SIKA AT WORK
Stavros Niarchos Foundation Cultural Center

Sika® SOLUTIONS FROM THE FOUNDATION TO THE ROOF

BUILDING TRUST

STAVROS NIARCHOS FOUNDATION CULTURAL CENTER

GENERAL

The Stavros Niarchos Foundation [(SNF) (www.SNF.org)] is one of the world's leading private, international philanthropic organizations, making grants in the areas of arts and culture, education, health and sports, and social welfare.

The Foundation's largest single gift is the Stavros Niarchos Foundation Cultural Center (SNFCC), in Athens. The project's total cost was $740 million (€630 million). The SNFCC is designed by the renowned architectural firm Renzo Piano Building Workshop, and includes the new facilities of the National Library of Greece, and Greek National Opera, as well as the Stavros Niarchos Park, with a total area of 210,000m^2.

On February 2017, following the handover, the SNF announced its commitment to continue supporting the SNFCC for the next five years, through grants totaling up to $53 million (€50 million). The grants support the implementation of public programming and help cover part of SNFCC's operational costs.

PROJECT DESCRIPTION

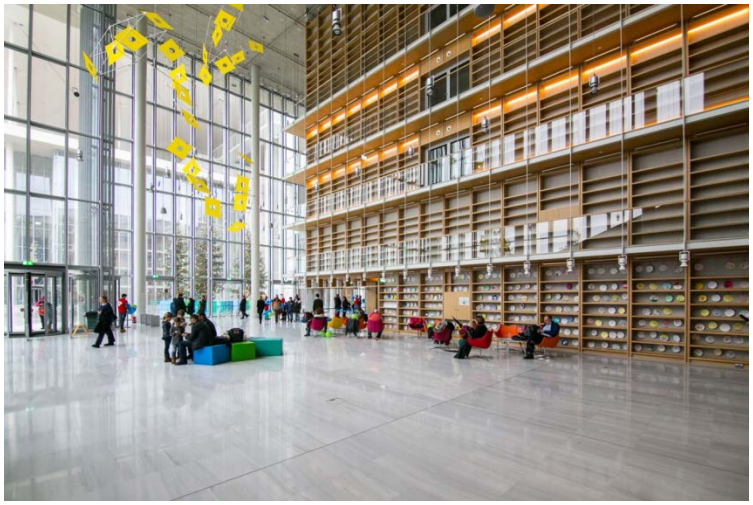
In 2006, the Stavros Niarchos Foundation (www.SNF.org) announced its plans to fund the development of the Stavros Niarchos Foundation Cultural Center (SNFCC), a project that includes the construction and complete outfitting of new facilities for the National Library of Greece (NLG) and the Greek National Opera (GNO), as well as the creation of the 210,000 m² Stavros Niarchos Park. In February 2008, after a closed international architectural competition, the Stavros Niarchos Foundation's Board of Directors announced its unanimous decision, to choose the Renzo Piano Building Workshop (www.rpbw.com) as the architectural design office.

The project site is located 4.5 km south of the center of Athens, on the edge of Faliro Bay, and the SNFCC is designed as a multifunctional arts, education and entertainment complex. The project's total budget of $740million (€630million) includes two grants of $6mil (€5mil) each to the National Library of Greece and the Greek National Opera respectively, aiming to support the organizations' transition to their new facilities. The SNFCC is the first private-public partnership of its type in Greece, and one of the most important civic (cultural/educational) projects ever undertaken in the country.

National Library of Greece

The new building for the National Library of Greece (NLG) (www.NLG.gr) will modernize an institution founded in 1832, allowing it to strengthen its research role while expanding, at the same time, its focus from an exclusive research facility to an all-inclusive public resource. In its new and enlarged role, the Library will support patrons of all ages and education—from academic researchers to children and young adults destined to become the next generation of users. The nearly 24,000 m² (235,000 sq. ft.) state-of-the-art building combines traditional with technological innovation, conservation with information and communication. The flexibility of its design, informed by consultations with the prominent British Library (www.bl.uk), ensures that the National Library can respond effectively to ever-changing needs and the challenges of the digital age. A nationwide digitization project will help make heritage materials available to the public and will offer access to the Library's various collections. Connectivity with other libraries both nationally and globally will allow the Library's users access to material abroad that is relevant to Greece or Hellenism. In addition, a Business Center will provide the public with an active hub for enterprise, knowledge, and innovation, offering computer workstations, laptops, and wireless connectivity.

PHOTOGRAPHS: Cover, panoramic of canal: Credits/SNFCC/Yiorgis Yerolymbos



A modern academic research facility found within the National Library will be an exemplar for other institutions. The new building will enable all existing research collections, currently located in three separate buildings, to be housed in a centralized location, with optimized access to collections for researchers and scholars.

Holdings include over 4,500 manuscript codices from the 9th to the 19th century and a rich variety of important historical documents and archives. Modernized climate control and preservation and digitization facilities will ensure that the Library's significant rare manuscript collection is available for future generations of scholars. The National Library of Greece will also have the capacity to function as a venue for exhibitions of its holdings. Selections of the National Library's manuscripts could be exhibited on a rotational basis, affording the public the opportunity to view Greece's treasures and cultural heritage.

