VI International Conference on Textile Composites and Inflatable Structures
STRUCTURAL MEMBRANES 2013
K.-U.Bletzinger, B. Kröplin and E. Oñate (Eds)

BATENSO NEW TEXTILE FAÇADE FRAMING SYSTEM: DEVELOPMENT, CFD WIND ANALYSIS OPTIMIZATION AND APPLICATION TO THE "OASIS" HOTEL AESTHETICAL REFURBISHING AND CLIMATIC IMPROVEMENT

STRUCTURAL MEMBRANES 2013

JAVIER TEJERA PARRA*

* BATSPAIN, C.E.O.
Calle de San Andrés, 25
28004 Madrid, Spain
e-mail: tejera@batspain.com, web page: http://www.batspain.com

Key words: Textile Façade, Framing System, BATenso, Solar Protection, Wind, CFD.

Summary. *This paper describes the use of BATenso Textile Façade framing system and its application to the Hotel Oasis refurbishing, for aesthetical and climatic improvement.*

1 INTRODUCTION

The "Oasis" Hotel was built on the Canary island of Lanzarote during 1990-1991 in an eclectic style, which mixed references to Islamic architecture built with traditional and sumptuous materials considered a symbol of luxury, with building systems that were considered "high tech" at the time (a large curtain wall façade and pyramidal skylights over the main access to the lobby).

Figure 1: Hotel Oasis façade, before and after the textile façade installation.

This curtain wall, besides representing an energy problem because it did not have any sun protection system, is crowned with pyramidal skylights that once met the aforementioned iconic role, but after more than twenty years, it was necessary to be redesigned since this icon image had not resisted with enough dignity over time. For this purpose, BATenso Textile Façade framing system was used in the refurbishing project.

2 THE SITE: EARTH, WIND AND FIRE

Canary Islands' climate is subtropical, due to the geographical location some 4º from the tropic of cancer. Temperatures between the seasons may vary only some 6º C, and the monthly islands average temperatures are from 18º to 24º C. Nonetheless, each one of the islands has specific conditions and climate variations.

Lanzarote is one of the seven Canary Islands, placed in the Atlantic Ocean at 1.800Km South West from the Spanish coasts and only 95Km West to the African coast and the Western Sahara and the desert Morocco's coast. Its climate is also subtropical regarding the temperatures, but dry and subdesertic referring the rainfall.

Earth is mainly black lava and basaltic stone, due to the volcanic origin of the islands, *Wind* is constant with a 2012 average of 22Km/h and a maximum of 85Km/h in June, and volcanic *Fire* is still present in the island with several active fumaroles and geysers.

A remarkable phenomenon in close relation with the strong wind which whips constantly the island is the so called "calima" or "sirocco" haze. Main wind direction is usually from northeast, but when it blows from southeast (sirocco wind), Sahara Desert dust in suspension flies to the Canary Islands raising temperatures and covering all with an orange colour dust.

