotland

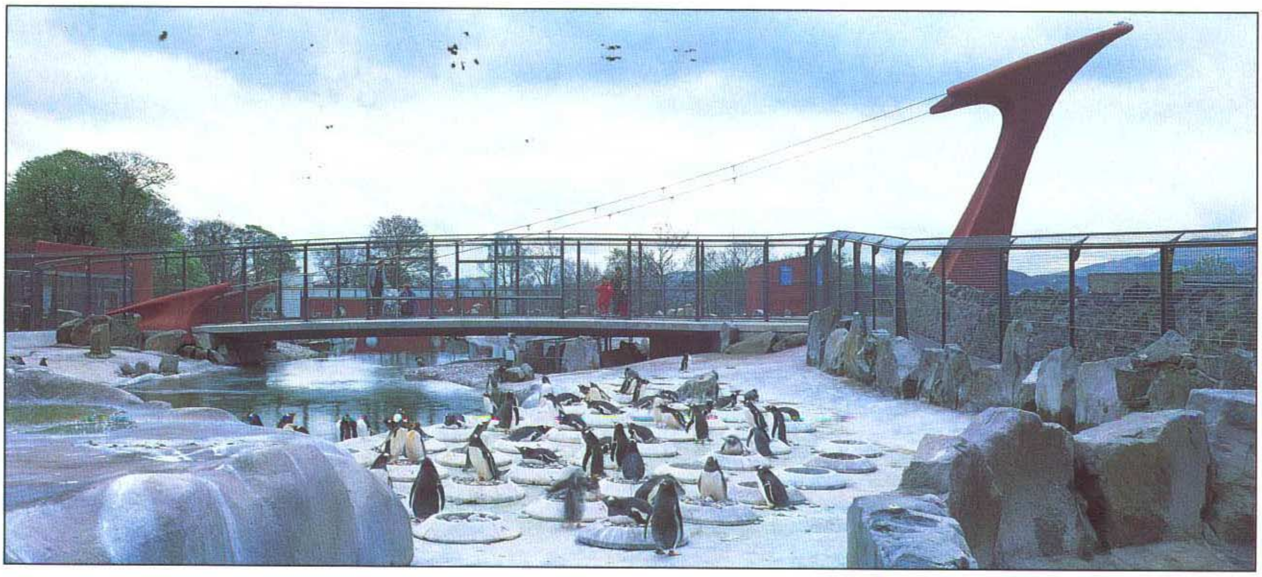
DESIGNERS
- Kim Jervis, Anthony Munden, Andrew Stooke, John Elkins, Charles Louwerse (formerly The Design Group, Sherborne)

ENGINEER
- The Anthony Ward Partnership

QUANTITY SURVEYOR
- Peter Gunning and Partners

MANAGEMENT CONTRACTOR
- Sir Robert McAlpine and Sons Management Contractors Ltd

PRINCIPAL CONCRETE SUBCONTRACTORS
- Gunite Contract Services Ltd (sprayed concrete)
- AHM Ltd [Moody's] (fibreglass moulds)



CONCRETE PIONEER

Eugène Freyssinet

(1879-1962)

FREYSSINET INTERNATIONAL

Sir Alan Harris CBE, FEng

Professor Emeritus Sir Alan Harris started in local government, served in the wartime Royal Engineers (Mulberry Harbour, Rhine Bridges), worked for Freyssinet in Paris, founded Harris & Sutherland, and was later a Professor at Imperial College.

'My fortune, my great good fortune, has been to be seized, since a child, by a vehement vocation. I have loved this art of construction which I conceived, as did my artisan forbears, as a means of reducing to the extreme the human labour needed to achieve a useful object'.

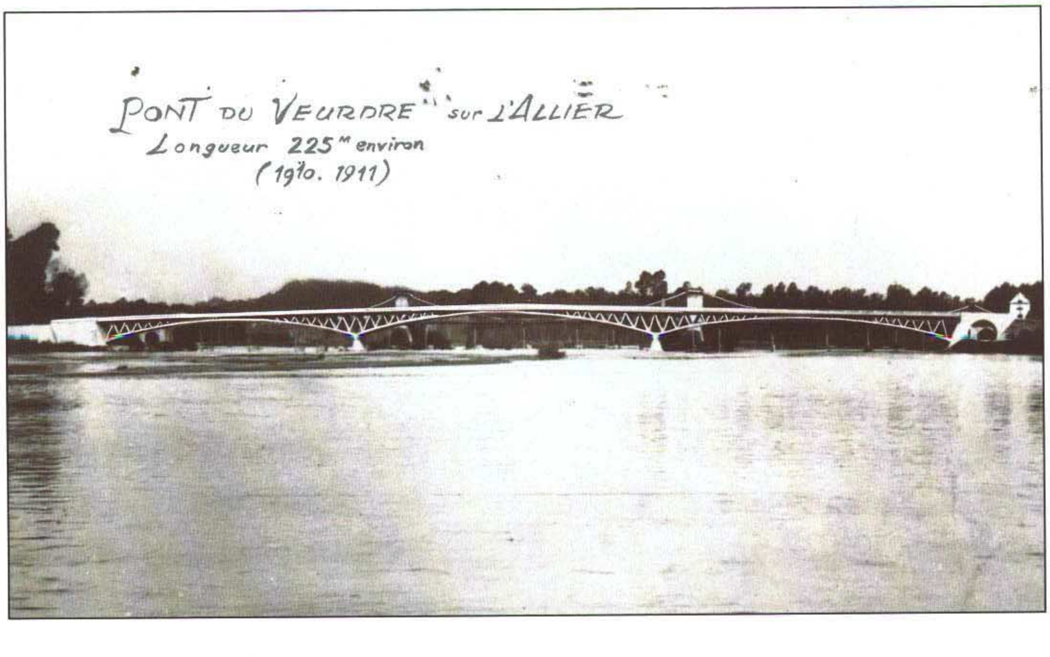
That vehement vocation called Eugène Freyssinet to an epic life. Consider. His father, an orphan from the cradle, was a farm labourer in the Corrèze, but energetic and intelligent. Freyssinet was taken to Paris by his parents when he was six; he went to an elementary school in a rough district of the City, which he hated. He was sickly and, despite the scholarly handicap, was often sent back to his beloved Corrèze. Nevertheless, he succeeded in the intensely competitive examinations to enter the École Polytechnique and then the École des Ponts et Chaussées.

He was now of the élite of the civil engineering profession and, *ipso facto,* of the nation. He was soon to be in active revolt against that élite.

His career henceforward falls into well-defined chapters.

Early years

He was appointed junior engineer to a local office of the Ponts et Chaussées at Moulins, near Vichy, where his job was adviser to a number of rural mayors. He loved it; he knew their needs and had total freedom to satisfy them with structures of his own devising in reinforced concrete, built with their own direct labour. "Anyone", he said "who told them that those bridges were contrary to the regulations would have run a heavy risk". (Here began his revolt). Many of those bridges are still there.



Pont de Veurdre (1910), first of the bridges over the Allier, had three spans of 72.5 m

All this led to three identical bridges over the R. Allier of which one, at Boutiron just below Moulins, remains to impress us. They were bridges of 3 x 72.5 m span each, three-hinged arches, very flat, built by direct labour. He made a test arch, using prestressed concrete as a foundation tie and discovered the existence of creep in concrete. The idea of the former remained with him until, in 1926, he could determine the extent of creep. He received a notable prize and considerable publicity for the second of these bridges. He had emerged from the rank and file of the mere élite – at the age of 30 he was asked from all sides for schemes. He resigned from State service and set up as a designer-contractor with two partners. They were *not* package dealers; they are better understood as designers executing their designs by direct labour.

Came the Great War. He was called up, sent to the Alps frontier for two months and then withdrawn to serve with Army Engineer Works where, a little from love but much from necessity (steel being short), concrete was the noble material.

Master of concrete construction

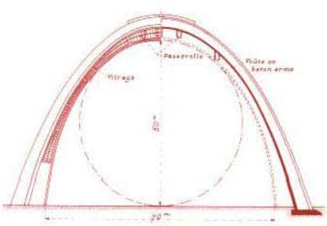
This was the second chapter. Construction of some 7-8 ha of concrete shell-roof industrial buildings, including the steelworks at Caen and an assembly shop at Le Creusot; extensive bridge reconstruction and a number of seagoing cargo ships as well as numerous more specifically military works.

At the end of the war, he was a master of concrete construction. He had been a pioneer in shell roof construction. By putting the stiffening ribs on the top surface, leaving the lower surface smooth, he simplified barrel vault, mitred

Twin unreinforced concrete arches carry the 100 m span of the Villeneuve sur Lot Bridge (1914-20)

vault and conoid north-light roofs. His ingenuity and economy in timber formwork was remarkable; he utilized sliding formwork widely. In his private laboratories of pre-war days he had obtained a profound knowledge of cement and concrete; in his war-time ships he had compacted the concrete in the hulls using vibrators borrowed from foundries where they were used on sand moulds.

The idea of prestressing, to him the obvious combination of concrete and steel, remained dormant awaiting the mastering of



Orly hangar: elevation/section

the difficulties of creep – of which he was acutely aware but could not yet evaluate.

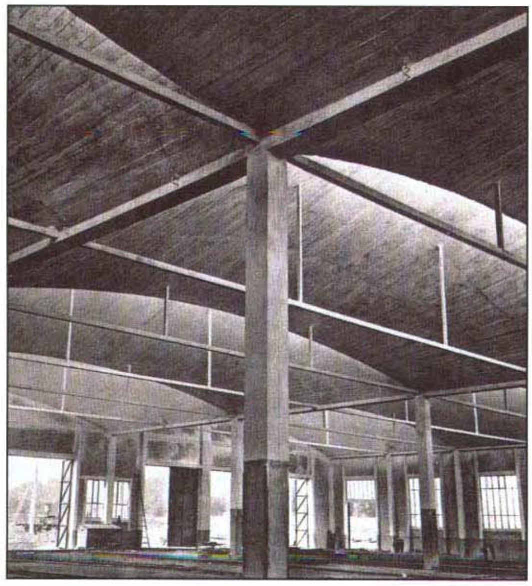
The next chapter, the decade from 1918-1928, marked his earliest period of first national and then international fame. Shell roofs (his final total came to about 1 km square) culminating in the airship hangars at Orly. Bridges, of course, progressively establishing records of span for concrete – not forgetting the 100 m span arch at Villeneuve sur Lot totally without reinforcement. The triumph – and the conclusion – was Plougastel, 3 x 180 m span arches with a double deck, one road, one rail. The triumph; Freyssinet was established in the architects' litany – Maillart, Nervi, Owen Williams, Faber, Arup, Torroja; later would come Candela. The conclusion; for the arches at Plougastel he needed to know the value of creep. The labour of post-war reconstruction had provided no leisure; now came necessity – and time during preparatory works. He got an answer; it revealed that prestressed concrete was possible. (He said later that had creep been twice as large as it was, he would have abandoned prestressing). Possible, it left Freyssinet no choice; his vocation obliged him to pursue it.

The Orly hangars (1921), each 56 m high and spanning 86 m

False start

Alas, his associates saw it otherwise – worse, they saw it as a betrayal; this madcap idea would ruin Freyssinet and them too. He left them; they conceived it their duty as friends to make his departure as difficult as possible. But go he did at the age of 50 and devoted his private fortune to developing prestressed concrete.

After a period of experimentation, a client emerged. There was to be a major expansion of the electric power grid, needing vast numbers of power-line pylons 12.16 m high. Mass-production, of course; five or six factories would be needed around the country. Freyssinet was to set up a pilot plant.



Bagneux – one of four workshops for the Paris Métro involving a total of 60 000 m² of shell roofs

He did; a marvel of mechanized precast concrete production; hollow tubes of 120 mpa concrete of 10 mm wall thickness, made by intense vibration combined with compression; steam heating gave a mould turn-round of one hour. The integrated plant took four years to develop, which bought him to 1933 – and the depression. The market collapsed – it had probably never really existed – and, apart from an order for a few thousand from old friends, his labour was wasted, his plant was useless and sold for scrap and he and his wife were ruined.

12 m pylons – the first prestressed concrete products

Had he not been ruined, he would never have dared to offer to solve the problem of the disastrous settlement of the Gare Maritime at Le Havre, the intended base of the soon to be completed SS *Normandie*. Had he not taken and won this gamble, it would have been long before prestressed concrete was launched. ▶

Breakthrough

The Gare Maritime had been founded on piles bearing on a 10 m deep layer of gravel; the old quay wall and platform were on gravel at 30 m depth; between them was mud. The quay held firm, the Gare Maritime squeezed out the mud and was sinking rapidly; cracks abounded. To offer to remedy this was bold, to offer and to fail was to be sure of financial disaster. Only a desperate man would venture.

Freyssinet (now well known – indeed famous) raised some money and was accepted though proposing techniques he had never used before. First, he prestressed together in three long and massive beams the pile heads of the existing foundations. Then, through holes in these beams, he jacked down concrete tubular piles cast, steam-cured and prestressed in 2 m lengths.

As soon as the first piles reached the deep layer of gravel, subsidence slowed down;

FREYSSINET INTERNATIONAL

Timber centring, floated out on two concrete barges, was used to cast the arches

eventually he used the piling jacks to restore the building to its intended level. (In 1944, bombing demolished the Gare Maritime; its replacement was built on those same three beams and supporting piles).

A sensational success, in the direct gaze of the nation, well aware of the troubles and their possible consequence. Great men

FREYSSINET INTERNATIONAL

Another record-breaker: Plougastel Bridge with three clear spans of 172.5 m

assembled to congratulate; M Campenon of Campenon Bernard, was among them. He engaged Freyssinet and backed him for the rest of his life.

Prestressing was now launched. The combination of Freyssinet's reputation, the success and magnitude of the works at Le Havre and the standing of Campenon Bernard made it a candidate for major civil engineering works, a stage of development which would have taken many years to reach had there been nothing to build on but the power-line pylons, even if commercially successful. No less important, Freyssinet's own confidence in the value of his work had been confirmed.

Prestressing takes off

There followed caissons at Brest; dams in North Africa; pressure pipes and road bridge beams developed with licensees in Germany, Wayss and Freitag. Brilliant engineering – but it awoke no echoes in the fast-developing modern school of architecture. Freyssinet was a friend of Le Corbusier; "not a very good architect; indeed, not very intelligent at all. I had described ideas to him which were directly relevant to what he was trying to do, but he could not see it. He was just a major prophet". After the war, mass-produced flooring joists played their part in reconstruction but not until the early 1950s did prestressing begin to affect architecture.

During the Second World War, of necessity he could do little more than minor R&D. It is of interest however that he sued Hoyer, The German who was mass producing prestressed concrete beams for German fortifications, for infringement of his patents and, with the support of Prof Mörsch, won his case and was paid royalties!

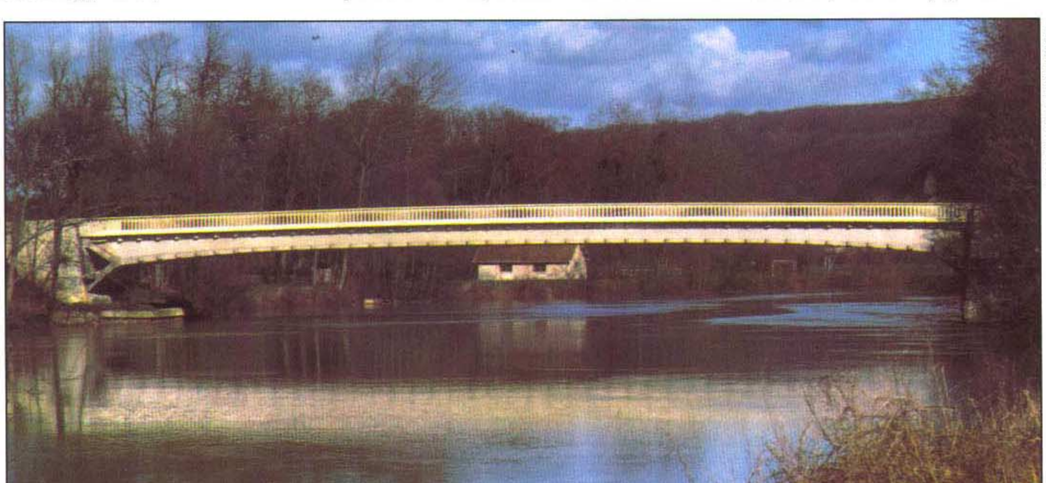
After the war, with a huge need for bridges, harbours and hydro-electric energy, and given the existence of numerous post-tensioning systems, the use of prestressed concrete was soon world-wide. But Freyssinet continued to produce major works bearing his own unmistakable imprint up to within a year of his death in 1962.