Greek National Opera

In its new home, the Greek National Opera (GNO) (www.nationalopera.gr) will become an exciting destination for music lovers and architecture cognoscenti alike. The building will be a multi-use venue capable of hosting a variety of performances and events. The new 28,000 m^2 (301,000 sq. ft.) auditorium is an architectural jewel, designed to enhance the opera experience for patrons and artists alike. Its world-class acoustics, mechanical capabilities, flexible staging, and innate beauty will position it for immediate entry into the world opera circuit, ready to play host to the most technically demanding operas, international multimedia art productions, and formidable solo vocalists. The auditorium is in par with the best European opera houses, and its multiple stages configuration allows for efficient scene changes and the staging of complicated productions. The comfort of the 1,400-seat main auditorium will be equaled in the backstage dressing rooms and rehearsal spaces, and the technical capabilities will extend to the scenic design and costume shops.

Stavros Niarchos Park

Linked by an ecological concept, physical topography and functionality to the National Library of Greece and the Greek National Opera, the Stavros Niarchos Park is a vital green space, a breath of life for Athens and an important addition to a city with the lowest per capita green space in Europe. A respite from urban concrete, the Park provides opportunities for learning, recreation, rest, and new experiences.

Greece's strong horticultural tradition is celebrated in the open, sunlit Mediterranean Garden. The plant palette alone makes the garden a destination: evergreen and other endemic plants such as boxwood, coronilla, cistus, and lentisc, salvia, oregano, thyme, lavender, rosemary, roses and euphorbias – all add to the sensual pleasure of a visit. Each month brings a new color, and each season introduces a different combination of flowers or foliage.

The spectacular features of the Stavros Niarchos Park are not all earthbound. Soaring 14 m above the summit there is a 100m x 100m photovoltaic canopy. An engineering and construction wonder, supported by 40 sinewy metal pillars, the canopy makes a fascinating addition to the city skyline.

At ground level, a tree-lined pedestrian Esplanade runs parallel to the glass façade of the structure. Alongside is the Canal, a figurative extension of the adjacent sea. The Esplanade readily accommodates people with special needs, and is suitable by day for running, biking, and other activities. Directly across the Agora and on the other side of the canal, wide marble steps offer a space for impromptu performances.

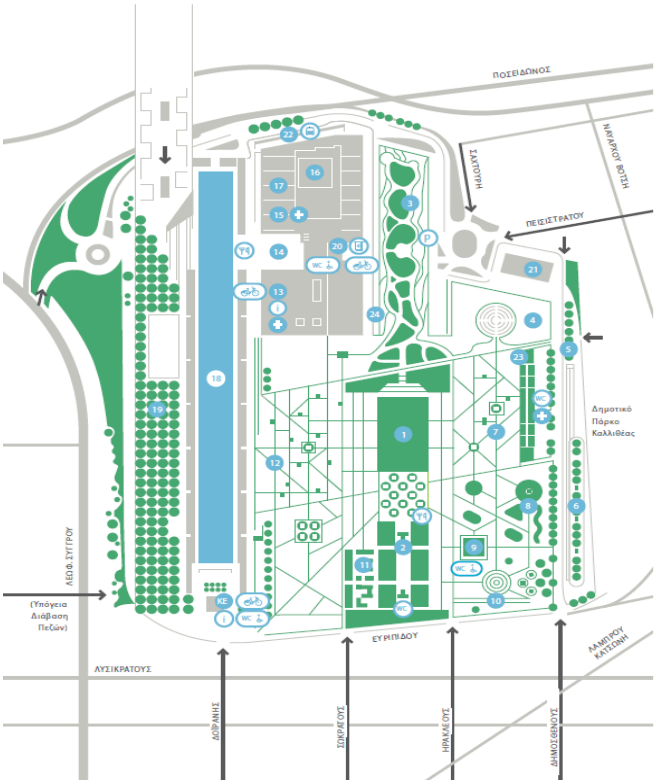
PHOTOGRAPHS:

- Panoramic of SN park: Credits/SNFCC/Yiorgis Yerolymbos
- Library, Opera: Credits/SNFCC/Nikos Karanikolas
- Sailing in canal: Credits /SNFCC/Leonidas Kalpaxides

Source of information material: www.snfcc.org

SUSTAINABILITY

Environmental sustainability was one of the core values of the Stavros Niarchos Foundation for Culture. The creation of an environmentally friendly and sustainable infrastructure for buildings and the Park was an important goal of the design and construction of SNFCF. SNFCC has won the LEED Platinum Certification as a Green Building, the highest existing distinction for environmental and sustainable buildings. The system certifies that a building is designed and built on the principles of sustainable construction methods, using environmentally innovative practices, aiming at saving energy, rational water use, reduction of CO_2 emissions, improvement of the indoor environment, rationalizing the resource management and addressing their impacts. LEED Platinum is the first distinction for such a scale cultural building in Greece and Europe.



The system provides certification that a building has been designed and built using strategies to improve energy efficiency and water efficiency, reduce CO_2 emissions, and improve the quality of the indoor environment, resources and addressing their impacts. SNFCC is the first public building in Greece and one of the few buildings of the same scale and complexity worldwide that received the LEED Platinum certification.

