READ ABOUT

PULASKI SKYWAY: DUCTAL® REHABILITATION OF A LANDMARK STEEL BRIDGE

RODEZ MULTIPLEX: 250 M² CELESTIAL VAULT
INSIGHTS - 3 > 5

Bernard Vaudeville
The engineer’s perspective

MARKETS - 6 > 17

Facades > 6
Innovation: Sprayed Ductal® offers new fabrication solutions

Bridges > 10
The Pulaski Skyway: Ductal® rehabilitation of a landmark steel bridge

Standardisation > 14
UHPC: from experience to standardization

PROJECT - 18 > 21

Multiplex cinema > 18
A weatherproof, ultra-thin Ductal® canopy with embedded LEDs to shelter theatre patrons

NEWS - 22 > 23

PAMM > 22
GBWAY DC & Newsflashes > 23

INSIGHTS

The material is not only paving the way to a new architecture, but also changing our relationship with the very act of construction.

Bernard Vaudeville, École Polytechnique graduate, École nationale des ponts et chaussées graduate in engineering and architect, believes that buildings have become highly complex objects that require the invention of a new form of collaboration between architects, engineers, prototypers, material manufacturers, precast fabricators and construction companies.

Managing Partner of T/E/S/S Consulting Engineers. Engineering graduate of the "École Polytechnique" and "École nationale des ponts et chaussées" (National School of Bridges and Roads). Qualified architect. Chairman of the Civil Engineering and Construction Department of the École nationale des ponts et chaussées-École des Ponts ParisTech.

Bernard has completed many projects with OVE ARUP, RFR and more recently T/E/S/S, including, in France, the Simone de Beauvoir footbridge in Paris, the peninsulas of Terminal 2F and reconstruction of Terminal 2E at Paris-Charles de Gaulle Airport, and, in New Delhi, the glass dome for the Parliament Library Building. In conjunction with RFR, he is managing the project owner teams working on the envelope, roof and roof glazing of the new Fondation Louis Vuitton in Paris.

AFGC (French Civil Engineering Association) Gold Medal winner in 2006.
Think of materials not only from the point of view of structural calculations, but also in terms of their physical and chemical qualities.

At what point does the consideration of materials enter the design process?

Bernard Vaudeville: It’s impossible to isolate the choice of materials from the practice of architecture. So it’s inevitable that this issue arises at a very early stage in the project. But it’s becoming more complex now than it used to be, because the choice of material is no longer restricted solely to the structure. When we talk about ‘the choice of material’, we’re not talking only of concrete, steel or wood. That’s just one question amongst many. What characterizes today’s projects is the extensive multiplicity of materials, because buildings have become highly complex objects. At the same time as the structure, you have to think about thermal insulation and weatherproofing systems, and the need to protect them with cladding and envelopes. Then there is glass curtain walls that require their own structural frameworks and highly sophisticated sealing systems. I’m not even taking into account here the enormous variety of materials that come into play when we start looking at internal layout and technical services. So the issue of materials and their choice is no longer just one simple question. A further layer of complexity is added by the fact that the range of materials available is expanding and changing all the time.

All these reasons have gradually led T/E/S/S and our partners to develop a special competency in this area, with a group of engineers led by Simon Aubry, who think of materials not only from the point of view of structural calculations, but also in terms of their physical and chemical properties. They have amassed substantial experience in developing and validating new applications for materials in construction.

Perhaps one of the most striking examples is a Ductal® envelope for Frank Gehry’s Fondation Louis Vuitton, due to open soon in the Bois de Boulogne in Paris. On this project, we worked in conjunction with RFR as part of a single joint team. This white envelope clads the majority of the building’s closed surfaces. What makes its appearance exceptional is its final finish, which can already be seen from the Jardin d’Acclimatation, and the process of its technical and industrial development. That development was the result of a joint commitment between Lafarge, a very inventive prototyping company called Cogitect, the panel manufacturer Bonnia Sabla, the German company Hofmeister, which was responsible for lifting the panels, and ourselves (RFR and T/E/S/S). Our collaboration began very early at the preliminary planning stage. The opening of this building is sure to be a major event, and one that I hope will provide an opportunity to tell the story of this shared adventure.