He had a large staff of engineers, many of whom have become famous in their own right; in the days just after the war it was a sort of League of Nations. Above all, he had kept one or two general foremen of genius. He cared litttle for all but a few of the engineers – they persisted in telling him that calculations showed that he could not do what he knew he could – and invariably did. But he consulted his foremen and listened to them carefully. 'How to build it' was his first concern.

His own man

What was he like? Small in stature, with a pussy-cat face, he was capable of tigerish roars, but his angers were soon forgotten; all he asked for was complete devotion to the job. His wife was immensely

The world's first true prestressed concrete bridge, over the Marne at Luzançy (1941-5)



FREYSSINET INTERNATIONAL

distinguée and very beautiful; he used to say she beat him (no one believed it); others had it that he required her to sit on a gilt chair alongside the domestic drawing board doing needlework until the small hours when, his problem solved, he would call her over and say "look at that! pretty clever, what?" and then she could go to bed.

He had no taste for social life. There was once a garden party at his house in Neuilly (he was a keen gardener), disastrous, it seems. He turned up, however, at our wedding in Paris with M Campenon and my friends in the firm, and was charm itself. On the other hand, at the celebration of his 60 years in the Ponts et Chaussées, I found myself sitting beside him in the front row of a lecture hall faced by a stage full of the great and good of French civil engineering, waiting to speak in his praise. "Watch that lot", he whispered, "every time prestressing is mentioned, each looks as if he had had a kick up the backside".

How did he see himself? As a peasant, of course, born of a long line of peasants. (I have seen his parent's house, at Objat near Brive in the Corrèze, and have spoken to his nephew and great-nephew; 'peasant' seems an incongruous word).

Of his immediate ancestry, he thought he resembled most a surly, solitary grandfather who sought only to be left alone. More remotely, it was his fancy that he was descended from an English deserter from the armies of the Black Prince. (His grandmother's house was called 'Maison des Anglais').

Erecting the central portion of one of Luzançy's three 55 m span box beams

He had a feeling for the English. "The genius of English Engineering" he told me soon after I joined him "is the direct apprehension of physical reality". (I didn't know we had a genius). It pleased him to oppose a somewhat idealized picture of English (did he mean British?) Engineering to the formality of French Engineering – "These noodles" (I quote) "who see nothing save through a fog of x's and y's". The proliferation of Codes of Practice in this country lately would have enraged him (as it does some of us). He was over here for an honour (was it DSc Leeds or the Structurals' Gold Medal?) and, at a cheery dinner in London, said "I had always heard that the English were moody, melancholy, if not morose; but this evening I feel I am back in the South of France".

I have reduced the cost... of construction

He wrote no books but many papers of philosophical tendency – with many a lapidary phrase. Here are a few.

'Science and intelligence are but tools possessing of themselves no creative force'.

'One thing is certain; qualities of character – courage, probity, love and respect for the task undertaken – are infinitely more necessary for the engineer than those of intelligence which is no more than a tool controlled by a moral being'.

His own austere epitaph – "I have reduced the cost of certain forms of construction".

And I? "Harris" he once said "is an engineer – a real one".

Medals, decorations, honours, let them all come and thank you very much indeed, but know that I was sated long ago. ■

One of Freyssinet's last major projects – the 12 500 m² Basilica of St Pius X at Lourdes (1958)

MARCEL DURAND

PARKING SCIENCE

Mike Crane

BSc, CEng, MICE

Mike Crane is a Partner of Whitby and Bird. He returned to consultancy after ten years with a national contractor, during which he was named Building Manager of the Year. He has wide experience of most building types and a special interest in contract procurement.

Photographs – Trevor Jones

A new Science Park is being developed on the southern outskirts of Oxford. By spring 1991, unit lettings in the new Magdalen Centre building were well advanced, the Sharp Laboratories building had been completed, design of the Sheraton Building was at an advanced stage and confidence in the further expansion of the Park was fired.

To meet the parking needs, and eliminate the threat of a sea of parked cars which could restrict the site's development potential, the master plan had proposed provision of a series of discreet decked car parks.

In April it became clear that the first of these, providing 175 spaces and capable of future extension, would need to be in service by the autumn.

Concept

The project managers, Hawk Development Management, set out detailed criteria for the structure. These included requirements for column-free areas well lit by natural light, flexibility for extension, and that materials should be durable, locally sourced and requiring minimum maintenance. Landscaping was also of primary importance, with planting required within and around the structure to integrate it into existing planting. These factors, combined with Hawk's strict financial, programme and quality requirements, created a demanding challenge for the design team.

Design and construct tenders for the three-level structure were invited from frame contractors for the basic structural alternatives. Analysis revealed that an in-situ concrete frame would require columns within the parking zones, and that both in-situ and steel would need cladding to achieve acceptable elevations. A totally precast solution, however, offered the potential for a single, self-finished solution within the initial budget of £4000 per parking space. The exposed concrete structure would clearly express the architectural form of the building and, at the same time, offer a straightforward consistent aesthetic. Of equal importance, it would be quick to build.

IN-SITU CONCRETE with post-tensioned ribbed decks
£505 500

STEEL with precast/in-situ composite decks
£452 700

PRECAST CONCRETE with double-T decks
£407 800

Frame options examined

As structural engineers for the Magdalen Centre we had initially been commissioned to carry out foundation design for the car park and subsequently we were appointed lead consultant.

Our early sketches echoed the brief and, by using special forms, led to an interesting cavernous form. Sadly, this idea floundered on cost and it became clear that we would have to progress the scheme making maximum use of standard units.

Detailed design

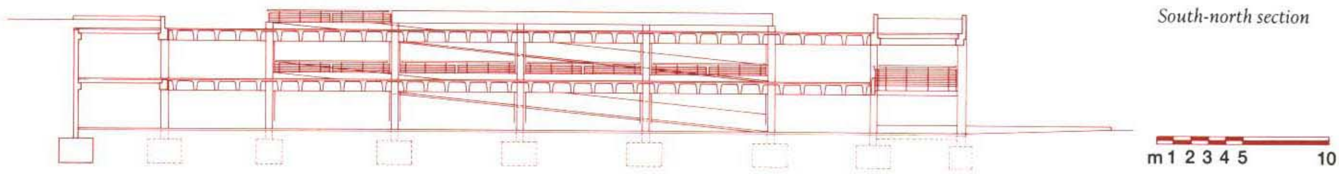
The master plan had indicated horizontal brick panels to the car park elevations. The adoption of a precast solution represented a significant change in approach and led to some delicate negotiations with the local planning officers.

Texture, colour, modelling and weathering of the elevations were carefully balanced with cost and construction considerations. To explore a range of finishes, ranging through as-struck, and acid-etched to heavily-worked, several samples were made using a number of aggregate types and coloured cements. The planning authority responded positively, and detailed design proceeded on the basis of bold concrete elevations contrasting with fine metalwork within the structural framework. While the concrete undoubtedly dominates, progressive interest is added by layers of metalwork which advance from a simple lining frame on the rear elevation to perforated screens and vertical stainless steel wires for the planting on the front elevation.

Into construction

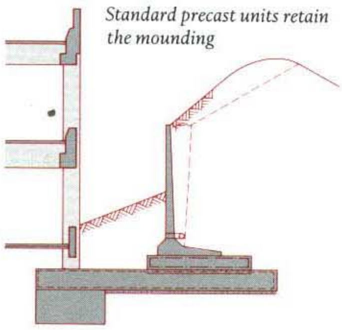
From the outset Crendon Structures Ltd, the appointed frame contractor, was creatively engaged with the design team for both concrete design and constructional solutions. The need for special formwork was limited to the deep roof-deck perimeter beams; the columns, internal beams and double-T floor units were all formed in standard moulds. This yielded significant cost savings which provided the opportunity to enhance the surface finishes in key areas.

Natural lighting to the centre of the car park was considered particularly important to achieve 'user-friendliness'. This was



South-north section

achieved by forming a void, which may appear on first inspection to be generous in relation to the 175 parking spaces. The void accommodates the access and exit ramps, which run parallel for simplicity and to minimize the number of structural components, and a narrow lightwell on either side of the ramps which allows daylight into the centre of the decked areas. The apparent disproportionate loss of net area is explained by the fact that the deck area served by the ramps is designed to be extended at a later date.



Standard precast units retain the mounding

Interface with landscaping

The car park is bounded to the south by deep landscaped mounding which gradually reduces along the western side to reveal a clear view of the entrance on the north side which faces the Magdalen Centre.

Careful thought was given to the siting of the structure within the landscaping, and particularly to the interface between concrete finishes and type of planting. Simple, as-struck precast retaining wall units were used to achieve stepped levels, while delicate climbing plants are set against the finely finished elevations. A large precast concrete planting box at roof level allows foliage to cascade over the parapet wall framing the front elevation.

Innovative roof-deck treatment

Weatherproofing and subsequent maintenance considerations of the roof-deck and ramp led to the incorporation of Caltite admixture into the 75 mm structural concrete topping, in preference to a post-applied system. This is the first use of Caltite for this purpose in the United Kingdom. Fibre mesh was also incorporated into the topping to control shrinkage cracking.

Developed by Cementaid, the Caltite system permits a lower water-cement ratio thus reducing the volume of capillaries in the hydrated concrete. The addition of the admixture to the concrete during mixing causes a chemical reaction which results in the formation of a waxy material – calcium stearate. As escaping free water evaporates during the initial setting process, the calcium stearate is pushed to the sides of the capillaries. As a result the capillary walls have a highly water-repellent lining which resists the ingress of water and reverses the 'sucking' action of the concrete.

A second process blocks the entry of water under a pressure greater than can be repelled by the calcium stearate. This is achieved by a suspension of microscopic particles of a highly refined asphaltic material. When water under pressure forces its way past the stearate it pushes ahead the 'asphalt' globules which eventually block the capillary and prevent further water ingress.

Concrete incorporating Caltite is, therefore permanently impermeable, maintenance-free and highly durable. No special measures are required during construction – indeed it is easier to place, compact and finish than normal concrete.

Savings on structure were used to enhance surface finishes

Lightwells to the centre of the decked areas increase user-friendliness

On time, on budget

Oxford Science Park's first car deck has proved highly successful. The design emerged from initial appraisal of a range of structural options and was progressively developed and refined to a crisp, finely detailed building.

It was completed in four and a half months, on budget, and fully met the client's criteria. Moreover the compact plan shape finally adopted has eliminated dead ends and large areas devoid of natural light and ensured that users will feel comfortable and safe. ■

CLIENT
■ Magdalen College *and* Prudential Insurance Joint Venture

PROJECT MANAGER
■ Hawk Development Management plc

STRUCTURAL ENGINEER
■ Whitby and Bird

ARCHITECTURAL CONSULTANT
■ Allies & Morrison

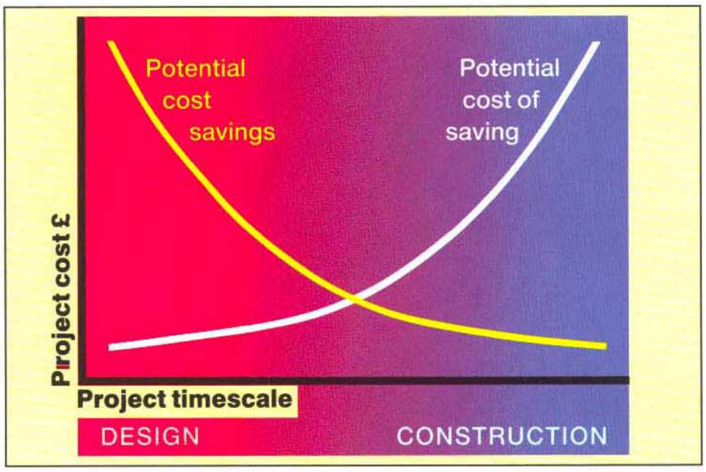
QUANTITY SURVEYOR
■ Beaufort Ellis Associates

MAIN CONTRACTOR
■ SDC Builders Ltd

CONCRETE FRAME SUBCONTRACTOR
■ Crendon Structures Ltd

PERSONAL VIEW: MICHAEL WALKER, CONSTRUCTOR

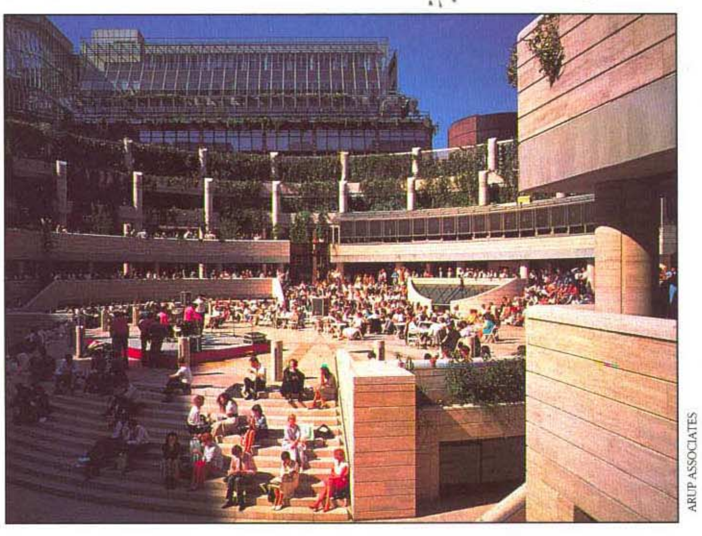
Michael Walker MCIOB, MASI, ACIArb joined Bovis Construction in 1964 as a senior quantity surveyor and was appointed to the Board in 1974. The following year he established the company's Tehran office and subsequently worked on a range of overseas projects. In 1986 he was appointed Managing Director of the Commercial and Engineering Services Division which embraces cost planning, and technical, engineering, procurement, legal and computer services. While retaining this responsibility in Bovis Construction, in 1991 he was also appointed Managing Director of Bovis Engineering Ltd.



Value Engineering opportunities are greatest at the design stage

In the heady days of high workload and the high speed 1980s (you remember!), Bovis took factory philosophy to heart. Prefabrication was possible, and the building as a kit of parts was becoming a reality.

Toilet pods, plant rooms, lift shafts, stairs and cladding panels were all assembled on a production line and delivered to site ready for immediate installation. The industry branded this approach 'fast-track' and, to sustain its momentum, Value Engineering came into its own.



Fast-track at Broadgate achieved exceptional speed without sacrificing quality

ARUP ASSOCIATES

Value Engineering – sometimes known as Value Management or Value Analysis – is defined by Bovis as 'a management tool which utilizes logical and creative techniques to obtain the best functional balance between cost, reliability and performance of a product or project'.

When and how

Value Engineering (VE) should be applied on all phases of a project but, as the graph shows, the most dramatic results are obtained at the conceptual design stage. The new Earls Court 2 exhibition hall is a fine example of just what can be achieved. The conceptual cost plan came out at £60 million, which made the scheme totally unviable. By applying VE, in close co-operation with the design team and client, we were able to bring the cost to £45 million (a viable figure) without losing a single square foot of exhibition space.

Alternatively, appointing a full-time Value Engineering Manager throughout the entire project period can help to achieve first-class results, albeit in a less dramatic fashion. The VE Manager acts as an integral part of the design team, identifying opportunities for detailed desk studies. At the Ludgate Development for Rosehaugh Stanhope Developments the technique of continuous VE is being applied to maximize the investment return for the developer while matching the standards of quality and specification set at projects such as Broadgate. Building costs are being reduced by 30% without jeopardizing quality.