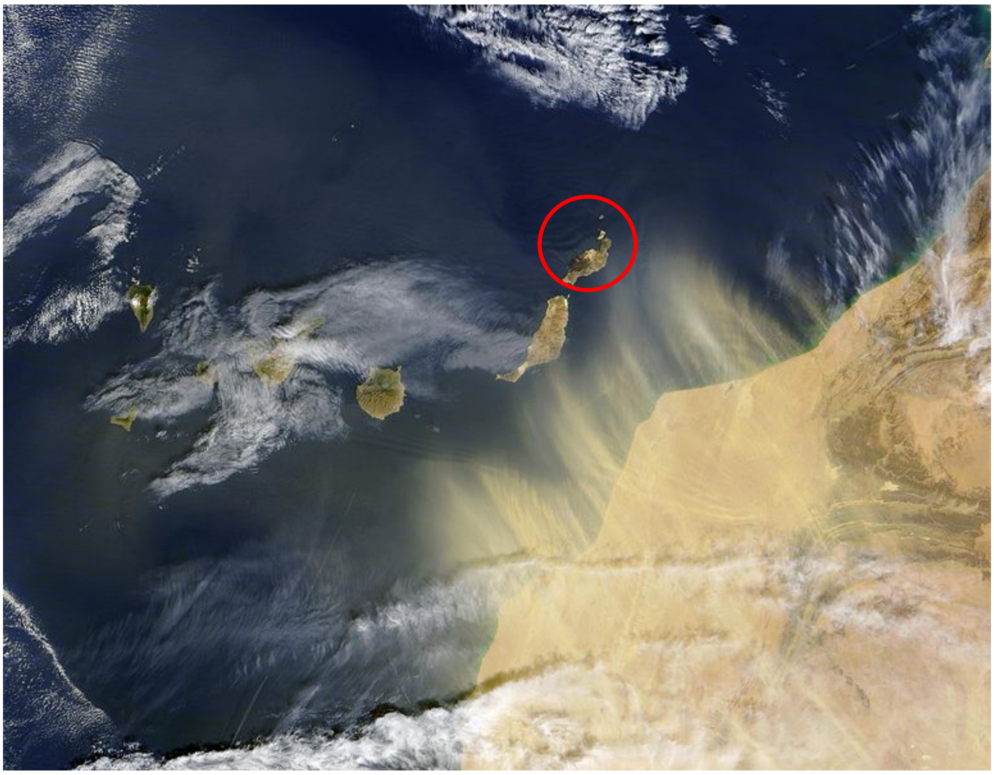

Figure 2: Lanzarote and the Canary islands under *calima* or *siroco* haze phenomenon. Strong wind throws streamers of orange dust from the African desert coast. Nasa Terra/MODIS.

It will be shown later how this haze phenomenon was considered in the fabric type selection, its composition, finishing and colours.

Wind was not considered as a "static" load applied on a stiff building, following the current regulations (CTE, *Código Técnico de la Edificación* in Spain), but as a dynamic load applied on a deformable shape, which generates different shapes depending on time and therefore, a certain amount of wind energy is dissipated in textile + frame + structure deformation.

Figure 3: Whilst a flag flutters in a turbulent flow (with high oscillation frecuency and fast deformations), a membrane structure gallops in it (low oscillation frecuency, slow shape variations).

By means of *CFDtex* calculation method developed by the author in his Ph.D.[1], consisting on several iterations between CFD (Computer Fluid Dynamics) and tensile structures software, a significant wind load reduction was achieved, as shown on Table 1.