This was achieved through planning and actions on three levels:

- During the design and construction of SNFCC, strict environmental standards have been followed according to the demands of the LEEE specification.
- Negative environmental impacts have been minimized through preventive and protective measures, recycling of 95% of building waste and supply of local low emission materials.
- Pollution and disturbances in the area were limited by specific control procedures.

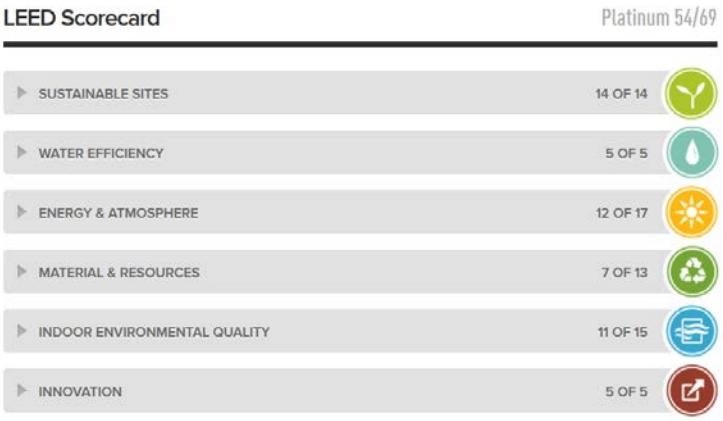
The sustainability of SNFCC is also ensured during its operation period:

- Energy efficiency initiatives contribute to annual energy savings of 7.4GWh, equivalent to ~ 2,750 tons of CO_2 and savings ~ €0.6 million annually.
- Water management initiatives cover irrigation needs of the Park with non-drinking water and minimize water consumption.

The Stavros Niarchos Park has already improved the local ecosystem & biodiversity:

- 1,450 trees & 280,000 bushes create a sustainable ecosystem with visual effect on fauna.
- "Green" roofs occupy an area of 17,000 m^2 of the Park's surface.

There are four levels of certification: **Platinum** certification is the highest distinction received which the SNFCC achieved in November 2016 with a score of 54/69.



CONSTRUCTION PHASE / PROJECT REQUIREMENTS / SIKA'S PARTICIPATION & CONTRIBUTION

A project of this magnitude has set high requirements from the beginning of its construction and has imposed the maximum possible coordination of designer, main contractor, subcontractors and suppliers of materials and systems. Depending on the phase and the construction element, there were different needs that had to be met, and in many cases, before carrying out on site work, it was imperative to perform laboratory tests and then tests on a pilot scale.

Sika helped in every phase of the project, both by carefully studying and proposing the appropriate materials and systems based on the specifications, as well as via practical presence and technical support that provided on site.

For this grand project Sika Hellas provided materials and systems literally from foundation to the roof, which not only met the project's requirements in terms of technical specifications but also in terms of sustainability and environmental impact requirements as any product or system applied in the project, should meet the specification characteristics as well as emissions of VOCs based on methods described in the LEED assessment and be accredited accordingly (LEED Attestation).

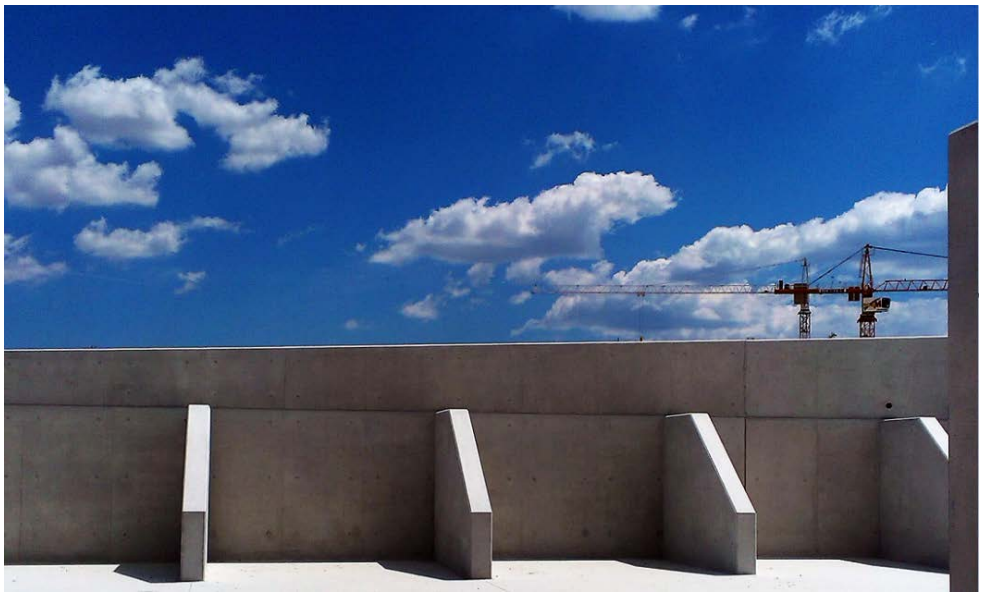
From all phases of the project, we can mention the following as prominent, which outweigh Sika's contribution to the implementation phase of the project:

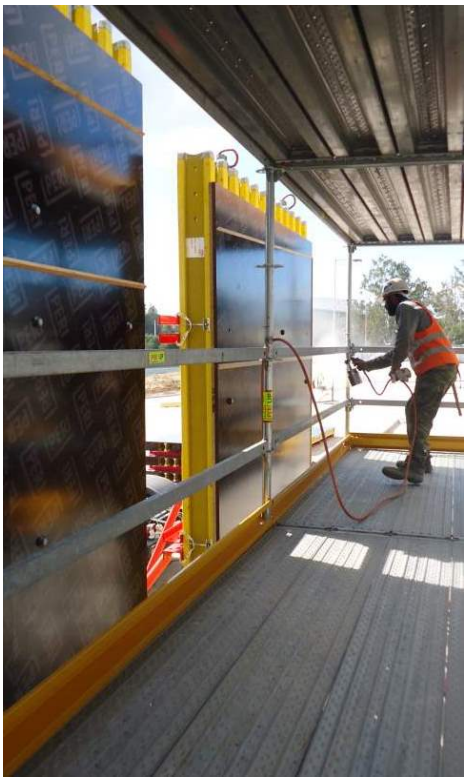
Visitor Center: The Visitor Center was a temporary light construction on the eastern boundary of the SNFCC site on the Esplanada deck that operated throughout the construction phase of the project and until the completion of the SNFCC. Through the Visitor's Center, the public had the opportunity to visit the site and to be informed about the technical details of the construction of the project, as well as the mission and vision of the SNFCC. On the floor of the Visitor Center, the high performance, polyurethane, uniform colour, broadcasted, with UV resistant coating **Sikafloor®-MultiFlex PB-21 UV** was applied. The waterproofing of the Center's roof was performed using the synthetic, reinforced, PVC membrane **Sikaplan® G-15**.

The finally adopted concrete mix design for the fair-faced concrete was SCC produced using **Sika® ViscoCrete® Ultra-600** superplasticizer in combination with **Sika® Stabilizer®-4R** viscosity modifier for the thinner elements.

Sika admixtures were incorporated in all mixes, from the least to the most demanding concrete classes. On the mould surfaces, the high performance **Sika® Separol® W-320** demoulding agent was used, while during curing the special liquid membranes for control of water evaporation and proper curing **Sika® Antisol®** were applied.

Concrete production: For the construction of the project, ~149,000 m^3 of 10 different concrete classes and technical characteristics were required. The requirements of all mixes had to be met, but naturally, the architectural (fair-faced) concrete had to meet additionally high aesthetics of the final surface. The surface of the fair-faced concrete had to be smooth, without pores and voids and of uniform colour. Fair-faced concrete was also used for the Library and Opera buildings. In order to evaluate the various concrete mixes, as well as the influence factors such as concreting, curing and demoulding, full scale mock-ups were constructed.





Construction of Opera & Café Canopy using the Ferrocement method:

The Opera building is covered by a 100m x 100m dimension canopy. This is the most important element of the project, both architecturally and statically.

The architect has envisioned it as a cloud hovering over the building, remaining at the same time independent of it and separate. Therefore, the canopy had to be light but compact, providing a perfectly smooth and continuous surface. The basic material selected for the canopy was ferrocement. Ferrocement is a thin, composite material that can be easily molded for lightweight constructions. It consists of a high flow cement mortar and laminate layers of fine metallic meshes. Having previously been used in shipbuilding, this is the first time worldwide that it is used for a building work of this scale, and in particular for a bearing construction! The SNFCC canopy consists of two ferrocement surfaces – the bottom and top- connected to each other with non-visible metallic elements externally. The canopy's maximum thickness in the center is 4.5m and ends to a thinner section of 30cm on the perimeter including the rain water drainage channel. The whole construction is based on a system of metal poles that rest on the Opera building's concrete bearing structure. During the whole construction phase, the composition of the mortar itself plays a huge role.

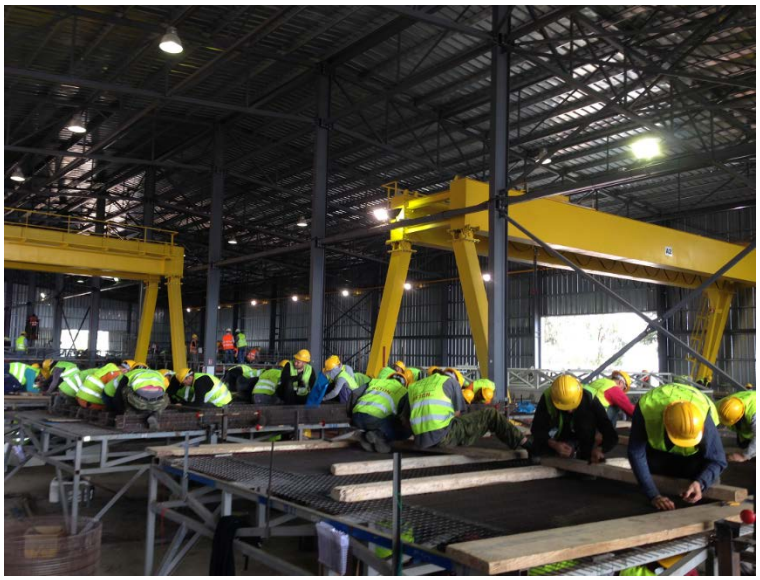
Prior to the full scale construction of the canopy, a mockup of 5mx5m had to be constructed and presented. The success of this mockup actually was a prerequisite for the approval of the main contractor during the tender phase.