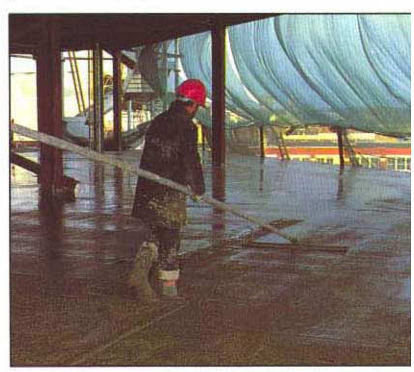
Conceptual VE studies, lasting from four to six weeks, are carried out by a multi-discipline task force led by the VE Manager. In North America and Australia VE is often carried out by holding workshop sessions at pre-specified intervals during the construction period.

All these methods have their place, and need not be mutually exclusive.

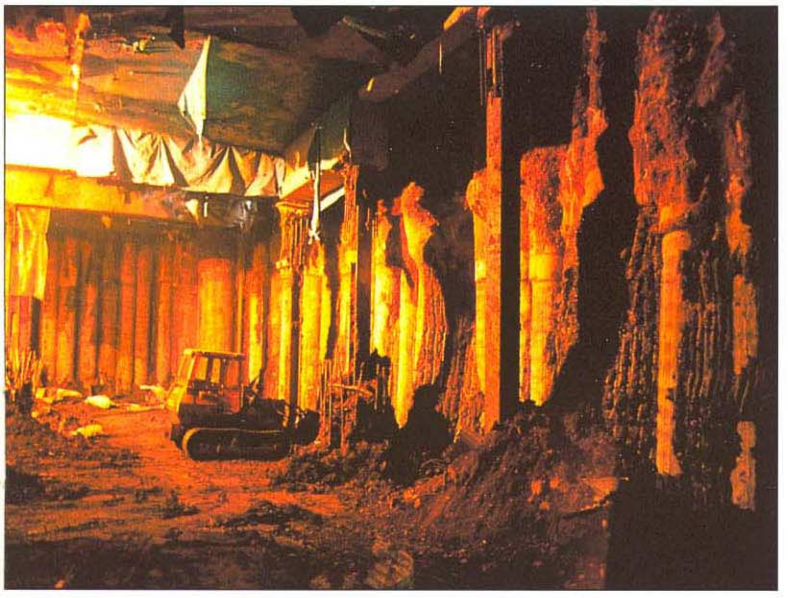
Value engineering and concrete

While concrete was not generally regarded as a high tech material in the 1980s, significant efforts are now being devoted to improving all aspects of its performance.

In the market place, concrete must today be seen to be as high tech in application as it is in design. But, although some very good trade contractors are already well established as masters of craft and sequence, the 'labourer' label has yet to be finally banished.



Brought as hand luggage from New York, the skip-float was put to good use at Chelsea Harbour



Top-down basement construction at 20 Old Bailey

Continued industry collaboration will be required, and initiatives like the Structural Precast Concrete User Group and Bovis' own 'Effectiveness Initiative' – which is seeking major reductions in construction costs and improved customer satisfaction – are catalysts for continued progress.

Where short leads are not a decision-driving factor, precast concrete may well satisfy the manager's brief, with the added potential of a 'one-stop shop' solution. Supply of frame, floors and cladding by a single precaster can offer a significant advantage in the reduction of trade contractor interfaces. On congested, inner-city sites, where logistics are a key concern, precast concrete may well be the obvious management choice.

We recently carried out a conceptual study on a project which included extensive rebuilding behind existing retained façades. Complex temporary works shoring would be required and a steel frame was proposed for the new build behind. Value Engineering identified precast concrete as a very viable alternative, with sections small enough to negotiate the restricted access and to be threaded into the existing building before demolition began. Temporary shoring would not be required and the noise of steel erection in the vicinity of a residential area would be avoided.

A conceptual VE study can result in a clear case for concrete. In 1986, when concrete was chosen for Chelsea Harbour, lead time and the need for speed were central to the decision making, so while the designers designed for speed, we sent a team, including the trade contractors, to New York to study concrete placing and handling methods that were to provide invaluable in London. As a result, prefabricated reinforcement and flying table forms minimized the on-site work and the speeds achieved on this scheme to set a new UK standard for fast-build frames.

The structural frame

The structural engineer will find many opportunities to apply VE.

On part of the Broadgate project we adopted a strategy of one pile per column instead of the traditional multi-pile grouping. This completely removed the need to construct pile caps, a very labour intensive and time consuming activity.

Omitting the ground slab as an early programme activity may eliminate delays in starting frame construction and also reduces pressure on the design and installation of all buried services.

Top-down construction – overlapping the superstructure construction with the basement works – actually creates two projects and two potential critical paths, so that basement plant installation often becomes the key link feature.

We adopted this technique to the full at the Old Bailey commercial development site, where a deep basement – a typical feature where site potential is to be maximized – had been planned. Construction of piles and a slab on the ground as a propped waling beam obviated the need for temporary works and formwork. The planned sequence was to go down to second basement level and construct an intermediate floor after excavation. We deduced that, with minimum additional expenditure, we could 'top-down' again and create a third basement. Furthermore, by taking advantage of a slope across the site, the top-level basement could be converted to prime lettable space without infringement of plot ratio rules. The minimal additional expenditure had saved the cost of temporary works and project programme time. An additional 11% of space had been provided and yield to the developer increased. ▶

Photographs = Bovis Construction
except where shown

Advance construction of a section of ground floor provided a crane base

A further adaptation of 'top-down' was to construct a portion of the ground floor as a crane base. Thus the materials handling equipment for the superstructure was immediately available, without waiting for the basement works to

Reconstructed stone and brick-faced cladding add quality and detail at 10 Cabot Square, Canary Wharf

be completed, and building services plant could be installed without hindrance in a dry space.

Building services

For the services engineer, a concrete frame comes with built-in fire protection and enhanced sound attenuation properties. We used to take the time during setting out to include cast-in, universal fixing channels. The idea was to save fixing time later for the following trades, and it often proved cost-effective to over-specify the quantity of channel to ensure total flexibility of fixing locations.

More recently, with use of soft zones, improved hand-held drills and fixing tools, fixing has reverted to the services contractors so today we seek to persuade design teams that nothing should be cast in.

Surface fixing to flat slab is usually a preferred option. While flat slabs require increased reinforcement at edges, and therefore may take longer on the drawing board, they do offer good time saving on site, where the setting out and formation of up- and downstands is completely eliminated.

From the viewpoint of the services engineer, flat slabs provide a clear run at fixing and simplified services co-ordination, but a suspended ceiling is invariably necessary.

In contrast, a recent project for Lloyds Bank in Bristol incorporated deep structural ribs of exposed in-situ concrete, and the standard of concrete finish was of paramount importance. The exposed coffered ceilings are here host only to specially developed wiring, control and lighting gear which is suspended from a return air duct through the head of the coffer. No suspended ceiling was required, as the raised floor above the ribs is itself the air-handling plenum.

Architectural merit

The architect's use of concrete is generally most apparent when the material is chosen for the cladding of a building. The range of textures, colours, profiles and finishing materials is almost limitless.

Gone are the brutalist concrete cladding aesthetics of the 1960s and 1970s. The cladding for Broadgate Phases 9 and 10, for example, was conceived as terracotta. When it became apparent that programme and quality demands could be better met by precast concrete panels, the concrete was specified to be of a similar colour and, with economic mould use, surface modelling was developed to the architect's satisfaction as a cost-effective solution.

A broad overview allowing a fresh approach to an individual

Conceived as terracotta, achieved in coloured concrete

element is intrinsic to VE. So, in respect of cladding, the process may begin well in advance of the cladding package. Minimizing wall-to-floor ratios, plate thickness and floor-to-floor heights, can significantly affect the out-turn cost of the cladding package itself.

Height restrictions, imposed by planning authorities to preserve views of St Paul's Cathedral, forced the omission of one entire floor level from a concept building designed to maximize lettable space. Redesign to retain viability produced a complex and costly steel composite frame, but with the lost level reinstated. VE studies to find a more cost-effective way of maintaining the level resulted in an in-situ concrete frame, with 200 mm thick flat slabs, matching steel in build time and saving £2/ft^2 on the steel solution. Studies for the now equally-reduced cladding package identified precast concrete

Flat slabs simplify services layouts and fixing

Early construction of the concrete road bridge saved nine months on the Castle Mall development, Norwich

panels as the most cost-effective way to achieve the cladding required by the architects.

Large, storey-height and column-to-column width prefabricated panels, incorporating fenestration, will always represent good opportunities for fast build and programme security. To keep the package cost effective, however, assiduous attention to the precaster's technology is essential. Here, as ever, early trade contractor input should always be encouraged. Typical VE targets will be to minimize panel weight and wall thickness (to increase lettable area) and to rationalize the elevations wherever possible to ensure economic use of the precaster's moulds.

It is also worthwhile to carry out a simple check that low profile locations are not given high-cost detail (so a basic panel may be used on a secondary elevation) and to review how concrete's versatility may offer a more cost-effective alternative to achieving a desired appearance.

The fish-scale patterns high on the building at Ludgate Hill nicely demonstrate the level of achievable intricacy in the use of reconstituted stone, and the patterned panels themselves represent clever re-use of the precaster's mould from lower down the elevation, where the window openings are considerably larger.

An in-situ frame with flat slabs matched steel for speed and saved £2/ft² (100 Ludgate Hill)

Value engineering proposals

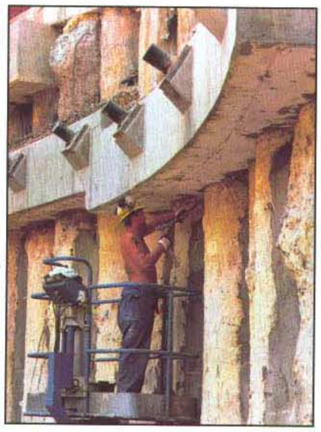
All disciplines come with forms to fill in and VE is no exception! All good ideas are logged on a Value Engineering Proposal Form which is circulated, discussed, elaborated and finally actioned or discarded. Proposals worthy of study will be assessed against a value checklist under headings such as Value to Environment, Value to Occupier, and Value to Developer, so that each proposal must not only be considered by each discipline but also remain on value target.

To succeed fully, VE must be a team effort involving the constructor, the design team and, not least, the client. However, it does need a focus and, at Bovis, our role as managers means that we are ideally placed to instigate and lead project VE studies.

The key to the success of any study is the relationship established with the design team to ensure their early VE input at all design stages. This relationship is essential for progress and must, of course, be backed up by consistent tracking to ensure that good ideas at design stage are carried through to tender and implementation on site.

Good ideas usually wear well – and Value Engineering is even more relevant to the leaner 1990s than ever before. In a climate of 'no frills' buildings I am certain that Value Engineering will have a crucial role to play well into the 21st century.

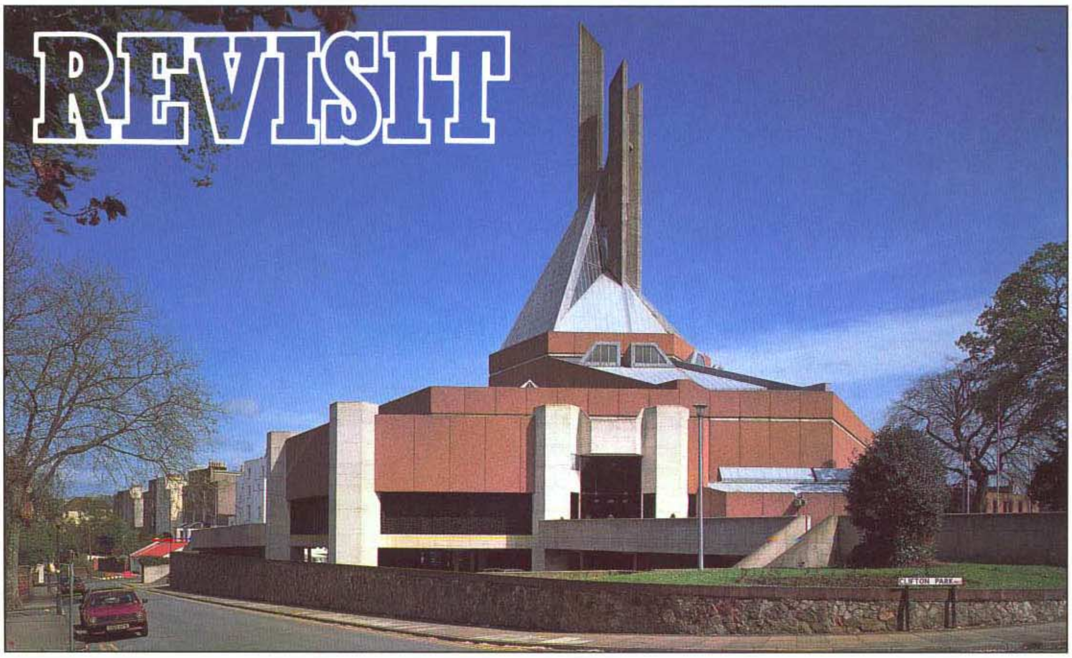
Michael Walker



At Norwich 375 000 m³ of earth were excavated within a perimeter wall of 800 piles

CLIFTON CATHEDRAL

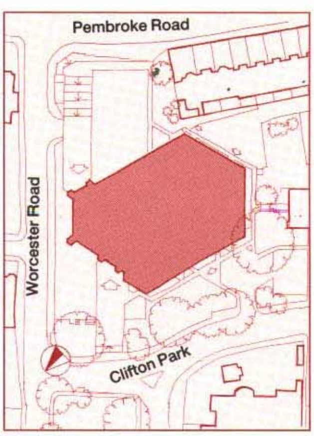
Frank Hawes DipArch, RIBA



Frank Hawes is a specialist in the architectural use of concrete and design to control long-term appearance, and is a regular contributor to CQ.

CONCRETE·AD·MAJOREM·DEI·GLORIAM

I would not have expected ever to be writing a piece headed with my old school motto, but they were the words that came to my mind several times as I wandered in and around the Roman Catholic Cathedral Church of SS Peter and Paul in Clifton. It was not so much the architecture which caused this – though there is a great deal to be admired in the design – but the care that clearly went into those two currently unfashionable materials, board-marked and exposed-aggregate concrete.



When I think how, in the first years of the 1970s, I was weakly accepting the impossibility of getting reasonable work out of overloaded contractors in an overheated construction boom I find it difficult to believe what was being achieved on this building which was consecrated in 1973. The medieval ideal that each task should be carried out *ad majorem Dei gloriam* – to the greater glory of God – seems to have been more in evidence on this building site than it ever was among us scruffy schoolboys in north London.

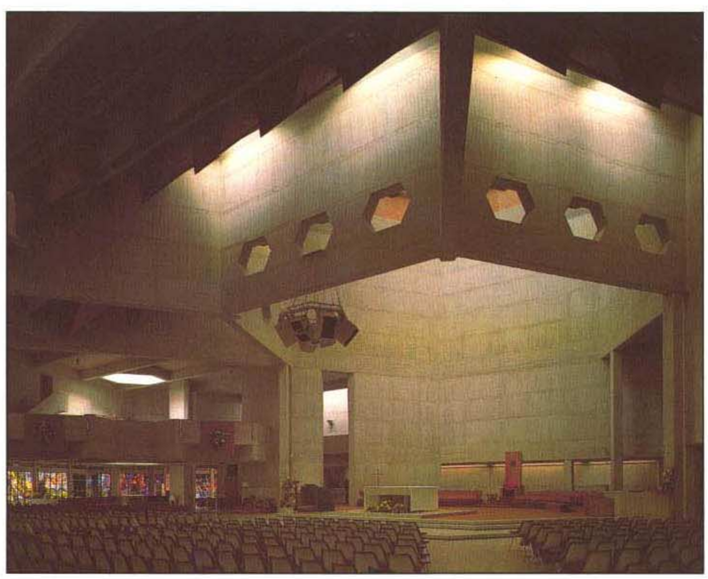
Not that everything is perfect – I would not want to oversell the building and disappoint anyone who has not yet visited it. On the other hand, because it is the nature and the task of these articles to discuss a building's successes as well as any shortcomings, I do want to make it clear at the start that I consider it to be one of the country's best pieces of architecture – and I am not going to qualify that statement with additional adjectives or even with dates!