What recent material innovations have particularly impressed you?

B.V.: I can think of a number of new materials with structural applications. For example, we’ve been working for a few years now with gridshells fabricated from composite tubes formed at the point of installation. This is an extension of the remarkable structure created in wood by Frei Otto in Mannheim, Germany. The use of a composite material is good, because it provides the opportunity to use very thin, very lightweight profiles. The R&D work involved is carried out in very close cooperation with the Navier Laboratory at the Ecole des Ponts et Chaussées in Marne-la-Vallée, near Paris, France. Most recently, this technique has allowed us to create a temporary structure for the pop-up cathedral in Créteil, France. Generally speaking, cladding and envelopes are a particular focus for our R&D efforts. As mentioned, the issue of envelopes has become crucial not for reasons of decoration or architectural fashion, but mainly because external thermal insulation demands it. The result is that the building flanking walls and facades are then double skinned. UHPCs can respond effectively to these challenges, especially as siding or because they can be used to create panels with integral insulation to seal the building.
External walls, solar gain control, weatherproofing, water/air insulation and support for joints; architects perceive the ability to combine several or all the functions of a building envelope into a single element as one of the major contributions made possible by the use of new materials.

This is even more the case if the material also offers a new architectural freedom through its ability to accommodate complex geometries at the same time as delivering product solutions with flexible implementation, a broad range of colors and flawless finish.

That was the thinking behind the development of Ductal® architectural solutions which, having been validated in numerous double-skin facades, provide a more extensive range of applications and implementation systems such as: weatherproof insulated envelopes, textured panels, perforated panels, lattices, sun-shades, integral balconies, interior and exterior roofing and canopies.

The corner of Pearl and Water Streets in Brooklyn, New York is undergoing a major makeover with the creation of a new residential development called the "DUMBO Townhouses" (Dumbo is an acronym for "Down Under the Manhattan Bridge Overpass"). Nested between the famous Manhattan and Brooklyn Bridges, the historic neighborhood has been transformed in recent decades - from an industrial zone to a bustling, mixed-use area that now thrives with galleries, shops, theatres and lofts. The six-story townhouses, constructed on the former site of an old warehouse, will comprise five luxurious townhouses; each approx. 3,000 sq ft with private parking, rooftop terraces, 20 ft ceilings, fireplaces and skylights.

The townhouses have been designed with energy-efficient building systems, and a high performance building envelope that incorporates a unique, louvered facade panel system made with Ductal®. Each of the large-scale (18 ft long x 11 ft wide) Ductal® panels - now in production by Gate Precast - will contain a series of ribs, and cover a total surface area of 8,650 sq ft. Most of the structural shell to be used for connecting the louvered Ductal® panels is a partially grouted CMU (concrete masonry unit) wall system. The connections will be done via a series of stainless steel rods, post-installed directly to the CMU blocks. To ensure success, this process will involve close coordination by the project team. Designed and created by local developer, Alloy, all of the townhouses sold in 2013. Occupancy is scheduled for 2015.

**Ductal® lattice systems**

**A guide to design**

With dozens of projects completed, from private homes to the Jean Bouin Stadium in France and the Rabat-Sale Airport in Morocco, Ductal® lattice systems have been embraced not only by designers, but also by project owners, who are now convinced by the creativity of these solutions for the building of more beautiful cities around the world. The lightness of Ductal® lattice systems is possible due to a void ratio of up to 70%. The thin panel profiles are achievable with no passive reinforcement, identical textured finishes on both sides, a large color palette, and an environmental impact lower than alternative solutions using other materials... all provide significant benefits for architectural creativity.

As part of our support services for architects and designers, Lafarge has designed and produced a special Lattice Design Guide.

**Examples of proven connection systems**

At the top of the panel, just the out-of-plane loads are taken using a system of double angle brackets.

**What benefits does the new sprayed Ductal® solution offer?**

F.P.: The sprayed concrete technique has a long history of being used to produce complex components (special one-piece shapes) or to repair and/or reinforce existing structures. The technique is used by many precasters and contractors, because it allows them to create lightweight elements without the need for heavy shuttering that can sometimes pose difficulties.