For its completion, 530 man-hours of Sika Hellas' engineers and technicians were required, along with 341 on-site man-hours of Sika Hellas' engineers.

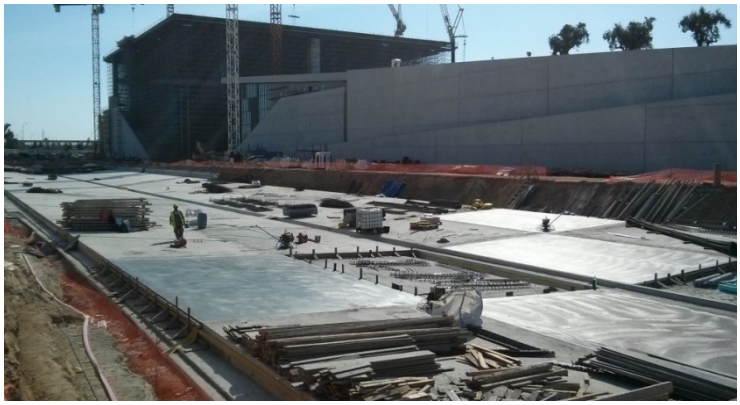
The mortar was injected into the mould, aiming to full penetration across the whole mesh surface. The superfluid Ferrocement mortar had 100Mpa compression strength and its composition consisted of:

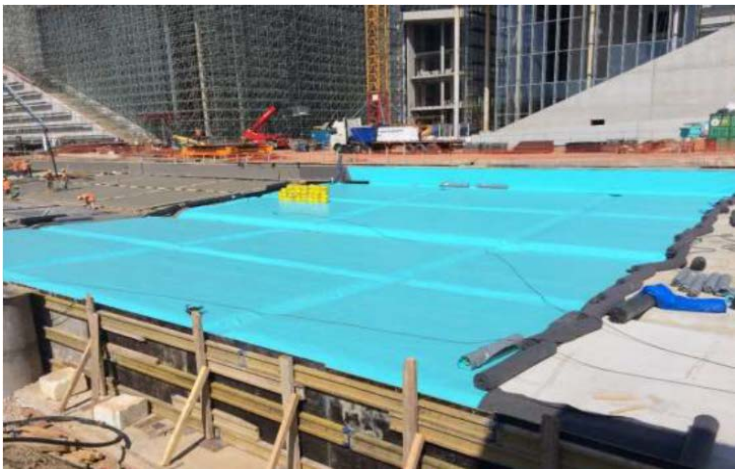
- I52,5 cement type
- quartz sand
- silica fume **SikaFume® HR-E**
- high range water reducer/superplasticizer **Sika® ViscoCrete® Ferro-1000**, which was specially developed (tailor made) from Sika Hellas' Concrete Laboratory for the project.

For the specific construction, 4 layers of metal mesh 8-15mm were formed. Altogether, 760 pieces of 21m^2 and 3-5cm thickness were produced. The canopy's total area was 10.000m^2.



Underground waterproofing: In a project of this magnitude, the waterproofing of underground and water retaining structures is of utmost importance. The underground waterproofing system had to be impermeable, without any visible expansion joints. For the concrete used in the underground elements, the Sika Watertight Concrete System was used, which comprises of waterproof concrete prepared using the special water resisting admixture **Sika® 1+**, in combination with **Sika® Waterbars** waterstops and the water swellable profiles **SikaSwell®-A**. In addition, the single system PVC membrane **Sikaplan® WP-1100 15HL** was used in a part of the basement, combined with **S-Felt A 300 F** geotextile and drainage membrane **Sika® Drain-S**.



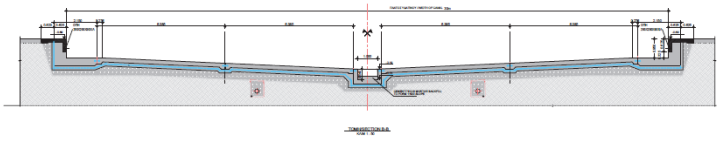


At the diaphragm walls below the Opera building, the special **SikaFuko® VT-1** injection hoses were installed.

Roof deck waterproofing: The roof waterproofing of all building structures had to meet high demands based on the specifications.

Car park, National Library, Opera, Light House, Buffer Zone roof deck waterproofing: In all roofs, the multi-layer, anti-root, synthetic roof waterproofing sheet based on premium-quality flexible polyolefins (FPO), containing stabilizers, with inlay of glass non-woven according to EN 13956 **Sarnafil® TG 66-20** (2mm thickness) was applied.