The start

In the 1960s the decision was taken to replace the incomplete 160-year old Clifton Cathedral with a new building on a new site.

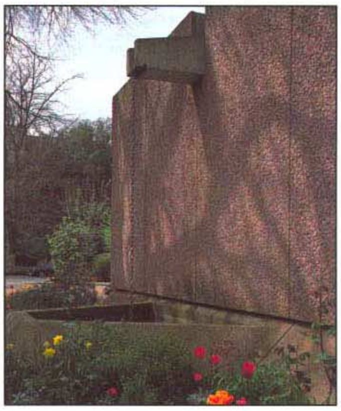
The late Bishop Joseph Rudderham got together a committee of churchmen and laymen who, after considerable research and interviewing several architects, decided to appoint the Bristol office of Sir Percy Thomas and Partners headed by Fred Jennett, who involved his then assistant Ronald Weeks. The brief was built up over a series of meetings which, significantly, were protracted by the Bishop having to

The spaces culminate in a soaring volume over the sanctuary



keep flying off to Rome for sessions of the Second Vatican Council which was in full swing at that time making fundamental changes to Catholic attitudes and liturgy. At these meetings all aspects of the brief were considered in that light – what then is a cathedral? what is an altar? and so on, at the end of which a diagram was drawn and agreed which summarized all the major points. According to Ron Weeks, all they then had to do was to build the diagram.

And, with the support and encouragement of an enlightened client body led by the Bishop and his Vicar General, Monsignor Hughes, this is what they did.



Water is drained from the ambulatory roof in a bold and interesting way

The solution

The analysis had produced a succession of spaces – external atrium, internal narthex, ambulatory, nave and finally the sanctuary; passing on the way the baptistery and Blessed Sacrament Chapel which are both part of, and separate from, the principal spaces. The succession winds inwards and the spaces increase in height, culminating in the soaring volume over the sanctuary which funnels light down over the high altar.

This plan was organized onto a grid of equilaterial triangles and hexagons based on a 457 mm (1′6″) module derived from seat spacing and other important dimensions. The grid was not just a whim but grew from the wish to wrap the congregation of 900 around the altar. One of the advantages of a 60° grid is that it gives you two modules – the height of the triangle (here 457 mm) and the sides of the triangles and hexagons (here 527 mm) and, provided that there are not too many small spaces involved, acute angled corners can be avoided. I doubt if there is an architect in the country who has not done a scheme or two based on such seductive geometry. Few of us ever get to build one – for most of us it is a fascination of our student days.

The structure

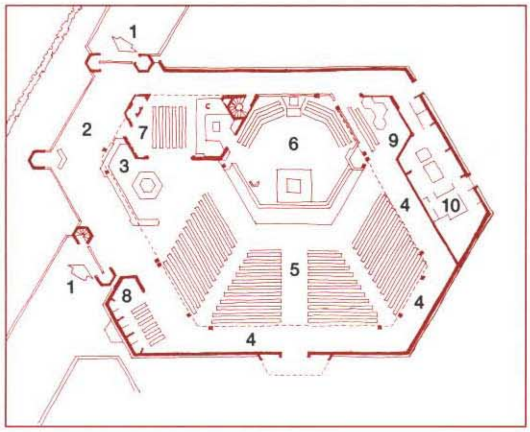
Although the ambulatory, the nave and the sanctuary are separate spaces they flow into each other and are defined more by their differences in height than by physical separation at user level. The concrete walls that wrap around the nave start at ambulatory ceiling level and are supported on a minimum number of unobtrusive columns. Even the great rear wall of the sanctuary, which soars up behind the Bishop's throne, has little visible means of support and yet I don't find it one of those clever 'look no hands' type of buildings. There is an intriguing ad hoc feel about the structure so that it comes as quite a surprise when examination of the plans and sections shows it to be really quite logical.

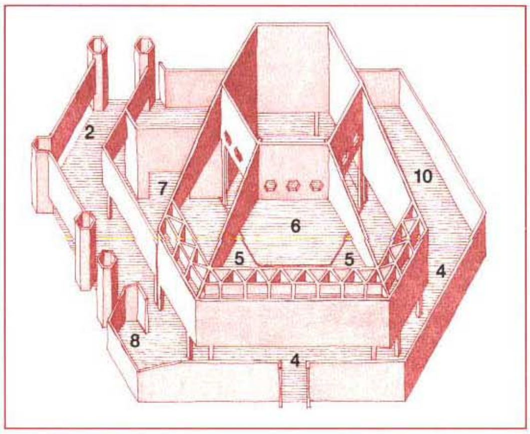
According to Frank Newby of Felix Samuely and Partners, the structural engineers, the 60° grid, the star beam which removes the points of support of the sanctuary roof from the line of vision and the decision to build in concrete all came together. I expect there was an element of fashion in the decision but, rather like the National Theatre, once the spaces had been conceived and walls and columns disposed there was no other real choice. The choice brought with it both benefits and difficulties. Concrete would provide the mass that the heating engineers required to make the electrical heating system economical but, if it was to be expressed internally, great skill and attention to detail would be demanded. We will discuss later how this choice was triumphantly vindicated. First, though, we should consider how this concrete housing for the new liturgy works on the outside.

The exterior

It was the planners, rather than the Vatican Council, who ordained that this simple arrangement should be surrounded by cars. Thankfully, the decision was taken to utilize and exaggerate the falls on the site so that the vehicles could be depressed below eye level, with the two atria forming bridges leaping over a sea of twentieth century icons.

Anyone who, as a result of this article, decides to visit the cathedral and arrives by car will think I have gone mad. The concrete down at this level is typical car park standard, complete with graffiti and stalactites. In fact the curtain of the latter under the steps at the front of the eastern atrium, stained in subtle shades of bitumen and/or rust is an art form in itself. There is probably a movement joint at the



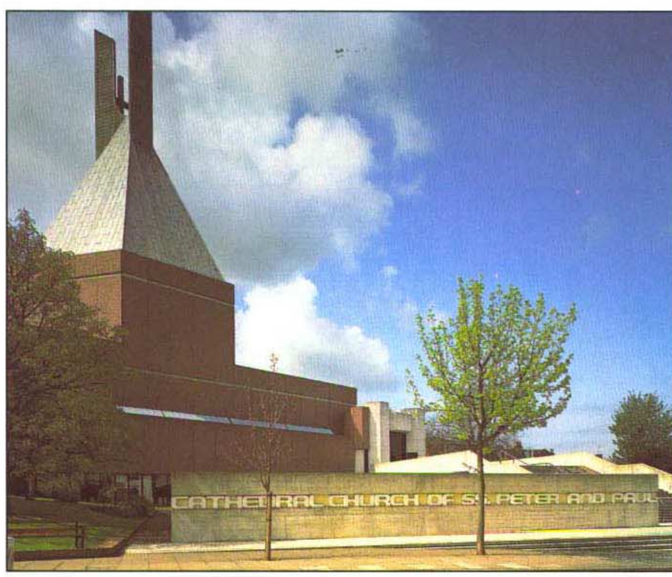


1 Atrium
2 Narthex
3 Baptistery
4 Ambulatory
5 Nave
6 Sanctuary
7 Blessed Sacrament Chapel
8 Lady Chapel
9 Choir and organ
10 Sacristy

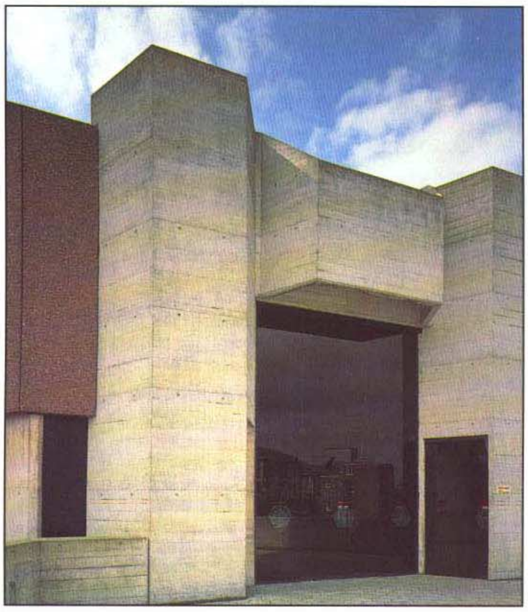
Axonometric of the in-situ concrete structure (campanile and porches omitted for clarity)

bearing of the steps to the bridge which has caused this concentrated leakage, but it looks as though most of the free lime from the bedding of the concrete tiles on the atrium above has ended up on this bulkhead wall. I suspect that architects and builders need to learn from good bridge engineers how to make these details. It might be acceptable if the only ▶

White board-marked concrete was extensively used



result were the limescale waterfall at car park level, but the staining unfortunately gets out onto the white board-marked concrete of the bridge parapet which at this point is at eye level to pedestrians on Worcester Road.



Parts were beyond the handyman's reach

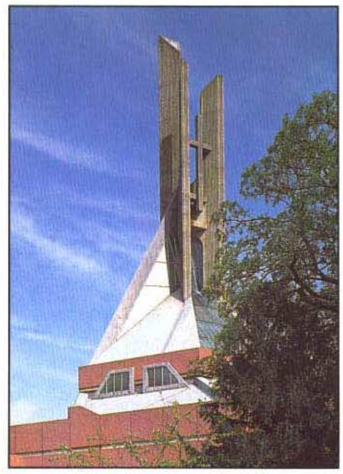
The bridge parapets, boundary walls, entrance portals and canopies were all built in the same white board-marked concrete as the interior. It was just the sort of decision, based more on architectural integrity than practicality, that most architects, including myself, would have made at that time. Two types of concrete on the building – white board-marked in-situ and red exposed-aggregate precast would have seemed enough. But perhaps the finish that has been so successful inside was not the best for walls which would not only be subjected to rain and pollution but would also be leant on, rubbed against and viewed at close quarters by those using the building. A bold white precast parapet or capping detail, which could have been made to the same standard as the cladding panels, might have been better.

Not that these walls and parapets are a great problem but they were cleaned three or four years ago and some areas are beginning to look in need of attention again. This has not necessitated calling on the specialist cleaning cavalry to come galloping to the rescue as required by some buildings in distress. In this case the cathedral's handyman hired a high-pressure hose and washed the concrete down himself. If you look at the walls around the portals you can see how far he could reach.

Photographs (taken in April 1992) – Alison Needler

You can also see that the uncleaned white concrete is a disappointing grey colour. This may be general city grime, but I incline to the opinion that it is an unusually even colonization of algae. If it were the result of exhaust fumes, or dirt stirred up by traffic, it would show more vertical variation and any form of dirt usually shows clear signs of being affected by water movements on the surfaces. We are perhaps more used to seeing patchy algae emphasizing the variations in surface density of poor quality concrete or changing the appearance of each stone in relation to its neighbours in a stone wall. Here, the evenness of the discoloration could be regarded as a compliment to both the quality of the concrete and the care of the detailing which does not seem to be producing any noticeable uncontrolled streaks.

The whiteness of concrete and stone can, as at Clifton, be restored by washing where it can be reached and one of those proprietary cleaners which claim to retain biocidal properties for a period might usefully be tried. But I fear that the three concrete pinnacles, which form the campanile and support the cross from the old Pro-cathedral, will be unlikely to get such attention and so may become progressively darker. Provided it happened slowly and, more importantly, evenly would it matter if they did?

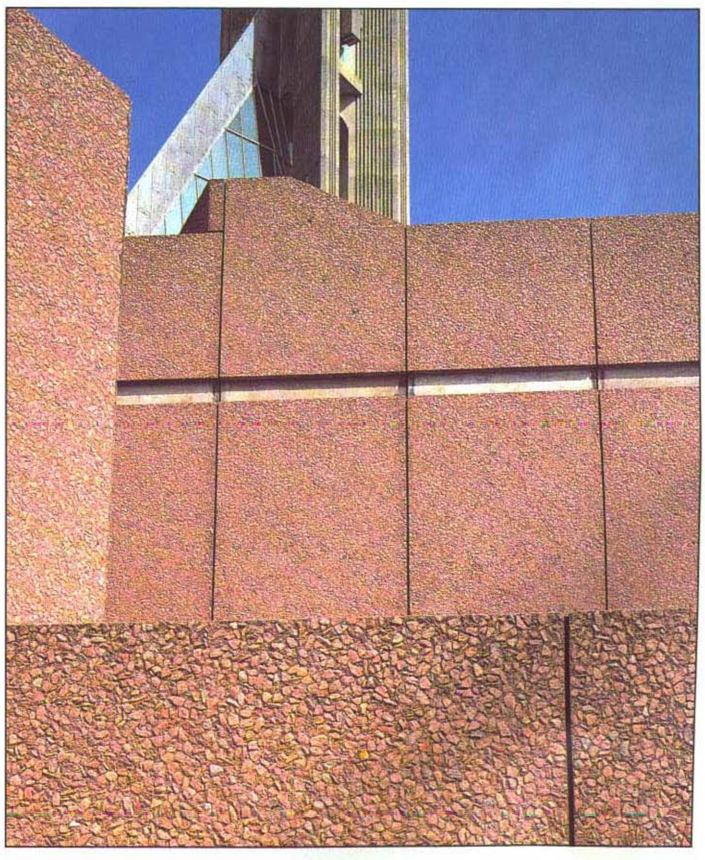


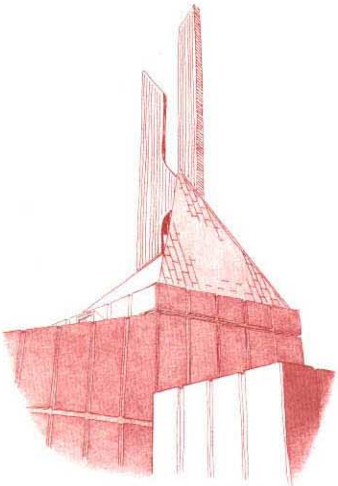
The pinnacles may become progressively darker

Cladding

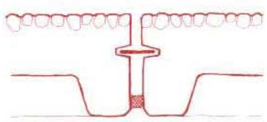
The thermal capacity of the concrete walls was utilized by enclosing them in a jacket of polystyrene insulation protected by Corrennie granite precast concrete panels. These have remained virtually unchanged in appearance facing all points of the compass for twenty-odd years. They were cast at the central Bristol works of the Marble Mosaic Company whose roots in an Italian family terrazzo firm no doubt provided both the incentive to get the contract and the will and skill to carry it through so well.

After 20 years the precast cladding is virtually unchanged



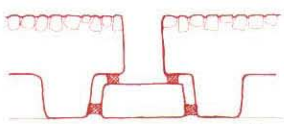


Sketch showing the effect of bolder joints



Narrow, open-drained joint as built

Rebates to form a wider joint would be hard to form well with face-up casting



A possible method compatible with face-up

I would not recommend face-up casting of panels like these without such commitment. The process is labour intensive and it is imperative that a proper bond is achieved between the backing concrete and the facing mix into which the 40-30 mm granite is rolled. At its best, as here, a face which is almost 100% granite is achieved but don't expect the same from a less specialized precaster.

I must confess that I have always found this particular part of the cathedral a little bland. The panels are in fact 250 mm thick overall but the neat open-drained joints make them look to me rather thin and gutless. To have raised the scale of the joints, which is what I feel is needed architecturally, would I know have complicated the finishing procedures and increased the cost and would have been very difficult to justify.

Interior

The architects and engineers knew that the quality and atmosphere of the interior could be ruined if the in-situ concrete were poor. We all now, I hope, demand realistic sample panels to set and maintain standards but this is the only contract I have known where the tenderers were asked to produce their sample panels at the time of tender. John Laing, having built Coventry, seemed to relish the thought of building another cathedral and the attention to detail that a concrete cathedral would require.