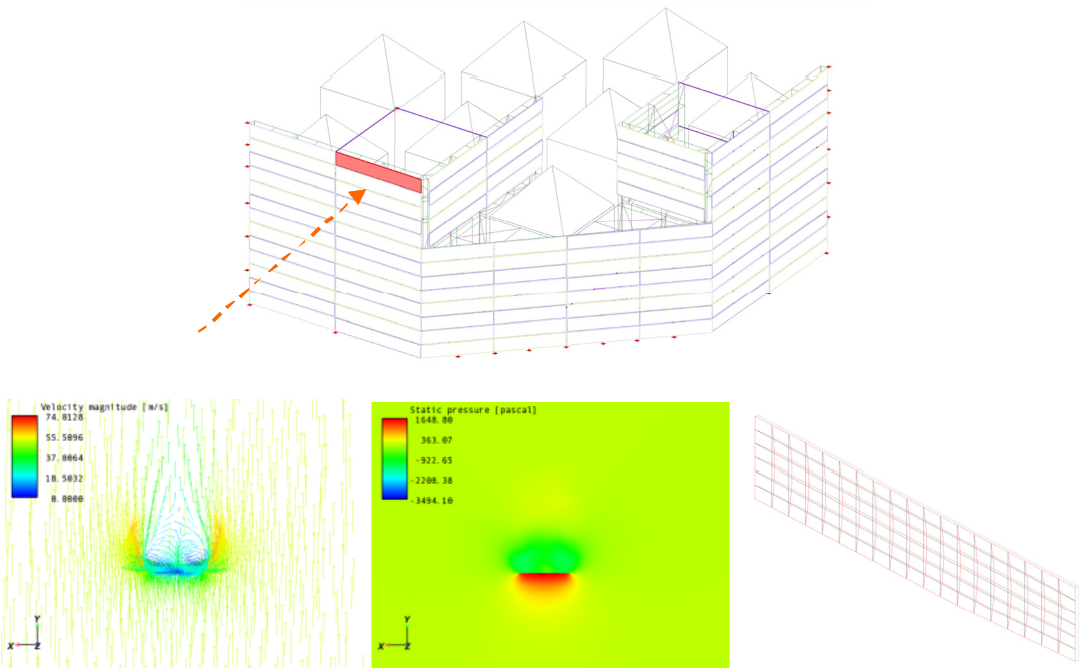

Figure 4: example of one of the frames (red) *CFDtex* wind analysis and deformed shape after several iterations.

Table 1: *CFDtex* results: CTE (Spanish Code regulations) vs. *CFDtex*.

	CTE (SPA code) KN/m^2	*CFDtex* method KN/m^2	LOAD reduction %
Iteration 1	1,29	1,19	-92%
Iteration 2	1,29	1,04	-81%
Iteration 3	1,29	1,02	-79%
Iteration 4	1,29	IRRELEVANT	IRRELEVANT

Modelling the complete façade alike, the load reduction is higher regarding CTE values (for a stiff and continuous façade), since wind flows through the frames' joints (50mm vertical joints and 100mm horizontal ones) reducing the final wind load.