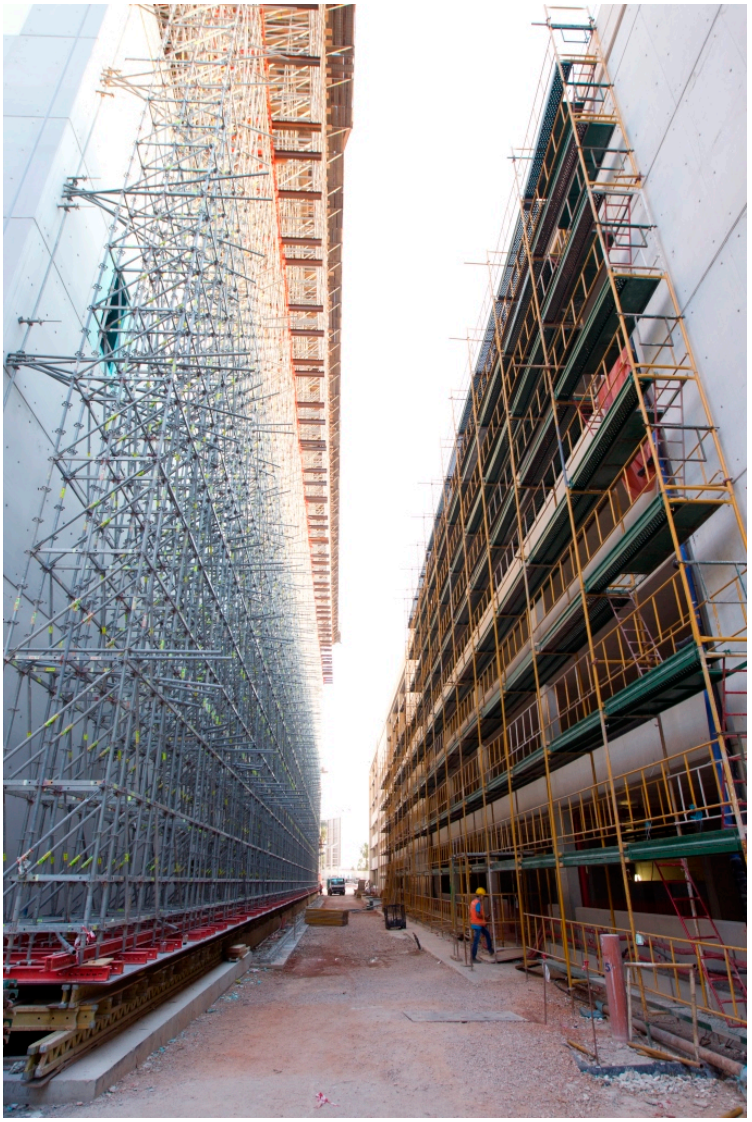
Canal waterproofing: The beautiful water body (CANAL) runs parallel to the Esplanada and contains ~15,000m^3 of brackish water. Its absolute watertightness was non-negotiable. Its waterproofing process was completed using the PVC based, reinforced with woven fabric membrane **Sikaplan® WP-3100-15R** at 1.5mm thickness, in combination with geotextiles **S-Felt A 300 F** & **S-Felt GK-400** and **Sika® Waterbar O-25 L** waterstop onto which the concreting was performed. **Sikaplan® WP-3100-15R** has high resistance against ageing and is UV stabilized.



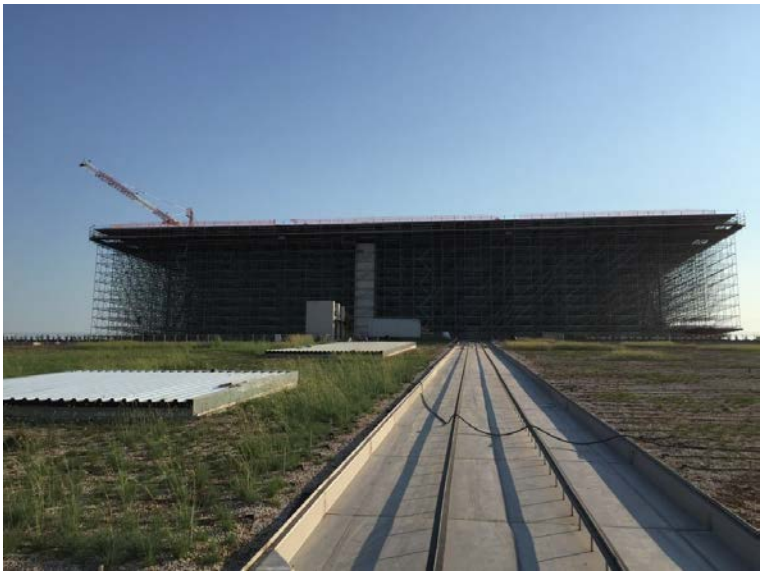
SNFCC has the largest size planted roof, in terms of area, but also in volume of substrates that has been constructed up to now in Greece. The green roof is the roof of the 10.000m^2 Car Park.

On the exit area towards the canopy, the adhered membrane **Sarnafil® G410-12 EL** was applied.

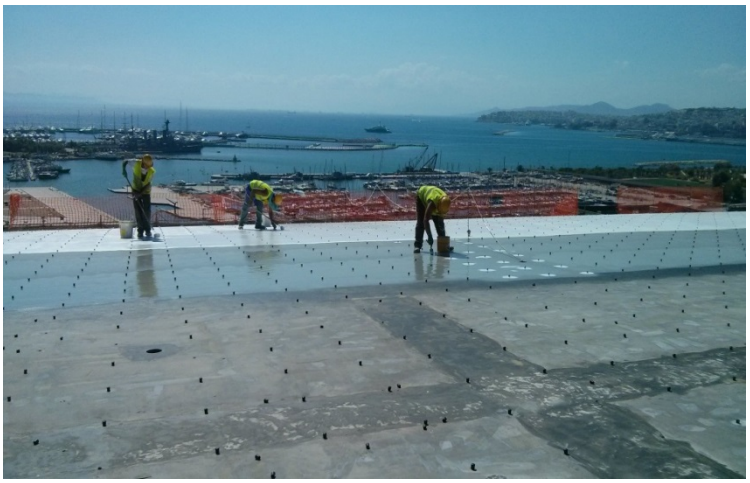
Buffer Zone is the area between the Library buildings and the planted hill. The roof also in the case was planted ("green" roof).