For instance, all those involved in the formwork and concreting were shown the model of the building and welded into a team who placed concrete each afternoon and struck the formwork each morning and themselves decided whether the panel was up to standard. No making-good was permitted until all the concrete was complete and the overall effect could be assessed. The architects and engineers were never put in the all-too-common position of being asked to choose between progress and quality. It was agreed that the concrete would be built in modest pours which would allow time for inspection and attention to detail and this spirit seemed to permeate all levels of the firm up to the Laing family themselves.

The sawn boards of Russian redwood, for example, were all from one shipment bought *en bloc* at the Bristol dockside. When, in the latter days of the work, more was found to be required, Ron Weeks tells me that the contractor traced the shipment back to its original port of origin, discovered that half had been offloaded at Hull before the ship came to Bristol and searched out and obtained the matching material from there.

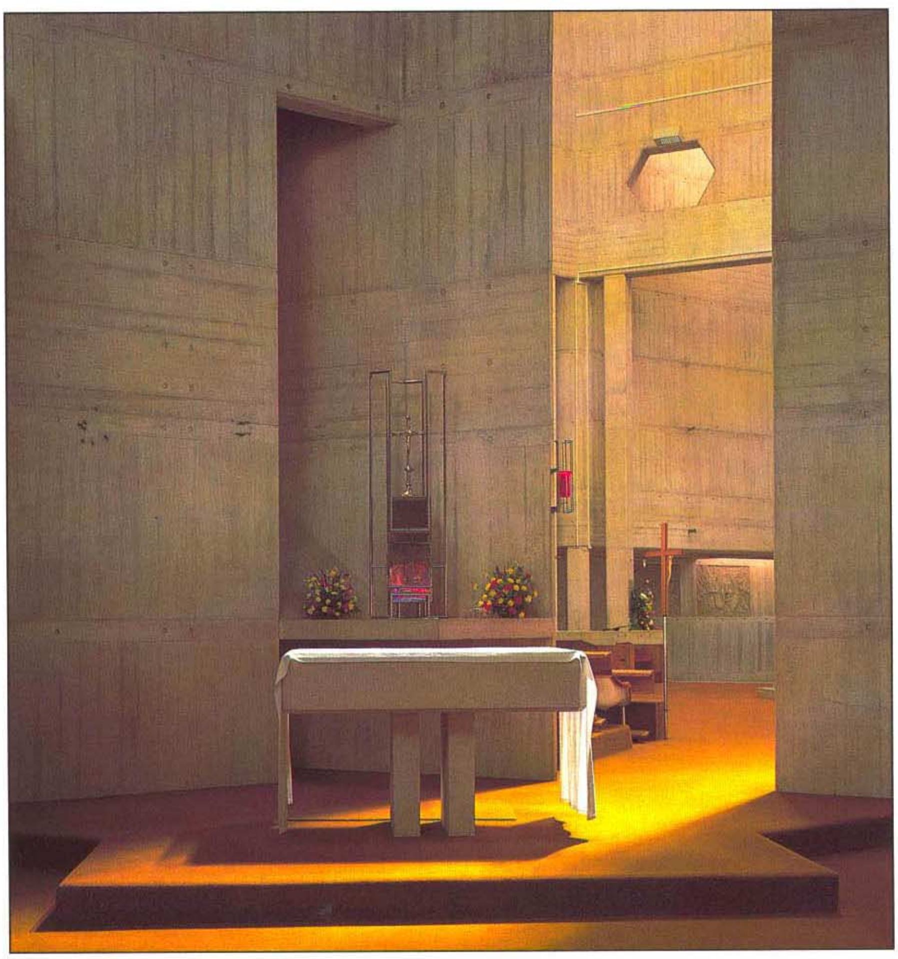
This is concrete as a crafted, quality material – so much so that, where it is seen adjacent to the perforated plywood panelling of the sanctuary roof or the suspended timber prisms which control the acoustics, I find it is the wood which looks outfaced and slightly cheap.

Conclusion

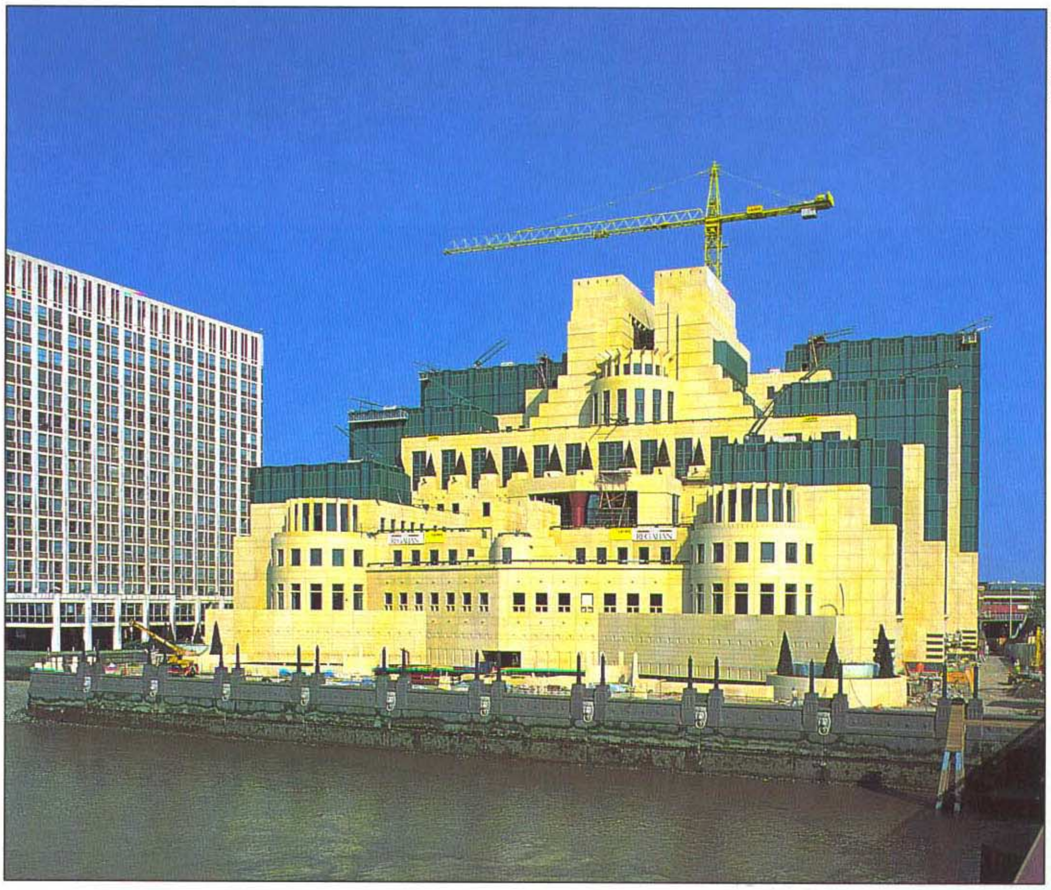
There is much more one could say about successes and failures – the building has had its share of flat roof leaks, the GRP doors did not last and the new public address system has involved some surface wiring, but I feel these must be seen in the context of a major architectural success.

The cathedral is a credit to the client and all responsible for its design and construction; it is an exemplar of what can be done in concrete when the will and the skill come together; it is a monument to those who took the brave decisions and saw them through, but most of all it is for me and for many others a real cathedral – a real twentieth century offering to the greater glory of God. ■

It is the wood which looks outfaced



CLADDING VAUXHALL CROSS



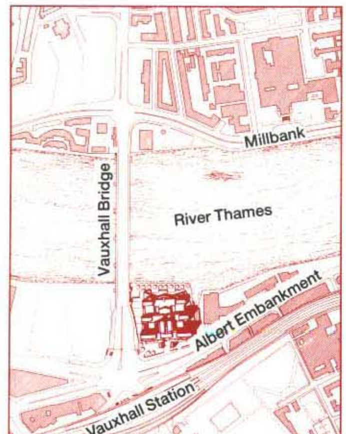
ROGER EASTELL

The acquisition of the four acre site on the south-eastern end of London's Vauxhall Bridge in August 1986 marked the end of a 30-year period of numerous attempts to develop either this site or its eight acre neighbour on the western side of the bridge. It was then that the developer Regalian purchased the site and employed Terry Farrell & Company (TFC) to design and obtain planning permission for a residential scheme. This was later changed to a bespoke office scheme which obtained outline planning consent in November 1988 and detailed consent in February 1989.

The project, now nearing completion, has involved one of the largest and most demanding precast concrete cladding contracts ever undertaken in this country.

Tim Thompson is an Associate at Terry Farrell & Company with 14 years' experience as a practising architect. He has been particularly responsible for the cladding at Vauxhall Cross.

The office scheme comprises some 45 000 m^2 of accommodation in a progressively stepped configuration, setting back from the River Thames in a group of three longitudinal blocks linked by glazed courtyards and atria. This arrangement not only provides the most suitable massing and micro-climate but also yields views of the river from within the site and allows daylight to virtually all internal cellular office spaces.



The structural frame is a flat slab construction of in-situ concrete. The cladding comprises equal proportions of curtain walling and reconstituted precast concrete panels which reinforce the concept of the three building blocks and the series of receding planes stepping back from the river.

The floor plate configuration, structural grid and core arrangements were developed to suit the particular requirements of the end user. Six perimeter cores contain plant rooms, service risers, escape staircases and toilets. Five further internal cores contain passenger lifts servicing all floors.

The frame

The structural grid varies from 4.8 m to 9.6 m, with intervals of 1.2 m. The typical floor-to-floor height is 4 m, while the ground and first floors are 6 m and 5 m respectively. The nature of the structural grid was to lead to several different precast cladding structural design solutions which are discussed later. In-situ concrete was selected for the frame primarily

An in-situ concrete frame was chosen for its economy and flexibility

DENNIS GILBERT

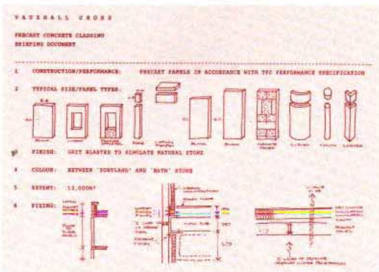
on cost considerations as there was no programme advantage to be offered by steel due to the frame configuration. This evaluation was carried out in 1988 when the alternative, steel, was subject to labour and procurement problems. Other factors in favour of a concrete frame were the variation in structural grid and the large spans of 8.4 m and 9.6 m where structural depths could be kept to a minimum for the ceiling void services.

Why precast cladding?

The decision to use precast concrete cladding was made at the outset because we wanted to achieve the mass of a traditional stone building in a way that would balance the metal and glass cladding. As well as being more economical than natural stone on metal trusses, precast gave both real and apparent weight to the building helping to meet both performance and aesthetic requirements.

Design and manufacturers

The design source for the precast cladding had some attribution to the work of the architect Ricardo Bofil, who, although different architecturally, has used precast cladding extensively. This led to initial enquiries to, and assistance from, Partek Ergon of Belgium for the preparation of the design shown on the planning drawings.



Cladding requirements were outlined in the briefing document

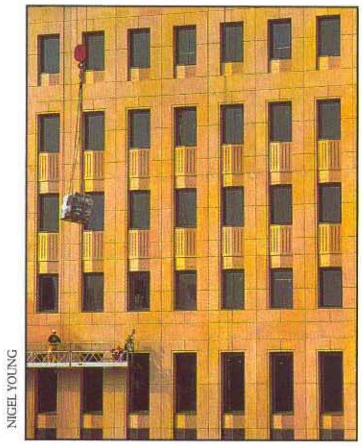
Following the planning submission in the second half of 1988, TFC carried out a programme of detailed research into the precast concrete cladding required. A briefing document was prepared outlining the quantities, type, sizes and performance requirements. This was sent out with general enquiries to several continental and UK precast manufacturers. Favourable responses led to initial interviews and then visits to manufacturing plants and projects.

Agendas for both the preliminary discussions and factory visits were drawn up. These covered items such as project design details, programme, production rates, panel construction, finishes, erection, storage, transportation, craneage, QA/QC procedures, drawing and design facilities. These agendas acted as a checklist and enabled us to make an objective, detailed and direct comparison of companies for the preparation of a tender list.

This process also enabled the detailed design and production drawings to be prepared in accordance with manufacturing and erection processes. Needless to say, each manufacturer had his own individual methods, but we were able to produce the production drawings in a way which did not exclude manufacturers' idiosyncrasies yet still indicated clearly the basic principles required of the cladding system.

Design principles

The precast panels generally span from floor to floor and are bottom-supported on a continuous nib to the slab edge with a top-restraint fixing to the slab soffit. The nib was the most economical way of obtaining the smoke/fire stops for the floor compartmentation. The planning grid of 1200 mm and the typical floor height of 4 m is expressed on the cladding as a 1200 x 2000 mm grid into which the panelised system is incorporated. This grid is expressed by a 20 x 20 mm joint either between panels or as a cast-in feature. This joint was originally to be 15 mm but a study of feasible manufacturing

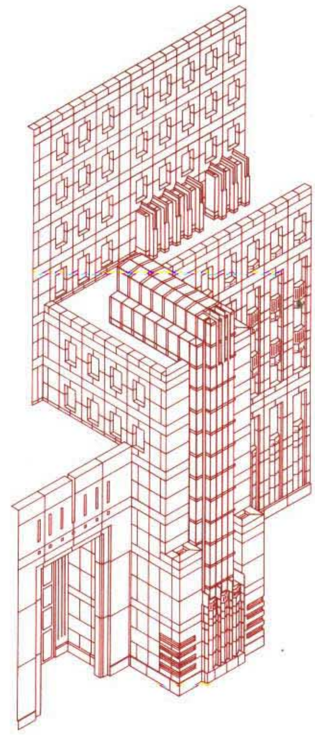


Storey-height panels on the Albert Embankment elevation

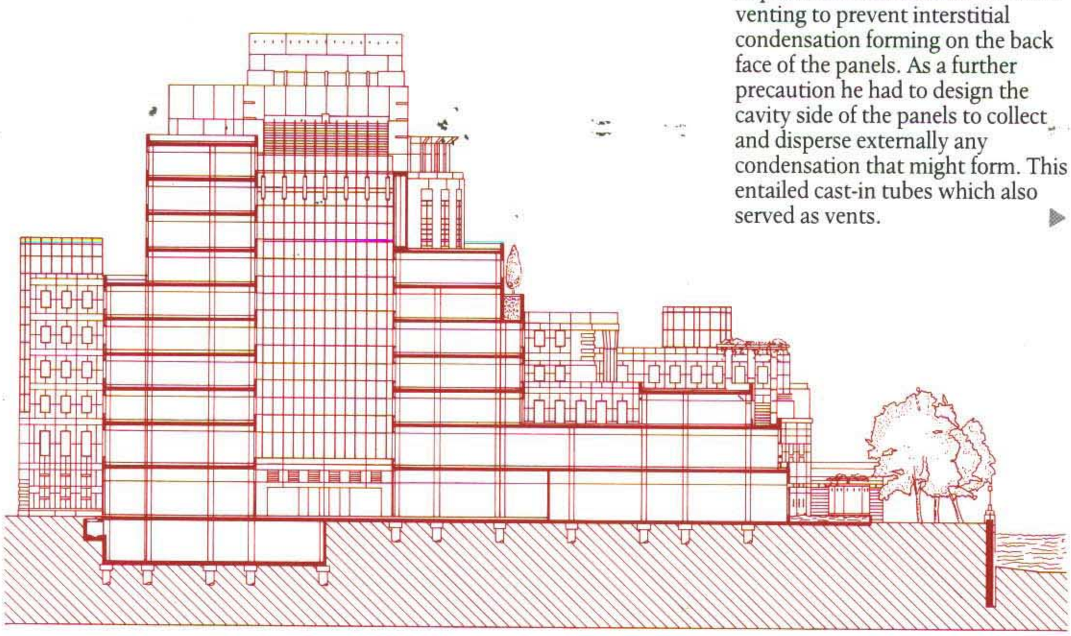
tolerances from potential tenderers suggested that 20 mm was more practical and achievable.