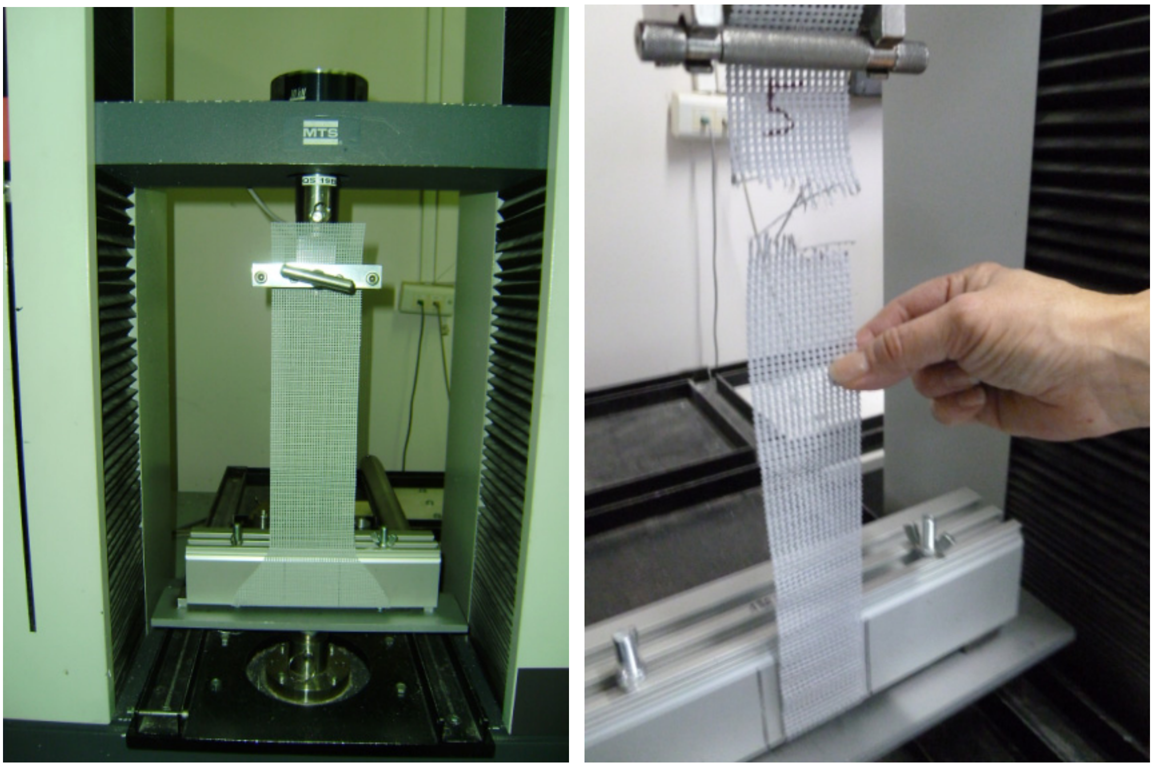

Figure 5: BATenso tests: the system shows higher tensile strength than any kind of membrane.

In spite of these reductions, since wind load was still the main challenge of this façade due to its location, two BATenso Textile Façade framing system characteristics made it specially suitable for this project: its high prestress level applied in workshop, and the possibility to restress the fabric on site after some time.

3 THE HOTEL AND THE REFURBISHING PROJECT

As part of the renovation project, it was raised the partial occultation of the main façade, the pyramidal skylights over the lobby and the panoramic elevators' cores inside it.

Figure 6: Hotel Oasis project render.

The solution should allow nuanced transparency from inside, as it was not seeking to generate an opaque screen but a filter to keep the view of the Lanzarote landscape that existed from the hotel atrium. In panoramic lifts, it was searched precisely not to lose its panoramic nature, keeping the views from them, but hiding from outside all the machinery and enclosure walls cladding in "old fashioned" marble.

Regarding the façade role, it had to be a solution not only to renew the look, but also to improve the energy efficiency performance, using a product that would combine characteristics adapted to this target, with a range of enough colors in order to achieve an aesthetical solution. To fulfill all these premises, it was selected the recyclable Polyester/PVC mesh Stamisol FT 381 by Serge Ferrari, following the architects color design: *purple red* color in the elevator cores and the combination of three different colors (*changing grey*, *blond ash* and *grey dust*) on the exterior façade, not only regarding aesthetical criteria but also as the best colors in terms of aging and suitable for the haze "sirocco" phenomenon described above.

Fabric longevity is guaranteed due to the special construction of the mesh, which is prestressed during its manufacture and allows high prestress levels which last after many wind exposure cycles, and a thicker coating of the yarns than similar meshes which is dirt-and-dust protected, making easier its cleaning, and suitable for marine environment.

Regarding the climatic improvement due to solar protection, each color has different values: the average percentages are 35% Rs (Solar Reflection), 30% Ts (Solar Transmission) and 40% As (Solar Absortion). So a final value of shading coefficient "g" total exterior = 0.33 was achieved, whilst former curtain wall façade "g" was over 0.65.

Previous thermal simulations[2] estimated a power consumption reduction for cooling of around 42% along the year.

The main project credits were:
Property: INVERSIONES INMOBILIARIAS OASIS.
Property Manager: SUMASA, Miquel Fibla
Project : INTEGRAL S.A.
Architect: Jordi Seguró Capa
Technical architect and Project Manager: Ángeles Atoche Peña
Collaborators (design): AdM arquitectes
General Contractor: HORMICONSA CANARIAS S.A.: Mario García, Juan J. Fernández

Textile façade engineering: BATSPAIN: Javier Tejera, Marian Marco
Textile façade manufacture and installation: BATSPAIN
Fabric supplier: SERGE FERRARI

4 ADAPTING THE FAÇADE TO THE EXISTING BUILDING

For adaptation to the existing building, both in the core lifts as in the outer façade it was designed and built a steel structure which generated the new envelope, with different nuances since the exterior had to bear the Lanzarote's wind loads.