The development of sprayed Ductal® targeted this requirement by focusing particularly on applications that would enable the design of lightweight facades in an enormous range of forms and colors to create architecture consistent with the existing urban fabric.

The central challenge was to achieve the practical implementation flexibility offered by the spraying technique by designing a Ductal® solution whose finish, durability and strength go way beyond those of the kind of concretes traditionally sprayed.

By its very nature, Ductal® is a self-placing concrete that flows very easily into shuttering and molds for optimum filling and high-quality finish and texture.

Our R&D team therefore got to work designing a new range of Ductal® products with flow characteristics suitable for the fabrication processes used by our partners. A Ductal® formulation that is fluid enough to be sprayed, but stays in position on a vertical wall, makes it possible to have the best of both worlds. The real innovation here is the ability to produce a concrete that performs identically to a cast Ductal® formulation, but has flow characteristics that are fully adjustable to fabrication processes.

**How did you test and validate this innovation?**

F.P.: Once we had unlocked the science, we validated the benefits of these formulations on two different scales. We began on a small scale with an industrial production site set up at the LRC with a spray chamber, pumping system and spray system identical to those used by our customers.

We then worked in conjunction with an external partner - Bestinor - to refine the requirements and arrive at a full-scale prototype.

**MARKETS**

**Innovation**

**Sprayed Ductal® offers new fabrication solutions**

Interview with Fabien Perez, Ductal® Research Program Head at the Lafarge Research Center (LRC)

As part of constantly developing the options for fabricating elements in Ductal®, Lafarge has perfected a new formulation with flow characteristics that allow it to be applied as a spray without compromising any of the technical performances or aesthetic qualities of the cast solutions. It is the story of a long-awaited innovation.
Bridges

The Pulaski Skyway

Ductal® rehabilitation of a landmark steel bridge

A structure that symbolizes US bridge engineering of the 1930s, the Pulaski Skyway, which links Newark to Jersey City has been partially closed as it undergoes a massive rehabilitation project - the largest in its history.

The project was a perfect opportunity for the Federal Highway Administration (FHWA) and the New Jersey Department of Transportation (NJDoT) to take full advantage of the technical benefits offered by Ductal® joint fill.

Infrastructure rehabilitation is a major political issue in the USA, where estimates suggest that more than 70,000 bridges are now structurally obsolete. This priority was anticipated by the FHWA, which has carried out tests for many years to identify the most permanent, highly durable and flexible solutions for use in rehabilitation projects whose urgency reflects the need to maintain mobility and traffic flow on a continuous basis.

With support and assistance from Ductal®, engineers, combined with the ability of the Lafarge Group to drive innovation, the FHWA has proven through testing the capabilities of Ductal® joint fill as an effective solution.

“We have been working for more than 10 years on the development and implementation of this solution,” explains Dominique Corvez, Head of Ductal® for North America.

“We conducted a significant number of trials, in partnership with the FHWA in the Lafarge and FHWA research centers, as well as on pilot project sites, in order to validate a solution that is now in place on about 100 North American bridges, including 30 which were completed in 2013 alone.

Thanks to the ongoing validation from the FHWA, many states (see map on page 13) have adopted this solution and their Departments of Transportation have contacted us with a goal to collaborate on projects built around this technology.”

The Pulaski Skyway is a bridge that many will recognize instantly - as a signature backdrop to the popular television series, “The Sopranos”. Named after General Casimir Pulaski, a War of Independence hero and “Father of the American Cavalry”, this four-lane highway bridge is one of the major links between Jersey City and Newark, New Jersey.

More than 40 meters above the Passaic River, which it crosses with two main spans of 170 meters, the steel structure soars above the industrial suburbs of Jersey City for more than 5.5 kilometers.

Since work began in early April, the duration of this project has been a major concern to the 74,000 motorists who use it every day.

“The Pulaski Skyway needs extensive restructuring work involving total replacement of the deck with precast concrete panels,” adds Dominique Corvez. “Specifying Ductal® joint fill provides the opportunity to adopt a solution whose strength and weather resistance has been validated by more than 2 million wheel load test cycles (fatigue testing). Stronger than the panels it connects, the Ductal® joints will transform what is typically a point of weakness into a point of superior strength. This fact has persuaded the contractor responsible for the Pulaski Skyway rehabilitation works to extend the use of the solution, originally specified for just the joint fill connections between the slabs and the shear packets, to the connections between the deck and haunches. For these applications, Ductal® is more cost-effective than the methyl methacrylate solution originally planned.”