The cladding system could not generally accommodate movements resulting from building deflections from either live loading or creep within the 20 mm joint width. It would, therefore, have to span from structural hard points at or close to the columns. As the panels would generally be 2.4 m wide by 4 m high, they would need to be connected so that they could collectively span the structural grid and be supported at the structural hard points. Design principles of panel connection were discussed at the pre-tender meetings and it was a requirement that proposals were submitted with the tender returns.

The precast cladding system consists of the panel acting as the rain screen, a vented cavity, and the thermal insulation and vapour control supplied by an independent drylining system. On the basis of given performance values of the drylining, the precaster was required to determine the extent of venting to prevent interstitial condensation forming on the back face of the panels. As a further precaution he had to design the cavity side of the panels to collect and disperse externally any condensation that might form. This entailed cast-in tubes which also served as vents. ▶



Panelisation and joints: isometric of Albert Embankment elevation adjacent to entrance

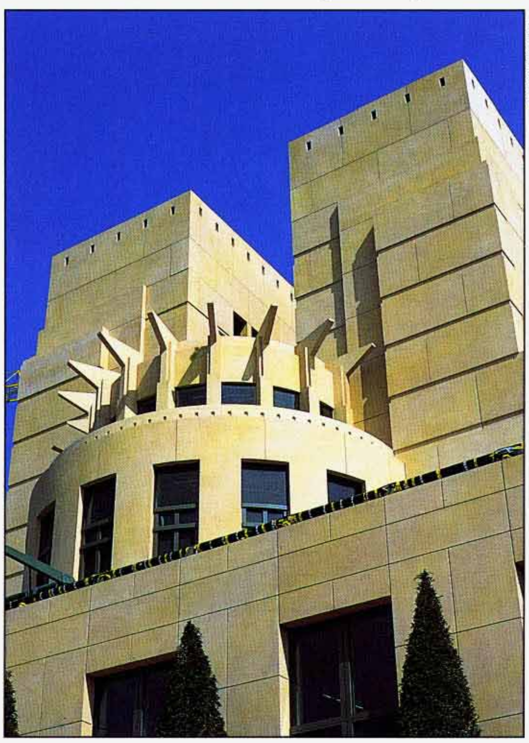


Section from Albert Embankment to the River Thames

Management contractor

By the time Laing Management had been appointed in September 1989 the design of the building and cladding was generally into the production drawing stage, and a provisional tender list for the cladding had been drawn up.

A slightly modified JCT Management Contract had been adopted, with a 29 month building period commencing on site in April 1990 and finishing in September 1992. Laing quickly identified that the design of the building permitted it to be broken down conveniently into parcels, with four (structure, precast cladding, curtain wall and MEP) accounting for some 66% of the total value and 23 other parcels the remaining 34%. The procurement and erection of the precast cladding was quickly established as being on Laing's critical path, with the appointment of a Works Contractor required early in 1990.



ROGER EASTELL

Precast cladding gives both apparent and real weight

Tender

The final tender list was selected on the basis of the manufacturers' capacity, quality, experience, design capability and resources.

The tender documentation comprised a Performance Specification and drawings consisting of general arrangement plans and elevations with 1:20 scope and key details and 1:5 constructional details. The colour and finish of the precast, identified in the pre-tender discussions with Empire Stone Limited (ESL), had been selected from an extensive sample room – probably the best of its type in Europe – in their works at Narborough. Samples from ESL also formed part of the documentation issued to all the tenderers for them to recreate, using material from their own sources, and submit as samples with their bids.

DENNIS GILBERT

In some locations windows are drained through gargoyles

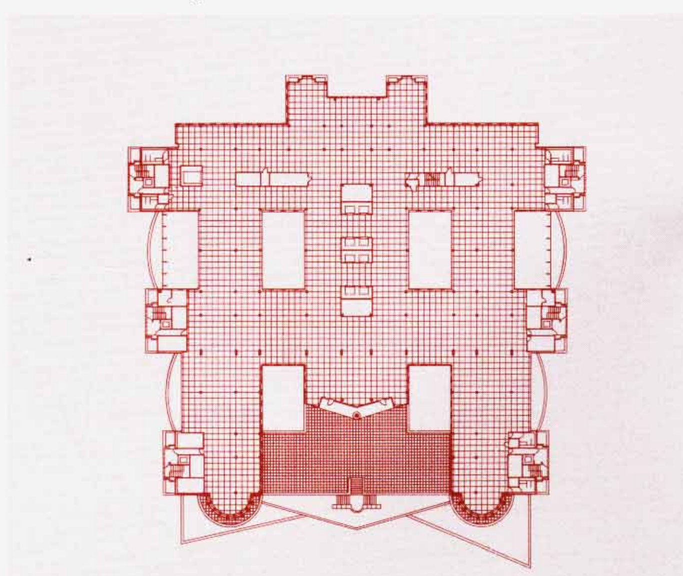
Issues which were of concern to TFC and Laing were raised by the tenderers during the mid-tender interviews. These were related to programme and procurement, tolerances and panelisation. The tender submissions and assessments highlighted two companies, one continental and one UK (ESL), as strong contenders for appointment as precast cladding Works Contractor.

To our surprise it was the Continental manufacturer which could not meet Laing's restraints programme without resorting to manufacture in more than one plant. This was not acceptable because the high level of colour consistency and associated quality controls required dictated that all production should be in a single plant.

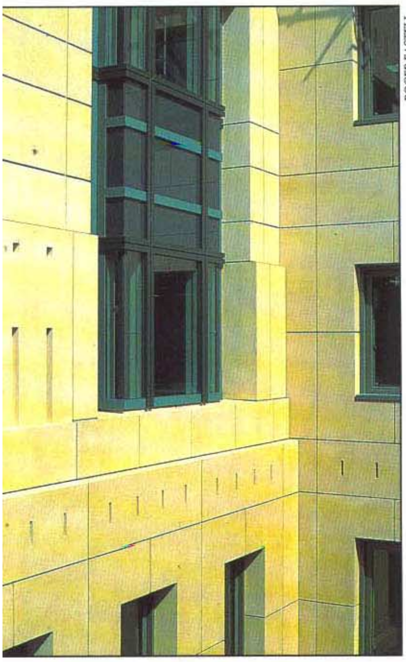
It was a strict requirement that no joints additional to those implied by our 1200 x 2000 mm would be permitted. With this design requirement the tender bids identified the largest and heaviest panels, which were checked against the tower craneage allowances established by Laing. This revealed that, for some panels outside the tower cranes' limits, additional mobile cranes would be required the cost of which was included in the tender bids.

Because ESL decided to allow this project to take up a significant percentage of their total output they had no such difficulties with

Plan at level three



the restraints programme. However, the issue of tolerances was at one point a stumbling block for ESL. The specified 20 mm panel-to-panel joint width dictated a set of panel manufacturing tolerances, identified in the Performance Specification, in order to maintain a reasonable level of visual consistency in the final joint. However, ESL wished to use their own manufacturing tolerances which are similar to those in CP297 and not as restrictive as those specified. Eventually, a compromise was reached and, with all other criteria of design, quality and price having been met, they were appointed in February 1990.



ROGER EASTELL

Window details at level three

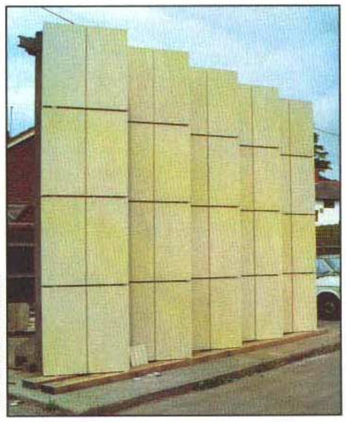
Detail design/shop drawings

Under the conditions of the JCT Works Contract and Performance Specification, Empire Stone Limited were responsible for the detailed design of the precast cladding which covered the engineering, structural, thermal, and acoustic criteria as well, of course, as weather exclusion. Design meetings were held every two weeks with Laing, Ove Arup – the structural engineers – and TFC. These were working meetings at which design solutions were tabled, evolved, discussed and resolved with the extensive use of 4B pencils!

At times, ESL had a tendency to look to TFC for design solutions. An instance was the effect on the cladding of the deflections and creep of the in-situ concrete frame. The frame had been designed by Arup to give a maximum long-term creep deflection of 15 mm at the slab edge. As mentioned earlier the 20 mm panel-to-panel joint could not accommodate any significant lateral movement of panels, and the system would, in most cases, have to span from column to column (or rather the slab edge adjacent the column). After several months of design work, ESL had covered most of the building but had not really come to terms with the creep movement of the building frame affecting the panels. But, with a little guidance and with their own specialist designers, ESL evolved several solutions. As a typical cast panel size was 2.4 m wide by 4 m high they are generally connected together in pairs or threes, and occasionally in fours.

The connection has been achieved by using three different structural principles: beam, tied arch and three-pin arch. Other solutions have relied on using steelwork either spanning between structural hard points or hanging from shear walls/columns. The deflection of the steel, due to the loading of the cladding, was shimmed out at the time of erection and thereby avoided the effects of creep.

ESL's learning curve and approach to problems during this period was indicative of the positive manner in which they would respond to a situation.



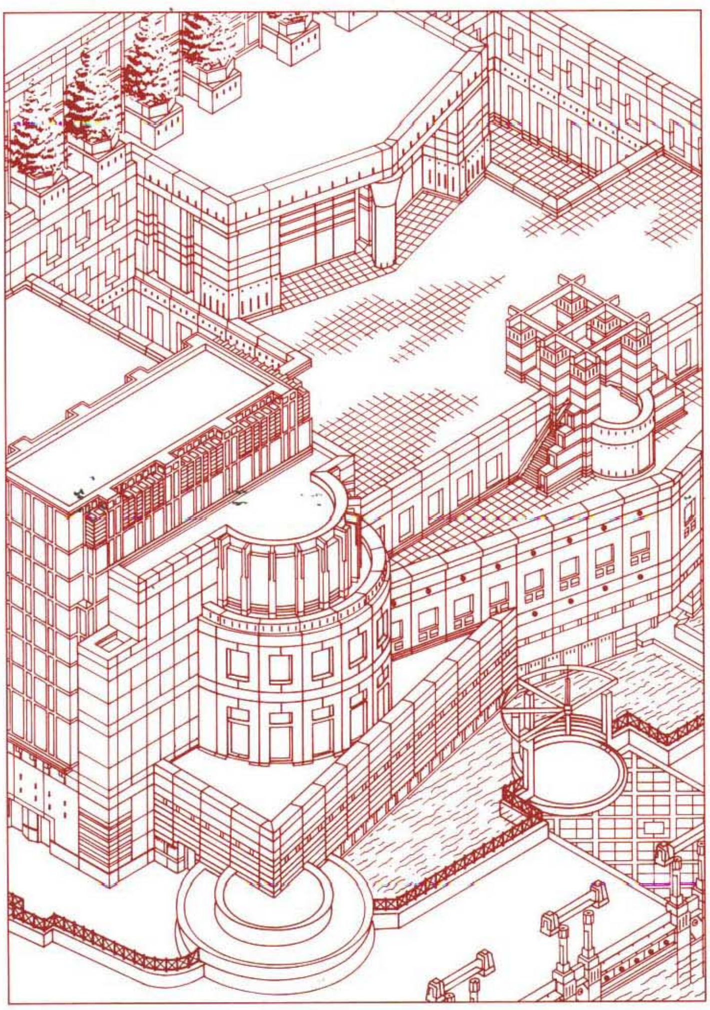
EMPIRE STONE LIMITED

Twenty panels were produced under varied conditions to establish colour limits

By the time production started in September 1990 all the principal design issues had been addressed, understood and largely resolved.

Manufacture

During panel manufacture, we were principally concerned with consistency and quality. After their appointment, ESL produced some 20 non project-related panels from which control panels, for the upper and lower colour variation limits, were selected. A significant quality problem was the control of mould marks, resulting from a two-pour process, on panels with a return face. It was a particular design requirement that the corners of ▶



Complexity and variety of panel types – part of river elevation

CLIENT
■ Regalian Properties plc

ARCHITECT
■ Terry Farrell & Company

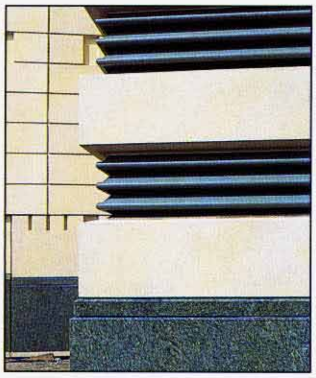
STRUCTURAL AND MECHANICAL ENGINEER
■ Ove Arup & Partners

QUANTITY SURVEYOR
■ Cyril Sweett and Partners

MANAGEMENT CONTRACTOR
■ Laing Management

STRUCTURAL FRAME
■ Swift Structures Ltd

PRECAST CONCRETE CLADDING
■ Empire Stone Ltd



Louvred units entailed complex casting: the granite plinth was fixed on site

the building were not finished in a panel butt joint, but rather that panels should have a return face to enhance the visual solidity of the stone element. As part of their quality control ESL constructed at their works a full-size, three-storey mock-up of selected panels to verify colour consistency of panels and confirm the detailing of features.

Further panels were also required for composite assemblies of precast and curtain walling for a regime of air- and water-testing at the Taywood Engineering Cladding Centre in Southall. The primary purpose was to assess interface junctions and the curtain walling itself. However, a surprise result from these tests showed that the vertical drop to the vent pipes was not sufficient to prevent rain from being blown back up into the cavity. The pipes had been cast in with a minimum 100 mm drop (the PSA *Method of building guide to precast cladding* recommends 75 mm). This came to light rather late in the day as many of the panels had already been cast. A solution was achieved by inserting into the vents an open-cell foam which allowed the passage of air but prevented water being blown back. Subsequent re-testing demonstrated its success.

The three blocks are progressively stepped back from the river

Erection

Panel erection on the building commenced in January 1991 and was substantially complete by the end of March 1992. This included the sealing of joints, back-up works and on-site finishing to over 2500 panels.

Precaster's Challenge

David Kennell

David Kennell is Sales Director of Empire Stone Limited. Apart from a brief period in civil engineering, he has spent most of his working life in the precast concrete industry, having started as an apprentice draughtsman in 1958.

For almost twelve months before receiving the official invitation to tender for the cladding on this project, we were engaged in active discussions with the architect both about the design proposals and also about the type of finish that might be chosen. This culminated in our providing the architect with a series of profiled mock-up samples (for which we were actually paid – a first, I think in Empire's history). For many months Tim Thompson had been showing us a couple of isometric details of the building showing the front and rear and I must admit that, for some time, we thought the project involved two buildings.

During this pre-tender period, Laing Management was also actively investigating precast supply in both the UK and continental Europe, visiting companies as far afield as Denmark and Italy. After these investigations we believe that Empire Stone was the only UK company thought by Laing to be competent to carry out this sub-contract, bearing in mind particularly the scope of the work, programme restraints, technical input required and, in particular, the demand by the architect for the highest possible quality of finish.

Demanding decisions

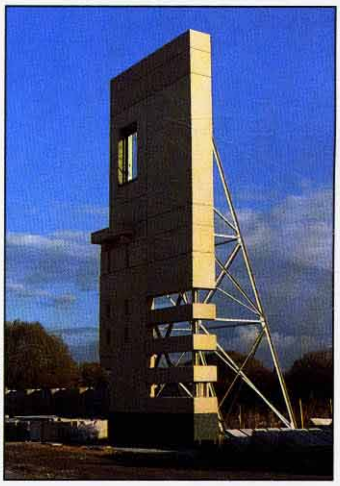
When the tender documents and drawings arrived we became fully aware not only of the size of the sub-contract but also of the aspects that were more dominant than in any contract we had previously undertaken. These included floor slab deflections which had to be accommodated within the cladding system, tight tolerances particularly relating to the joints between units, the interface between our cladding and the curtain walling system, the consistency of colour demanded by the architect and, of course, the programme, which was far from relaxed.