Light house is the building on which the hill ends:



Ferrocement Canopy waterproofing: The canopy itself as a project is pioneering and unique. The selected waterproofing system was the liquid sprayed polyurea membrane **Sikalastic®-8800** using two-component hot spraying equipment and **Sikafloor®-156** as primer, while the final, protective, polyurethane coating **SikaCor® EG-5** was applied. The total waterproofed Ferrocement canopy surface was 10,000m^2.



The final surface of the Ferrocement Canopy was covered with photovoltaic panels, which contribute to the sustainability of the project and reduce its CO_2 carbon print.

Seismic isolators: The Opera and Library buildings are based on seismic isolators. These are special constructions, which are placed between the vertical bearing elements and the building foundations. The seismic isolators form an alternative and practical method of seismic reinforcement of structures, which can significantly reduce the stress that a structure is subjected to from seismic loads. For the specific application, the 1-component, fiber reinforced, cementitious grout **SikaGrout®-312 RFA** was selected. Prior to final selection of this product, extended suitability tests were performed, while the application on site was performed before dawn as the construction took place during summer months with increased ambient temperature.

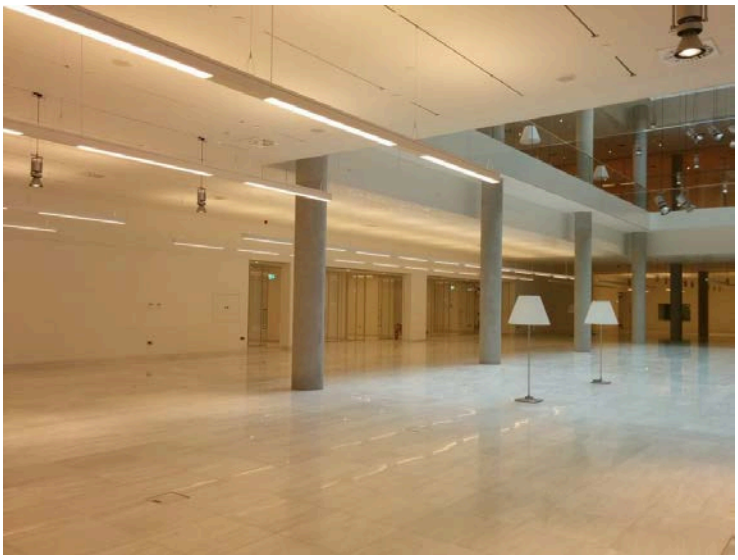
Car Park flooring systems: At the ~40,000m^2 parking area a polyurethane (~22,000m^2) and epoxy (~18,000m^2) flooring system was applied. The polyurethane flooring system **Sikafloor® MultiFlex PB-21 UV** was applied on the parking area next to the Opera building. **Sikafloor® MultiFlex PB-21 UV** is a highly aesthetic, anti-slip, crack bridging flooring system. It features high resistance against abrasion and is a low noise-producing system (noise produced due to tire movement), as the noise transmission during the performances on the Opera had to be kept to a minimum.

On the parking area under the Opera, the uniform colour, epoxy roller coating system **Sikafloor® MultiDur ES-14** was applied, which is suitable for application on medium to heavy duty substrates. All Sikafloor® systems carry a LEED Attestation regarding their VOC content, according to the accepted US Council methods.

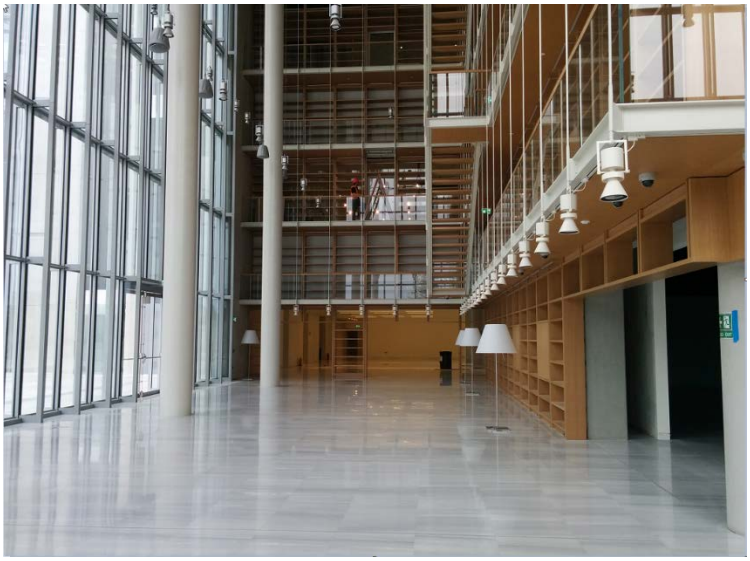
During the construction of the concrete floors, the mineral surface hardener **Chapdur Premix** was used.