The solution is more economical, because it is easy to apply on-site and its estimated working life is measured in centuries.

Lafarge provides the project owner and contractor not only with the raw materials (premix, fibers and additives), but also technical support; experts who have specialized quality assurance training. “In addition to offering a range of special mixers, our commitment to quality and safety also means that our on-site experts apply strict controls to every mix, with temperature, fluidity, and other tests. This close supervision is particularly appreciated by US departments of transportation, which now demand it for every operation shown in the specification,” continues Dominique Corvez.
Ductal®
Solutions tailored to local markets
Interview with Maik Strecker, marketing director for Lafarge USA

In the United States, the interest in and demand for the Ductal® range is leading to new prospects and increasing, specific demands in architecture and engineering projects. So how can a team of Ductal® experts offer solutions tailored to local markets? Maik Strecker reflects on the fundamentals behind the driving force of the Group.

How are the US teams structured to offer Ductal® solutions?

Maik Strecker: We pay very close attention to the sharing of technical expertise and skills between all of our teams, whether they are working with more traditional materials or with our latest R&D developments. Added to that the combination of our local market knowledge and unique technical expertise in UHPCs means that we can deliver high added-value solutions to the US market. I believe that this synergy of abilities is a powerful differentiating factor for an organization as close to its markets as we are.

Lafarge also delivers a guaranteed synergy of resources. So when our partners specify Ductal® for joint fill applications, for example, they know that they will simultaneously benefit from the experience of Ductal® experts and the support of our local company to provide on-site technical assistance.

Ductal® experts have also trained technical and sales managers in the US, so that they can now offer UHPC technical services and solutions as part of every new project. These specialists form the central core of a much wider team with the ability to deliver expertise to local markets.

The Pulaski Skyway project is a good illustration of this approach in action, and demonstrates that on a project of this considerable size, the full power of the Group can be leveraged to deliver Ductal® solutions by offering services that go well beyond simply delivering products, to include the provision of solutions-based support.

Together with Dominique Corvez, Head of Ductal® for North America, we support partner-product discovery with new solutions and new marketplace offerings developed out of our commitment to continuous innovation and constant adaptation. The bottom line is that we are not simply a supplier of products, but also of services.

Another key element to bear in mind is that many of our advances have been achieved by designing solutions that are developed jointly with the full range of stakeholders, from partners to internal experts, operations teams and management teams.

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“Combining technical expertise with local market knowledge.

**Combining technical expertise with local market knowledge:**

We are also very focused on demonstrating that the Ductal® team of experts, who are in great demand, receive the support they need from all Lafarge teams in order to respond effectively to the challenges posed not only by this unique project, but also by the other 40 bridge rehabilitation contracts awarded this year. In anticipation of the increased demand, a select group of technicians from other Lafarge units were trained during the winter, so that they can provide on-site assistance this summer.

This project is the largest Ductal® joint fill project to date and proves that this solution has succeeded in convincing America’s bridge and road engineers - some of the most cautious in the world - of its strengths and benefits.

“By capitalizing on the many joint fill bridge projects already successfully completed (in which the FHWA has received very positive feedback), this project will deliver a new level of proof; that the technique can be duplicated for use in all types of structures, including those requiring extensive reconstruction, like the Pulaski Skyway and a former project in Syracuse, New York, where the work was completed in just 48 hours, thanks to the Ductal® solution. In Europe Ductal® joint fill will be used on the Hammersmith flyover project, a 50-year old arterial road bridge also undergoing rehabilitation. Used by 90,000 vehicles per day, the four-lane structure links the west part of London to the core.

**TOTAL SUPPORT**

- **5.5 km long**
- **40 m high**
- **74,000 vehicles per day**
- **2 years of work**

The 5.5 km long Pulaski Skyway is a major link between Jersey City and Newark.

**MARKETS**
Integrating the experience gained from many completed projects in France, the new edition of recommendations published by the French Civil Engineering Association (AFGC) on ultra-high performance concretes sets the new benchmark.