It soon became apparent that this sub-contract would represent on average some 60% of our total production for up to 15 months. As a company with a wide client base we therefore had to decide whether to proceed, recognizing the possibility of prejudicing other prospects if we were successful.

Our decision was influenced not only by our anticipation of a recession but also by the fact that the British precast industry had received much criticism for its allegedly negative attitude towards major fast-build projects – and we were tired of hearing how well, in comparison, our foreign competitors could handle such work. We decided, therefore, that the need to establish Empire Stone's international reputation as a market leader was such that we had to go for it, and go for it competitively.

Into production

Our bid was presented. This was followed by numerous presentations covering aspects such as design, panelisation, site operations, logistics, and our understanding of the building movements. A two-horse race ensued between ourselves and Partek Ergon, and we were delighted to come out the winner on four major counts: quality; interpretation of the scheme as a whole; programme; and (after some value engineering) price.



A three-storey works mock-up helped to confirm detailing

We were surprised to see pinch bars used for the levelling and final adjustment of panels. While this method is common practice, and proved effective, it seems simplistic in this day of high technology cladding systems and can, of course, result in damage to the arrises and corners of panels.

The Performance Specification did not permit repairs larger than 75 mm to panels. But, in practice, once a panel is on the building it is extremely difficult to remove, especially for 'only minor' surface damage. The number of on-site repairs to panels, though small in relation to the project size, was still more than we had anticipated. As part of the quality control procedures, however, ESL had made some samples of repairs at the beginning of the project which were approved and became the control samples.

Summary

This is a major project, both in size and architectural presence, and the cladding is the key to its success as it has been built to match Terry Farrell & Company's design and performance levels. The precast cladding contract is possibly the largest of its type in the UK, but in the early stages of forming a tender list it was the very size of the cladding contract which almost precluded using a British company.

It is generally recognized by all those connected with Vauxhall Cross that it is a successful project which has shown that, in this area of cladding, British manufacturers can match, and perhaps exceed our continental friends. This is not just due to the completion within programme and cost, but perhaps even more to the successful and positive working together of the team who all came from different companies and skilled backgrounds. This team approach was generously promoted and supported by the client, Regalian, and it is a testament to all the works contractors and especially Empire Stone Ltd that they responded in equal measure. To be able to sit around the table and talk goes a long way, and much further than extensive, complex and rigid contracts.

ROGER EASTELL

Due to the architect's limited experience in the use of precast and reconstructed stone cladding it was necessary for us to demonstrate a high degree of colour consistency, particularly important with such large areas of cladding with some areas of plain face. To do this we produced twenty L-shaped units which were erected, echelon fashion, in our works. Each unit was manufactured under different circumstances from its neighbour: different time of day; different manufacturing and finishing gangs; and slight but intentional variations in the percentage of pigment. Even we were surprised by the consistency in the overall appearance of the erected colour mock-up and the architect had a very difficult time deciding on the upper and lower limits of acceptable colour variation.

Design proceeded in parallel with the final approval of finishes and we began with a team of nine design draughtsmen – which later peaked at 20 – and CAD was extensively used. The professional engineering services of Smithers Purslow International were also employed throughout. Barry Pears, our technical Director, was initially in overall control of the project and, as it moved into manufacture and site erection, responsibility moved to Ian Putley, Operations Director.

The interface with Schmidlin curtain walling was a vital element and design meetings were held both at their works in Switzerland and ours at Narborough. Another aspect of the design of this project that we had not previously encountered on this scale was the design and provision of secondary steel supports.

We started fixing the units in February 1991 with a team of four site operatives – later building up to 25 – and a contract manager resident on site throughout the operation. The carefully planned allocation of craneage, coupled with the lack of encumbrance of other trade contractors, facilitated meeting the required completion date.

Pride in the job

With the completion of cladding erection in March, all that remained was the reconstructed stone features to the external landscape works, by normal standards a fairly major sub-contract itself. It has become very clear that our decision to take on such a large project was entirely justified, with casting continuing until mid-1992 – well into the maximum depth (we hope) of the current recession.

Vauxhall Cross has been, if not the largest project that we have ever undertaken, without doubt the most complex. The following (rounded) statistics give some indication of the efforts required from every part of the company to carry out the job successfully.

Total number of units	2650
Number of different types*	1400
Heaviest unit	15.5 tonnes
Total tonnage	9400
Number of lorry loads to site	575

**meaning a mould alteration after every 1.84 casts on average!*

Our working relationships with Farrell, Ove Arup and Laing Management have been excellent throughout. The job was also helped immensely by the positive approach taken by Regalian, who ensured that problems were properly, professionally and fairly dealt with as they arose. We are delighted with our achievement which demonstrates to the sceptics in the construction industry that, on major projects such as Vauxhall Cross, a British manufacturer can successfully take on the best of our continental competitors. ■

SHELL COMEBACK

John Chilton
BSc, PhD, CEng, MICE

LINFORD HELI-PHOTOS

Concrete shell roofs over the Norwich sports halls and Aquapark

John Chilton is Lecturer in Building Structures at the School of Architecture, University of Nottingham. He is a member of the International Association for Shell and Spatial Structures and his research interest is three-dimensional structures of all types, and particularly space grids.

For around 2000 years single- and double-curved shell structures, like barrel vaults and domes, have been used to cover large spans in buildings. Generally, these were constructed from masonry or unreinforced concrete, materials strong in compression but relatively weak in tension. Early examples, such as the Pantheon in Rome (120-124 AD) and Hagia Sophia in Constantinople (532-537 AD), have a span-to-thickness ratio of less than 50:1, which is not as good as that of egg shells.

However, with the advent of reinforced concrete which is a mouldable material strong in both compression and tension, it became possible to construct thin shells with span- to-thickness ratios commonly in the region of 500:1.

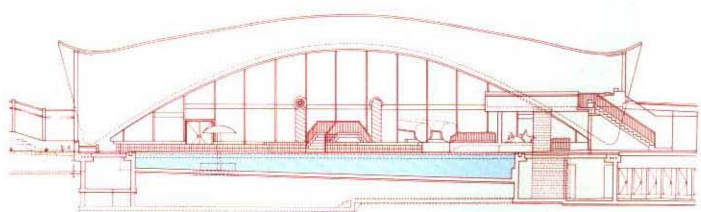
Thin shells are economical in the consumption of materials, and particularly steel which is used only for reinforcement and usually at quite a low density, so they were used widely for medium- and long-span roof structures from the 1920s until the 1970s. For example, the works of the great shell builders Torroja, Candela and Nervi were mainly constructed during this period when steel was often in short supply.

Since the 1970s, the use of reinforced concrete shells has declined in developed countries and this has been due to several factors. For instance, traditional shell construction is labour intensive which makes it expensive in high wage economies. Many structural steel sections are now available at competitive prices together with new long-span structural systems suited to steel construction. Further, the high cost of the formwork and falsework (which is often used only once) required to produce shell forms has also reduced their acceptability. More recently, tensile membranes have enabled architects and engineers to cover large areas with lightweight, translucent structures which have taken much of the potential market for shells.

Many developing countries do not produce their own steel (or produce less than they consume) and can ill afford to import large quantities of structural sections for building construction. In these countries labour is often cheap and most construction materials expensive, therefore, the economic argument for shells still holds true.

Membrane structures may be inappropriate for some situations because they have a limited life-span, depending on the material used, and are difficult to insulate without sacrificing the appearance of lightness which is their hallmark.

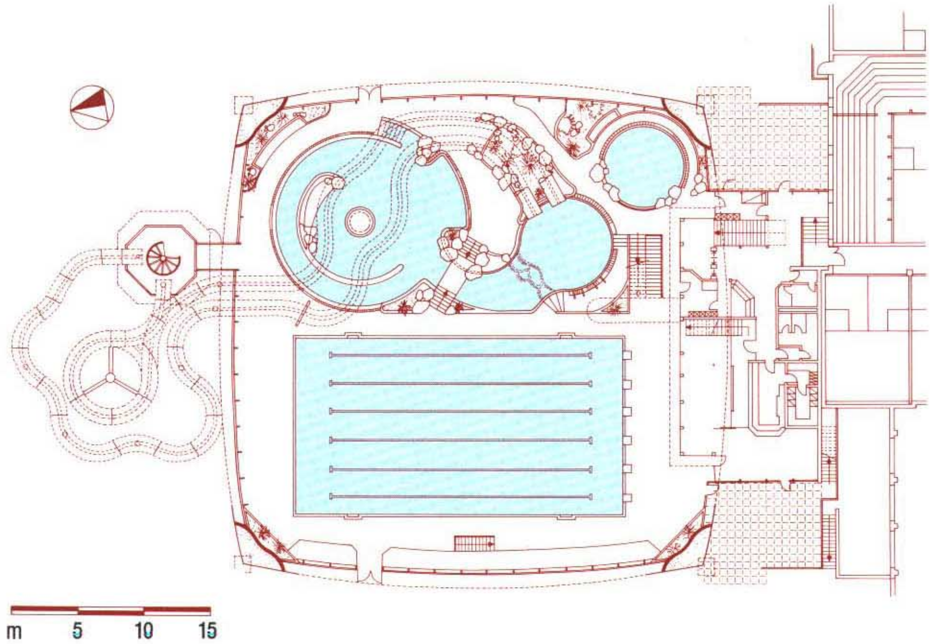
On the other hand, modern concrete shells are very durable and require minimal maintenance as they use well- compacted concrete, of good quality, which is maintained in compression to eliminate cracking. Sprayed insulation materials can be used to achieve the final shape of the shell formwork without having to resort to expensive timber lining. Improvements in concrete technology have also made the task of placing, compacting and finishing the shell easier. To demonstrate the advantages of current thin shell roof construction, a recent development in Norwich is described in detail.



Norwich Sport Village

Since the 1970s the construction of a reinforced concrete shell roof has become a rare event in the UK. But, since 1987, the architects Copeland Associates in conjunction with the Swiss firm of Haus & Herd have used ten such roofs in their design for the Norwich Sport Village. In the first phase of the development, nine similar shells, each 18.6 x 48 m in plan, rising to 10.5 m above the supports, were erected to form multi-sports halls.

The second phase of development incorporated a major water sports facility. The Aquapark, opened in May 1991, provides a six-lane, 25 m swimming pool, leisure pools with water slides 76 and 88 m long, bubbling spas and water cannons, water and air-jet loungers, a wild-water channel, children's pool, a restaurant, bar and seating for 330 spectators. All of these facilities are housed under a free-form, 35 m square reinforced concrete shell roof supported only at the four corners. At the centre of the shell the rise is approximately 9 m above the supports.



Re-usable Glulam beams on adjustable trestles created the curved profile

All ten shell roofs were designed by Swiss engineer Heinz Isler who has more than 30 years' experience of the design and construction of reinforced concrete shell structures. Most of his shells are free-forms, developed from studies of shapes in nature and from experiments with small-scale structural models.

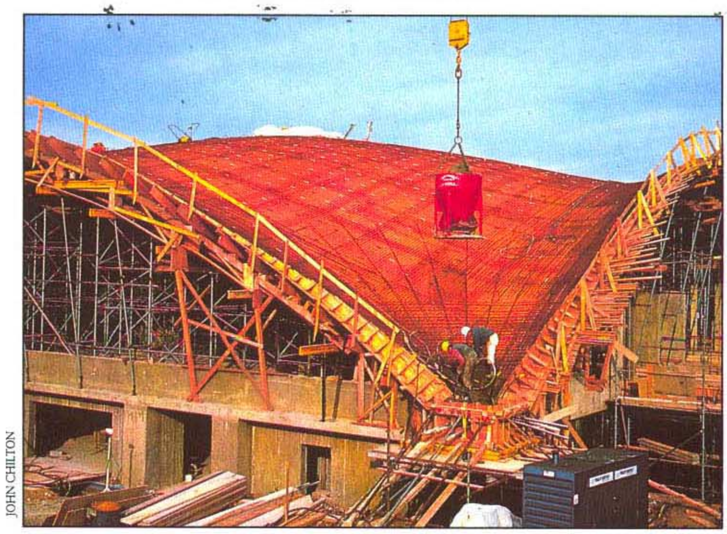
Form finding

To determine the appropriate form for any shell, Isler uses a variety of methods. One is to suspend a membrane between supports in the same relative positions as in the real structure and to apply a uniform load to the membrane surface (for example a layer of wet plastic material on a thin elastic sheet). Under this load the membrane takes up a shape such that, within it, only tensile forces are present. By inverting this form, the resulting structure will be in pure compression when subjected to similar uniform vertical loading. Therefore, a major property of concrete, strength in compression, may be utilised to the full. A desirable consequence of designing a concrete structure subject only to compression is that cracks are almost completely eliminated, which greatly reduces the possibility of corrosion of the steel reinforcement. To ensure that the shell form is in compression under all possible loading conditions, not just uniform load, it can be prestressed by pulling the support points slightly inwards using pre-tensioning cables within a foundation ring beam.

Formwork

Isler has had a long association with the nominated subcontractor for the Norwich shell roof, W. Bösiger of Langenthal in Switzerland. This has enabled them to overcome one of the main problems in shell roof construction, the cost of the formwork and falsework necessary to support the wet concrete, by developing re-usable systems.

In the case of the Aquapark roof, the curved profile was achieved by using curved glue-laminated (Glulam) timber beams supported on adjustable metal trestles. Thin timber strips spanning across the Glulam beams were then used to support two layers of wood-wool slabs and a layer of sprayed polyurethane insulation with vapour barriers between the separate insulation layers. To ensure that the insulation would not separate from the underside of the completed concrete shell, plastic fixings connected to the wood-wool slabs were fixed to the steel reinforcement with stainless steel wire. Plastic fixings were used to reduce cold-bridging through the insulation. ▶



The four corners were concreted on the first day

SHELL COMEBACK

CLIENT
■ IHS Sport Villages plc/Broadland District Council Joint Venture
ARCHITECT
■ Copeland Associates *in conjunction with* Haus & Herd
ENGINEER
■ Heinz Isler
MAIN CONTRACTOR
■ R G Carter Ltd
SHELL ROOF SUBCONTRACTOR
■ W Bösiger
CONCRETE SUPPLIER
■ Ennemix East Anglia

Shell thickness

Generally, the shell concrete is only 100 mm thick and is reinforced with two layers of 6 mm diameter steel bars at 100 mm centres on a square grid. However, the concrete becomes thicker at the corners where additional radial and transverse reinforcement is provided to cater for the concentration of loads being transferred to the foundations. For similar shells in Switzerland, Isler has, apparently, used a minimum concrete thickness of just 80 mm.

Concrete

Durability of the concrete for the shell roof is more important than its strength, as stresses under load are mostly fairly low except near the supports. It is also necessary for the concrete to remain workable for long periods, as the large surface that has to be compacted and finished has double-curvature and, therefore, it takes time to form to the correct profile. Approximately 210m^3 of a C35 concrete mix were used, with appropriate additions of plasticizer and retarder. This allowed pouring and hand finishing of the shell to take place over two days.

The concrete was delivered by truck-mixers from a local ready-mixed concrete plant and placed by skip using a tower crane. On the first day the four corners were poured, where the shell is thickest, and the surfaces were finished part way up each side of the roof. The remainder of the shell was poured and finished on the following day. Because of the form of the shell, the rainwater run-off converges on the corners and it is necessary to mould a gutter along the edges to channel the water into the drainage system. These channels were formed by hand, by a team of plasterers, after initial compaction of the concrete.

TOM MACKIE

The Aquapark roof is 35 m square

Prestressing

After placing was completed the concrete in the shell was allowed to develop strength for about three days before an initial prestress (25% of the final value) was applied to the foundation beams along each side. When the concrete had developed adequate strength (at about 21 days) the remaining prestress was applied. This pulled the corners of the roof in slightly and lifted the concrete shell with its three layers of insulation clear of the supporting falsework, which was then dismantled.