4.1 Façade, secondary structure

Thus this structure was designed *Vierendeel* type, wide 60cm from the glass façade, maintenance catwalks with tramex floor were designed, solution which while generating a light and highly resistant structure against wind, enabled an easy installation of the frames from inside the structure without using lifts or cherry-pickers, and allowing maintenance and cleaning of the textile façade and glass curtain wall.

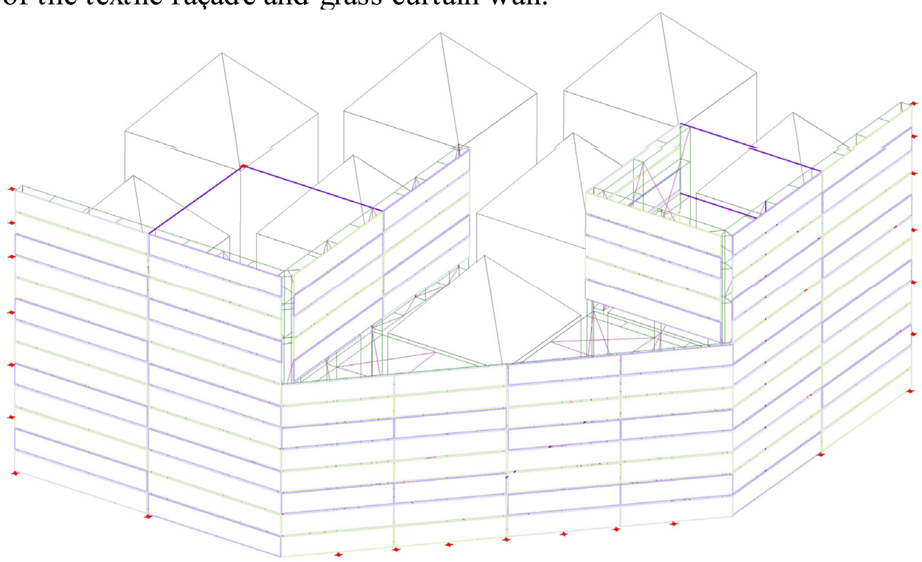

Figure 7: BATenso Textile façade framing system applied on 3D model

Former curtain wall façade did not have any external structure, so all the wind loads were transferred from the frames to the new steel structure and from it to selected points in the façade, which had a steel sheet cladding and a steel structure behind them. Due to the new façade design and volume, in several points there were no even curtain glass façade behind the new textile one, so it was necessary to transfer loads to other planes of the glass one, as shown below.

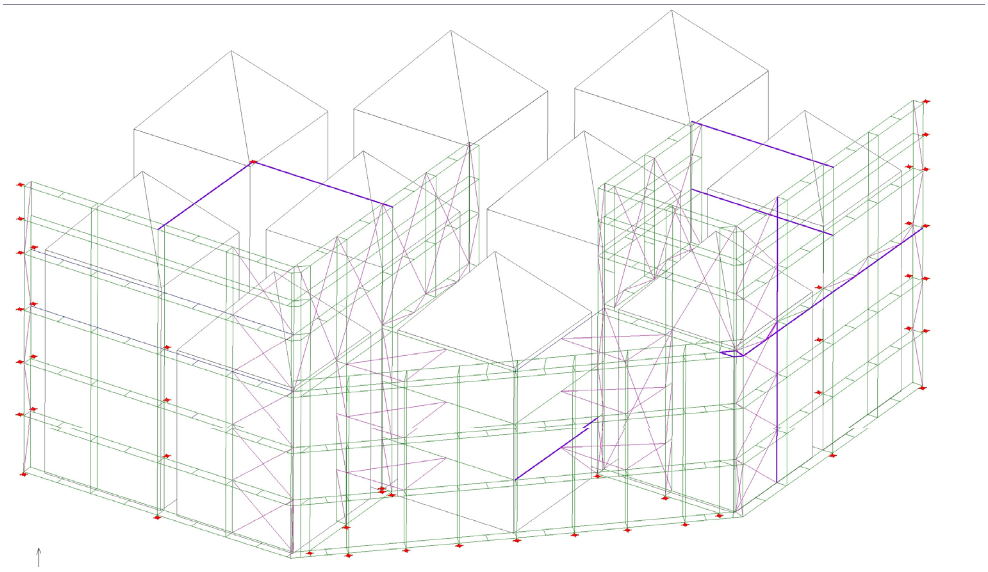

Figure 8: Façade secondary steel structure, 3D view

Steel structure was built on site and textile façade cladding was installed immediately after each structure module was finished.