“The experience gained over more than 15 years of using these materials, the increasing body of reference standards (especially the introduction of Eurocodes) and the volume of research results for UHPCs internationally have enabled the AFGC working group on UHPCs to revise its provisional recommendations,” emphasizes François Toutlemonde, Scientific Representative at the French Institute of Science and Technology for Transportation, Development and Networks (IFSTTAR).

This new edition confirms the increasing importance of UHPCs on all continents and in all fields of construction, from infrastructures and architectural structures to public buildings, and from new build to renovation.

In 2009, the experience of using UHPCs highlighted two main types of use in construction,” continues François Toutlemonde. “Slim prestressed or high-compression structural elements (beams, pillars, decks or shells) and strong, lightweight elements, like facade components.”

The areas identified as promising for these uses were bridges and walkways, exceptional buildings and high added-value applications. Today, bridges and walkways are still high-profile demonstrators for the structural efficiency of UHPCs but, particularly in France, UHPC producers are seeing increasing demand for facade components from architects seeking to exploit the architectural flexibility and structural effectiveness of UHPC solutions.

For more than 15 years, UHPCs have been paving the way for new concepts and innovative construction methods that have led to the creation of many sustainable, efficient and beautiful infrastructures and buildings. The positive feedback provides ample justification for today’s global infatuation with these materials.

It is against the background of this growth potential that the second international "Designing and Building with UHPCs" symposium, held last October at the MuCEM in Marseilles looked at the latest developments in the new challenge that UHPCs are now posing: the need for a shared and recognized standardization framework, not only for the technical evaluation of these materials, but also for their implementation procedures and structural calculation methods.

From experience to standardization

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From experience to standardization

The level of innovation and degree of associated complexity vary significantly from one project to another," confirms Sébastien Bernardi, Ductal® Technical Director. "That, in turn, requires appropriate design and inspection procedures. This is the reason why France has used all the available feedback to embark on a standardization process that aims to set performance criteria for UHPCs, their implementation and their structural calculation methods (see diagram on page 17).

"A number of other countries around the world - including the USA, China and Switzerland - have also started work on similar standardization processes, some of which take a rather different approach to that adopted here in France," explains Sébastien Bernardi. "We want to maintain regular meetings so that we're in a position to publish the materials and design standards in 2015. France will then be in a position to publish the materials and design standards."

The use of premix provides performance guarantees for UHPCs, because of the strict quality controls applied to both raw materials and their mixing. This measure of performance will be highlighted.

Several of the most important properties associated with the specification of UHPCs will form the basis of a definition of categories.

"Compared with the NF EN 206-1 standard, UHPCs require a performance-based approach with specific paragraphs to describe the requirements and associated compliance inspections in order to guarantee that the material has the specified structural properties," continues Sébastien Bernardi.

The key challenge involved in standardizing UHPCs is promoting French expertise in this area with the ultimate aim of establishing it as the international benchmark.

"The term 'performance-based' does not refer to the same properties in UHPCs as it does in other concrete. For UHPCs, it refers to the strength of the fibers because that is what governs the way in which the fibers are oriented, and therefore the strength of the resulting component. So in this sense, the performance-based approach to UHPCs does not apply to engineering concretes. Also, the technical rules are AFGC recommendations and not officially recognized in France. They cannot therefore be imposed authentically as an international benchmark. French standardization is the best solution for transcoding the French AFGC technical rules into a French reference standard recognized and accepted by all French civil engineers and the French government, thereby providing them with a solid basis on which to promote the standard internationally. Ultimately, it is also aboutfacilitating their incorporation into future international standards."

"What challenges are posed by the standardization of UHPCs?"

Thierry Kretz: The key challenge involved in standardizing UHPCs is promoting French expertise in this area with the ultimate aim of establishing it as the international benchmark. France is a leader in the use of UHPCs and extending that leadership requires the publication of an underlying technical reference standard, which can then be used as a benchmark by other countries. The current technical rules are AFGC recommendations and not officially recognized in France. They cannot therefore be imposed authentically as an international benchmark.

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Do you think that the performance-based approach used for UHPCs is the way forward for engineering concretes?