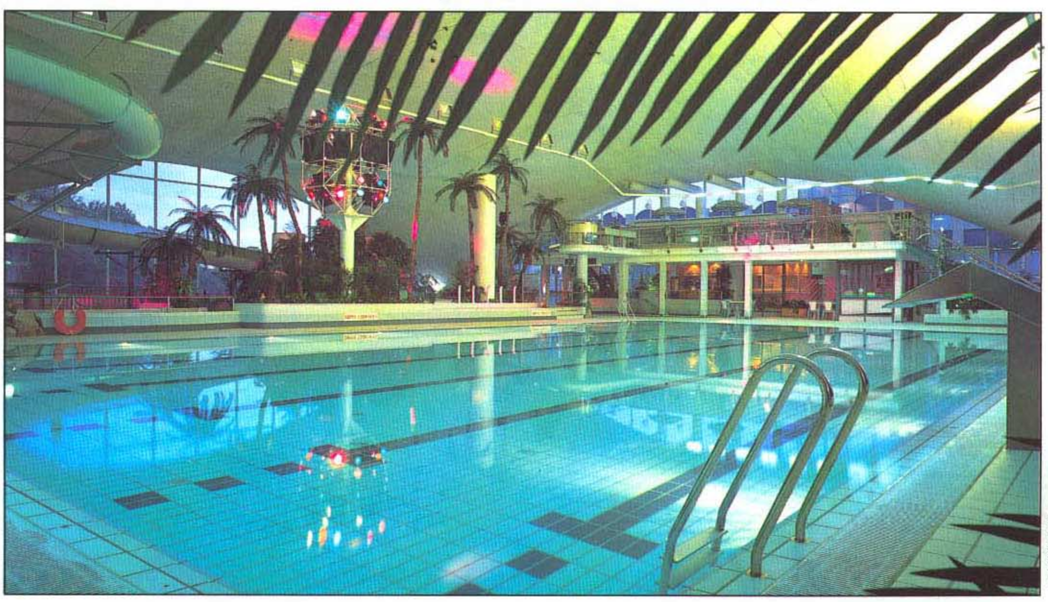
Surface protection

No surface protection is applied to the exterior surface of the shell as Isler's experience has shown that uncracked, well-compacted concrete with an appropriate cement content is a durable material. Compression shell roofs constructed using this method in Switzerland over 30 years ago show no signs of deterioration, having acquired a thin natural protective layer of lichens. Inspection of the sports hall shells at Norwich, constructed a few years ago, show similar weathering characteristics and would suggest that this is a low-maintenance form of construction.

Environmental considerations

For the comfort of pool users, the air within the pool area is ideally maintained at about 30°C with 55% relative humidity in use. The roof form makes possible a large-plan building with a minimum surface area, which reduces heat loss, and a low internal volume, which reduces the amount of air to be heated. At the same time, large areas of glazing can be accommodated in the elevations to provide a pleasant internal environment that is largely naturally lit. Other examples in Switzerland also have holes pierced in the shell to provide rooflights. The building form is, therefore, perfectly suited for a swimming pool as it reduces considerably the energy consumption of the facility.

A beneficial effect of having wood-wool slab thermal insulation on the inside of the concrete shell is that it also acts as an acoustic absorber to moderate the high noise level often encountered in enclosed swimming pools.



TOM MACKIE

The future

This is probably the largest shell roof to be constructed in this country for many years and it has rekindled interest in this elegant structural form. Currently, Copeland Associates and Heinz Isler are designing several similar developments to be built in the near future at other locations in the United Kingdom. ■

THEATRE IN THE ROUND

NORTHERN IRELAND TOURIST BOARD

Gordon Clarke
BSc (Hons), ALI

Gordon Clarke, a landscape architect with Ferguson & McIlveen, was the Design Co-ordinator for the development at Carnfunnock. He has worked with the practice for 14 years and has wide experience of recreation-related projects.

High-quality precast concrete has been used to create a radial amphitheatre in a once-derelict walled garden which is now the central attraction for visitors to Carnfunnock Country Park, near Larne in Northern Ireland. The park is being developed in phases by Larne Borough Council, and restoration of what was originally the Victorian vegetable and flower garden of the Dixon Estate was completed in 1990. It is in a magnificent setting overlooking the sea, with distant views of south west Scotland.

In-situ and precast paving was used for the paths

FERGUSON & McILVEEN

With a total area of 1½ acres, the walled enclosure offered a large space sheltered from the prevailing winds in which to develop attractive pleasure gardens. The amphitheatre was planned to derive from the fine surroundings and the microclimate, and the enjoyment of those attending concerts, open-air theatre and other events is further enhanced by the colour and fragrance of the flowers and shrubs.

The walled garden is divided into plant-themed areas, like the Rose Garden, the Rock Garden and the Scented Walk, and a Time Garden provides the perfect setting for many different types of sundial, from the simplest to the most ornate. These areas, and the amphitheatre, are linked by a series of paths.

Concrete was chosen as the principal paving material throughout because of its textural qualities, slip resistance and durability in the marine environment. Even on a dull day, its bright light colour in contrast to the dark green foliage creates a cheerful impression in the garden.

Blanc de Bierges precast concrete units were specified to form both the entrance area and the amphitheatre itself comprising five tiers of seating which rise to a level 3 m above the 20 m diameter 'stage'. The amphitheatre floor and approaches are paved with 140 x 140 x 80 mm straight-sided setts vibrated into a sand bed. The seats are formed by L-section modules with 200 x 200 x 50 mm slabs on mortar for the walkways, and the steps by inverted U-section units infilled with mortared slabs. Built off an in-situ concrete foundation, the proprietary units were not only a cost-effective solution but also provided a high-quality finish. Because of the large diameter of the stage, no major on-site cutting was needed to accommodate the radii.

Blanc de Bierges units form the amphitheatre

Elsewhere, brush-finished in-situ concrete was used to continue the colour theme of the entrance area on the main pathways. In the smaller themed gardens, textured concrete paving slabs set in coloured gravel were used where access for maintenance vehicles was not a design constraint. These materials are in scale with the smaller areas, and complement the surrounding planting.

Since its opening, the walled garden has been widely acclaimed, and become a popular venue for the local populace and visitors alike. The Borough Council maintains the planting to a very high standard and the floral displays are frequently changed. The hard surfacing has proved equal to the quality of its setting. ■

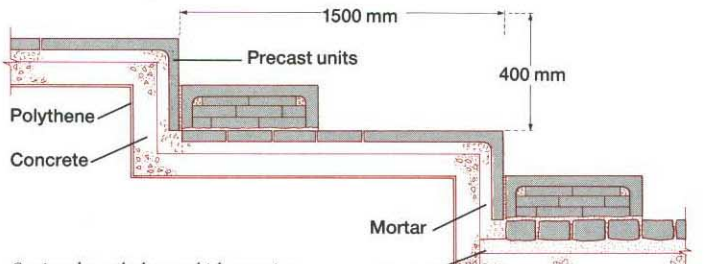
CLIENT
- Larne Borough Council

LANDSCAPE ARCHITECT
- Ferguson & McIlveen

CONTRACTOR
- H.G. Canning Ltd

PRECAST PAVING AND SEATING
- Milner Delvaux Ltd (Blanc de Bierges units)

PROJECT FUNDING
- Department of Economic Development, Tourism Branch (Northern Ireland)



Section through the amphitheatre tiers

Screeding Off

Taking the rough with the smooth

I had been offered a lift home by a moderately prominent newspaper columnist A highly intelligent and engaging writer, this one, of liberal views and moreover driving an eye-swivelling futuristic Toyota Previa. I climbed in, happy to fulfil my usual rôle of architectural guide as she deftly stirred her way through the treacly London rush-hour traffic.

The columnist and I, it must be said, do not exactly see eye-to-eye on architecture. She doesn't like anything that's much newer than her lovely Edwardian house in North London, though she's learning to tolerate the Thirties. I tend, in contrast, to champion the modern from my nearby and less lovely Victorian heap. Still, we got on well enough until we reached the Barbican and I started singing the praises of those marvellous, heroic bush-hammered concrete towers – splendid on the skyline, even better close up, and loved by their inhabitants. But the columnist's face assumed a mask-like quality. Every morning, she intoned, she drove her daughter to the girls' school here. The sight of those towers looming up in the mist, she added, was enough to cast gloom over her day.

"That's because", I countered, "all you choose to see is concrete tower blocks. What you ignore is the quality of the architecture. This isn't jerry-built prefab stuff like Ronan Point. Can't you tell the difference?"

She couldn't, so we spoke of other things. But her response was entirely normal. Raw concrete architecture is not only out of fashion – which places it as much at risk as redbrick Victorian buildings were in the 1950s – but has associations with the perceived failure of the social experiment of high-rise and slab housing. Ronan Point was concrete. Ronan Point and its like were bad. The National Theatre is concrete. Therefore the National Theatre is bad. As for the Brutalist stuff, like the Hayward Gallery and Queen Elizabeth Hall on the South Bank, only the cognoscenti have a good word to say for it. English Heritage's earnest attempt to get those buildings listed was regarded as quixotic at best, dangerous at worst, and was accordingly treated with contempt by the Government.

There is a huge gulf between the popular perceptions of the two main concrete-inspired architectures of the 20th century. It's now becoming acceptable, as my columnist friend would grudgingly agree, to like crisp, white-rendered, inter-war modernist buildings. Architect Berthold Lubetkin is revered, his Highpoint flats and his restored Penguin Pool at London Zoo places of pilgrimage. But it is emphatically *not* acceptable to like, or admit to liking, what Le Corbusier called *beton brut*. So poor old Erno Goldfinger's most monumental work – Alexander Fleming House at London's dismal Elephant and Castle – is doomed to demolition as if it were no better than the vile and justly condemned triple towers of the Department of Environment in Marsham Street. And although the National Trust has to some extent come to terms with the 20th century by agreeing to take over Goldfinger's modest brick-clad pre-war former home in Hampstead (so different from the work of Lubetkin, Amyas Connell *et al*), it has had trouble raising the necessary endowment to run it.

The upshot is that the new generation of modernist architects in Britain tend to take their cue from white 1930s modern, rather than the raw post-war years. In Japan, whose architects are among the best in the world, the plastic qualities of *beton brut* continue to be exploited in the works of Ando, Kurosawa, or Maki. In Britain, we can only offer an increasingly sophisticated concrete repair service, handy for keeping the Thirties' spirit alive.

Given that the British habitually learn to love a style of architecture 50 or 60 years after its avant-garde heyday, the architecture represented by the Barbican and the South Bank will be prized and jealously protected by all right-thinking citizens by the year 2010. The problem is the next 18 years of gung-ho demolition. Someone has to try to teach whoever is at the controls the difference between good concrete architecture and bad concrete architecture. Right now, the material alone is enough to condemn a building out of hand. Exposed concrete, indeed.

Hugh Pearman
Architectural writer and broadcaster and architecture correspondent of *The Sunday Times.*

FORTHCOMING EVENTS

Brief details of some of the BCA events planned into 1993 follow.

External rendering – right first time
Altrincham – 22 September
Southampton – 2 December

Rendering is a traditional craft that has suffered from lack of experience, and poor understanding of material properties. These courses will update specifiers and users on the technology of mortars and renderings.

High-strength and high-performance concrete
London – 28 October

This seminar will show how, in structures designed for strength such as bridges, high-strength concrete will lead to a more durable structure and the possibility of achieving longer spans. Conversely, where structures such as floors are designed primarily to resist degradation, high-strength concrete will give a stronger floor with better abrasion resistance.

Durable reinforcement for aggressive environments
Coventry – 5 November

New ways of providing reinforcement for concrete in aggressive environments are always being sought. BCA has conducted a study of cathodic protection, epoxy-coated rebars and new synthetic materials and this seminar gives an informed insight into the potential for producing high quality reinforced concrete suitable for aggressive environments.

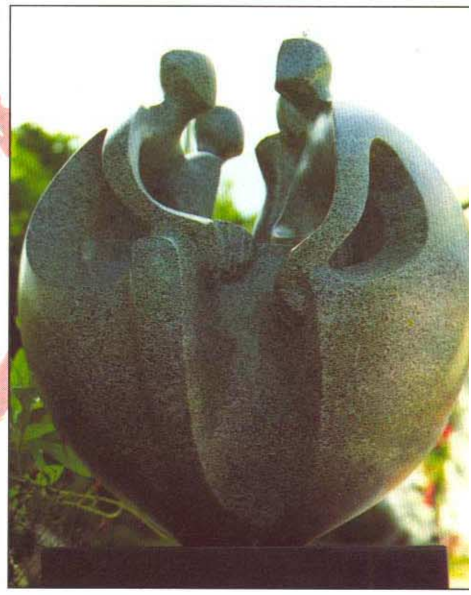
Architectural in-situ concrete – site practice and specification
Slough – 12 November

For clerks of works, architects, construction supervisors and specialist concrete contractors. Techniques for producing high quality in-situ concrete finishes to walls, columns and flat work will be demonstrated. Topics will include formwork and form liners, release agents, curing methods and how to minimize efflorescence and colour variation of finished surfaces.

Housing – an update on developments in traditional design and construction
Altrincham – 17 November
Crowthorne – 18 February

Will update architects, house-builders and structural engineers, looking for improvements in the quality and cost-effectiveness of design options, on developments in traditional brick and block construction. Using recent case studies, these events will examine changing customer priorities in areas such as construction quality, space utilization, and thermal and sound insulation.

For details and *Programme of Events* phone Events Department, Fulmer (0753) 660428. American Express/Access/Visa holders may book by phone.



Like her previous sculptures illustrated in CQ, Carole Vincent's Colloquy *demonstrates concrete's mouldability and strength. The highly polished finish reveals the Delabole slate aggregate in its white cement matrix. The sculpture was a feature of the BCA stand at the recent 'Building a better Britain' exhibition.*

NEW PUBLICATIONS

The following new publications are now available.

Appearance matters 2: External rendering
W. Monks
Ref. 47.102. £10.00. 32 pp.

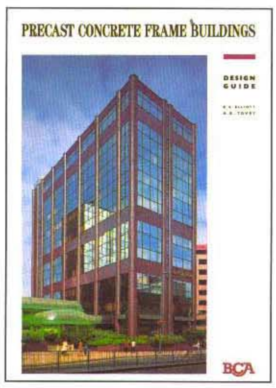
Recently revised to incorporate technical changes introduced in the 1991 edition of BS 5262: *Code of Practice for external renderings.* This publication explains the latest requirements, procedures and principles of rendering techiques designed to enhance a building's appearance and increase its durability and thermal efficiency.

Large area pours for suspended concrete slabs
J. L. Clarke
Ref. C/12. £40.00. 76 pp.

Reports on research into early thermal stresses in large area pours. It covers measurements of early age movements, analysis of early age stresses, structural effects and both laboratory and site trials. *A Reinforced Concrete Council publication.*

Precast concrete frame buildings: Design guide
K. S Elliot and A. K. Tovey
Ref. 47.024. £24.00. 96 pp.

This publication aims to help architects and engineers achieve a full understanding of precast concrete building structures and their procurement. It covers design, procurement, production, and erection on site. It is illustrated with examples of successful projects and includes an example specification. It will be of interest to those less familiar with this form of construction and to all those concerned with the procurement of buildings.



Concrete pavements for highways
Ref. 46.030. £1.50. 4 pp.

The first in a new series on concrete for highways, this publication looks at three options for constructing roads with a concrete surface, and a fourth using a continuously reinforced concrete roadbase with a bituminous surface. Looks at the specification for each option, the minimum slab thickness, reinforcement and construction details.

For BCA *Catalogue* and orders, phone Publication Sales, Fulmer (0753) 660440. American Express/Access/Visa holders may order by phone.

New year move for BCA From 1 January 1993 the new address of the British Cement Association will be:
Telford Avenue, Crowthorne, Berkshire RG11 6YS. Telephone (0344) 762676. Fax (0344) 761214