Figure 9: Secondary steel structure and textile façade under installation

Special BATenso hanging clamps were designed specifically to enable three-dimensional adjustment and regulation of the frames in order to adapt them to the structure with tolerances, avoiding errors during manufacture or installation since the frames were manufactured on theoretical measures and prior to the structure construction.

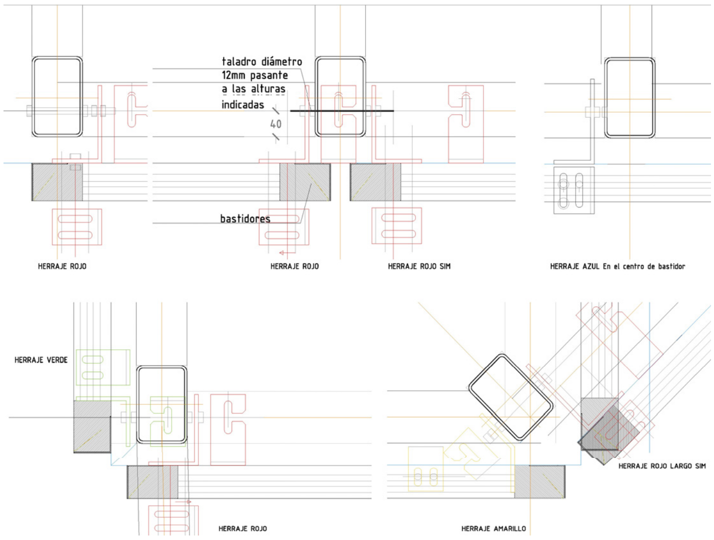

Figure 9: BATenso hanging clamps detail

Complete installation plans with simple colours codes were drawn in order to fit each frame with its own hanging clamps, making an easier installation.

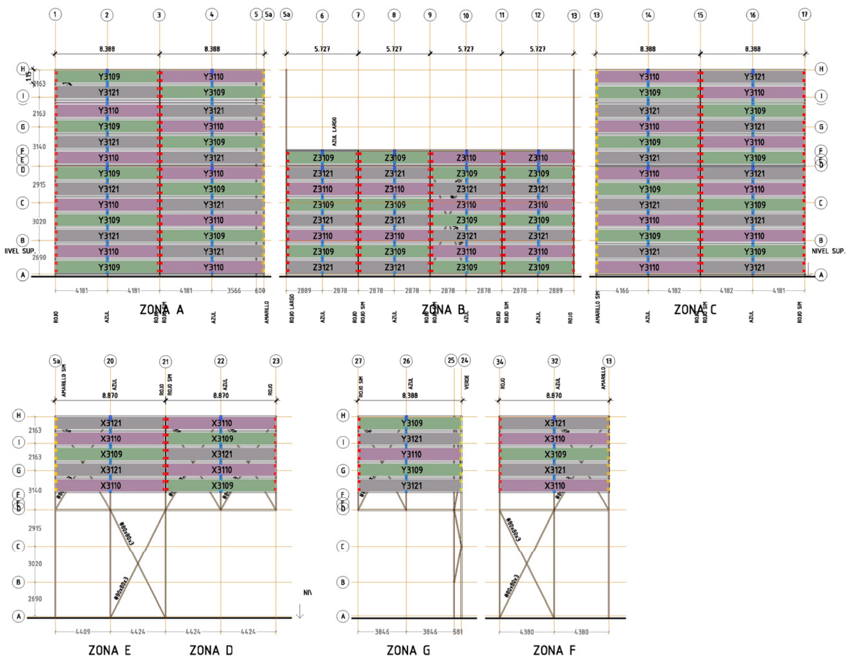

Figure 10: Façade installation plan. Each frame had specific colour and sizes codes, and hanging clamps type

4.2 Elevators façade, secondary structure

In panoramic elevators, the textile façade had only an aesthetical role, since it was not exposed to wind loads, so it was feasible to design a lighter structure: simple trusses were hanged from each slab, in order to bear the façade frames + structure self weigh loads.