T.K.: UHPCs are very special materials, and the design-stage justification of UHPC structures is inseparable from the manufacturing process, because that is what governs the way in which the fibers are oriented, and therefore the strength of the resulting component. So in this sense, the performance-based approach to UHPCs does not apply to engineering concretes. Also, the term ‘performance-based’ does not refer to the same properties in UHPCs as it does in other concrete. For UHPCs, it refers to the strength of the structure on the basis of the manufacturing process. But for other concretes, it refers to durability. On the other hand, I do think that the performance-based approach described in the new document number 65 on the construction of civil engineering structures in reinforced or prestressed concrete does provide a way forward for expanding the scope of engineering concretes as defined in the national annex to the NF EN 206-1 standard.
The new multiplex cinema in the French town of Rodez fronts onto a public square that is also home to the Community Hall and the future "Musée Soulages" museum. The architectural dialog between these civic amenities creates the day and night-time focal point typical of communities in the south of France.

It is in this environment that the spectacular 9.5 m, 250 m² cantilevered canopy designed by Atelier d'architecture Emmanuel Nebout puts the finishing touch to the restructured urban space by providing shelter for theatre patrons and a meeting place for pedestrians in the square. Created using Ductal®, the canopy is only 4 cm thick and is studded with LEDs to create a new kind of starry night sky for Rodez residents. A poetic marriage of design and function.
UHPCs are a major innovation in mechanical engineering: one of those that profoundly changes capabilities and opens up completely "new ways of working."

Emmanuel Nebout - Architect

"A record cantilever, a floating shelter of exceptionally blade-like thinness, a suspended panel": in the words of those who experience it, the canopy designed by Atelier d’architecture Emmanuel Nebout summarizes the performance delivered by Ductal® and the creativity it enables.

"This meeting place is a gift to the town to its people," explains its designer Emmanuel Nebout. "A roof for everyone that celebrates the cinema's entrance, and creates an architectural event that encourages interaction between the old town and the new.

Our aim was to provide a generous amount of shelter for more than 300 people without interruption at ground level and which would not compromise the view of the cathedral.

Having conceived this giant protective panel with no supporting component, the technical challenge was to extend it for the maximum distance using the minimum of material. We then had to decide which material had the mechanical qualities needed to achieve the very thin profile we wanted over such a span without any visible connection between columns and panels.

We considered many technical solutions, but only UHPC had the mechanical performance to deliver such an elegant result, at the same time as providing the weatherproof properties of a canopy for use in a region where the winter snow can be as aggressive as the summer sun.

Especially since we also wanted to stud the smooth, dark underside of the canopy with LEDs that would create a starry sky at night and make the canopy itself effectively disappear.

UHPCs are an impressive outcome from all the concrete-related R&D conducted over the last 20 years. They represent the kind of breakthrough development that makes it possible to work in completely new ways on projects of very different scales. Such things occur so rarely that it makes the design process a thousand times more enjoyable."

With its 250 m² cantilevered overhang, the Rodez Multiplex canopy seems to float above the piazza. "An additional challenge in a region where the weight of snow and very high winds are size-governing factors," explains Romain Ricciotti, Director of Lamoureux & Ricciotti Ingénierie consulting engineers. This giant leaf of concrete is supported by two structural elements (a rear element taking the uplift tension, and a second further forward acting in compression) secured by a system of bolts to the metal structure of the building. It is created from 12 components: 10 central elements (1.31 x 14.31 m) with a half-rib on each flank, and 2 end-cap elements (2.11 x 14.31) with one central rib and one flanking half-rib.

"The two end-caps were designed by the architect with a lateral overhang of 80 cm to avoid the 63 cm-high ribs being visible from the gable end," adds Romain Ricciotti. "The fact that UHPC is inherently fully weatherproof at minimal thickness meant that we needed no other weatherproofing component, which also helped us to keep the lightness of touch intrinsic to the original design."

The LED-studded underside of the canopy attracts the gaze of visitors. To incorporate this lighting system, blockout holes were cast into the structure by the precast contractor Bonna-Sabla, which casted the elements with ribs uppermost to ensure an excellent finish on the underside. The reinforced ribs were fabricated with passive metal reinforcement. The protruding reinforcements were then picked up by Ductal® in the slab casting process. Sound anchoring between the ribs and the panel, combined with the uniform texture and color of the Ductal® material, guarantee perfect unity between all the elements to create a seamless appearance.