Anchoring: All anchoring of the special 15cm thick architectural wall that was placed in front of the Opera were performed using the special epoxy based anchor **Sika® AnchorFix®-3+**.

Elastic sealing & bonding: Wood floor bonding at the Opera building was performed using the 1-component polyurethane adhesive **SikaBond®-54 Parquet** (full surface bonding) and the 1-component polyurethane adhesive **SikaBond®-52 Parquet** (skirting boards, vertical surfaces).



All floor joints, as well as the building façade joint on concrete substrates were performed using 1-component polyurethane based sealants of **Sikaflex®** series, while sealing of the natural stones (white marble) was performed using the 1-component silicone **Sikasil® WS-355**, specially suitable and approved for contact with natural stone (does not stain).



SALES VOLUME IN PROJECT:

Concrete production:

- 540 tn superplasticizers **Sika® ViscoCrete® Ultra** series
- 29 tn superplasticizer **Sika® ViscoCrete® Ferro-1000**
- 61 tn waterproofing admixture **Sika®-1+**
- 123 tn silica fume **SikaFume® HR-D**
- 10,5 tn stabilizer **Sika® Stabilizer-4R**
- 130 tn retarder **Sika® Plastiment-20 R /-30**
- 29,1 tn evaporation control membrane **Sika® Antisol S**
- 2,7 tn curing membrane **Sika® Antisol E**
- 5 tn demoulding agent **Sika® Separol®-320 W**

Waterproofing:

- 200 m of special injection hoses **SikaFuko® VT-1**
- 4.2 km sea-water swellable profiles **SikaSwell® A-2010M**
- 2.6 km swellable profiles **SikaSwell® A-2010 / A-2005**
- 750 cartridges of swellable sealant **SikaSwell® S-2**
- 4.7 km waterstops **Sika® Waterbars**
- 2.75 tn cementitious waterproofing mortar **SikaTop® Seal 107 SH**
- 4,100 m^2 PVC membrane **Sikaplan® WP 1100-15 HL**
- 15,400 m^2 PVC membrane **Sikaplan® WP 3100-15R**
- 480 m^2 drainage membrane **Sika® Drain-S**
- 20,100 m^2 geotextile **S-Felt A 300 F**
- 13,700 m^2 geotextile **S-Felt GK 400**
- 24 tn sprayed membrane **Sikalastic®-8800**

Roof waterproofing:

- 2,900 m^2 bituminous felts **Sika® Bituseal T**
- 1,800 m^2 FPO membrane **Sarnafil® TG 66-15**
- 36,520 m^2 FPO membrane **Sarnafil® TG 66-20**
- 680 m^2 PVC membrane **Sikaplan®-15 G**
- 500 kg liquid applied membrane **Sikalastic®-612**
- 320 m^2 adhered FPO membrane **Sarnafil® G410-12 EL**

Rehabilitation:

- 22 tns cementitious repair mortar **Sika® Monotop-627**
- 2 tns cementitious repair mortar **Sika® Monotop Dynamic**
- 2 tns cementitious repair mortar **Sika® Monotop-621 Evolution**
- 1.8 tns εποξειδικών ρητινών **Sikadur®**
- 112 tns cementitious grouts **SikaGrout®**
- 5,784 epoxy chemical anchors **Sika® AnchorFix-3+**
- 4.65 tns of coating **SikaCor® EG-5**

Elastic sealing & bonding:

- 5,680 sausages of elastic polyurethane based sealants for façade joints **Sikaflex® AT Façade / Construction+ / SikaHyflex®-250 Facade**
- 146 lt epoxy primers **Sika® Primer-3 N /-206 G&P**
- 6,800 sausages of elastic polyurethane based sealants for floor joints **Sikaflex® Pro-3 /-Floor**
- 417 cartridges of special silicone for natural stones **Sikasil® WS-355**
- 1.62 tn cementitious tile grout **SikaCeram® CleanGrout**
- 3.7 km joint backer rod **Sika® Backing Rod**
- 2,315 cartridges of multipurpose sealant & adhesive **Sikaflex®-11 FC+**
- 4,800 sausages of engineered silicone **Sikasil® WS-605 S**
- 1,300 cartridges of fire rated sealant **EverBuild Fire Sealant-300**
- 5.0 tns of elastic wood floor adhesive **SikaBond®-54 Parquet**
- 950 sausages of elastic wood floor adhesive **SikaBond®-52 Parquet**

Industrial flooring:

- 200tns mineral based surface hardener **Chapdur® Premix**
- 4 tns epoxy primer **Sikafloor®-156**
- 7 tns epoxy primer **Sikafloor®-161**
- 33 tns polyurethane coating **Sikafloor®-375**
- 17 tns polyurethane top coat **Sikafloor®-359 N**
- 9 tn epoxy coating **Sikafloor®-264**

PROJECT PARTICIPANTS

Architectural design / Project architect: RENZO PIANO BUILDING WORKSHOP
Associate architect: BETAPLAN
Main contractor: K/Ξ Salini Impregilo-TEPNA
Surrounding area study: DEBORAH NEVINS and Associates, Inc.
Associate of surrounding area study: H. PANGALOU AND ASSOCIATES
Structural design: EXPEDITION
Associate for structural design: OMETE
Environmental study: HPC – PASECO
Project management / Sustainable planning & costing consultants: FAITHFUL+GOULD

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