* Source: Le Moniteur issue 5719 07/05/2013
In Washington DC, the roof of the new G8WAY DC open-air, multi-use facility was designed with Ductal®. The pavilion is both a canopy and rooftop terrace; a place where visitors can relax and enjoy views of the US capital. This 16,000 ft² open-air venue is intended for a farmers’ market and community events. With a sculpture-like quality, the roof (400 ft long x 25 ft high x 60 ft wide at its broadest point) is just 1¾ inch thick, and supports the large, landscaped seating area above. According to project architect, Cody McNeil, Ductal® was an obvious choice thanks to its “exceptional strength and precision aesthetics.”

FRANCE, MONTPELLIER, PONT DE LA RÉPUBLIQUE
A CONCRETE BLADE SUPPORTED BY NEEDLES
The Pont de la République opened to cyclists and pedestrians on March 18th in Montpellier, France. Designed by the architect Rudy Ricciotti and Lamoureux & Ricciotti Ingénierie consulting engineers, the bridge is 74 m long and 17 m large and is entirely made of UHPC. The deck is supported by two rows of 17 Y-shaped piers made of Ductal®. A challenging project characterized by its immaculate elegance.

FRANCE, PARIS, JEAN BOUIN STADIUM
ENVIRONMENTAL INTELLIGENCE
Lamoureux & Ricciotti Ingénierie consulting engineers carried out a comparative environmental assessment of three solutions for the envelope of the Jean Bouin Stadium, France. The assessment reported that the primary energy necessary for the implementation of Ductal® is 3 times less than steel cladding and 5 times less than a glass roof. Water consumption and CO₂ emissions are between 1.5 and 2 times less when using Ductal®. When taking into account the lifecycle of the building, the results can be multiplied by 2 or even 3.

SWITZERLAND, MONTREUX, CHILLON VIADUCTS
REINFORCEMENT OF THE CARRIAGEWAY PANELS
Opened to traffic since 1969, Chillon Viaducts is one of the most impressive motorways in Switzerland. It links the Rhône plain with Vevey and is used by 50,000 vehicles a day. The carriageway panels, measuring a total of 2.2 km long and 24 m wide, of the two Viaducts now need to be reinforced with the casting of a 4 cm thick Ductal® layer. The reinforcement works will start in June 2014.

PÉREZ ART MUSEUM MIAMI
Hurricane-proof Ductal®
“Concrete as a structure and a finish,” summarizes Christine Binswanger, Partner at Herzog & de Meuron, talking about the Pérez Art Museum Miami (PAMM). The spectacular location of the building and the climatic demands placed on it by intense heat, violent storms, onshore winds and sea air have uniquely conditioned this project. The challenge here was to open up all the internal spaces to the lush vegetation of the surrounding park and Biscayne Bay, at the same time as protecting its exhibits and visitors from the heat and onshore winds. The museum floor is supported on piles that become the columns supporting an enormous shade-creating canopy. “The use of concrete and the extensive canopy are part of an overall strategy to keep the heat outside the building,” explains Christine Binswanger. Ductal® was used for the 100 or so long-span vertical mullions - up to 4.80 meters in length - that separate the curtain wall glazing elements.

The architects at Herzog & de Meuron chose Ductal® to ensure that the mullions blend with the structural elements to create a soft contrast with the surrounding vegetation.

"Concrete as a structure and a finish"
Christine Binswanger,
Partner at Herzog & de Meuron

In Washington DC, the rooftop of the new G8WAY DC open-air, multi-use facility was designed with Ductal®. The pavilion is both a canopy and rooftop terrace; a place where visitors can relax and enjoy views of the US capital. This 16,000 ft² open-air venue is intended for a farmers’ market and community events. With a sculpture-like quality, the roof (400 ft long x 25 ft high x 60 ft wide at its broadest point) is just 1¾ inch thick, and supports the large, landscaped seating area above. According to project architect, Cody McNeal, Ductal® was an obvious choice thanks to its "exceptional strength and precision aesthetics."
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