Figure 11: Panoramic elevators: BATenso textile façade framing system and steel structure, 3D view, pictures

For this purpose it was crucial the selection of a textile façade system which allows big frames sizes with a relatively light weigh in comparison with traditional façades, the same way that textile roofs must have structural ratios much lower than conventional ones[3]. In elevators' façade, the Textile Façade + steel structure weigh was less than 10Kg/m^2.

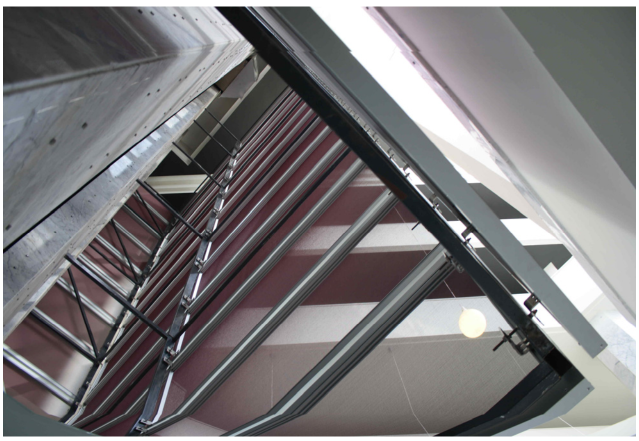

Figure 12: textile façade inner view, clamping system

5 BATENSO TEXTILE FAÇADE FRAMING SYSTEM

As it was exposed above, regarding the textile façade system to be used, the wind area of Lanzarote, with strong winds whipping constantly the island, and the need to send by sea in containers precast complete façades finished, decided the use of the new textile façade framing system BATenso by BATSPAIN, consisting on precast aluminum frames in a transportable size with special features:

Table 2: BATenso Textile Façade framing system, main characteristics.

	BATenso TEXTILE FAÇADE, CHARACTERISTICS
1	It is a framing system, precast in workshop. Big and light frames.
2	It allows a high prestress of the membrane.
3	It is possible to restress on site after some months or years.
4	It is possible to install PES/PVC, GLASS/PTFE, GLASS/Si, PTFE, ePTFE.
5	It fits membranes and films, not only mesh.
6	It adapts to temperature changes without wrinkles.
7	It avoids dirt to come between membrane and frame.
8	It allows anticlastic geometries on facades.
9	It does not need any machine to be assambled-prestressed, just hand tools.
10	It is economically competitive.

In the “Oasis” project a total amount of 182 frames were installed, which were transported to the site properly protected and ordered by colours and sizes according to the installation plan, in order to minimize movement in situ that could damage them due to its big size.

Figure 13: BATenso framing system process, from workshop to installation

6 CONCLUSIONS

- Textile Façades fit perfectly with the special requirements of refurbishing projects in which lightness, economy, solar protection and aesthetical renovation are imperative.
- BATenso Textile Façade framing system is suitable for refurbishing projects as the exposed above, in which its main characteristics (precast framing system, lightness, high wind resistance, etc.), makes it perfect for this purpose.
- Special features such as BATenso high prestress levels, or its on-site retightening ability, fits perfectly in projects with wind exposed facades.
- Analyzing membrane structures wind loads with the combination of CFD and Tensile Structures software, significant reductions can be achieved, optimizing the result.
- All pieces in a textile façade should have adjustment ability and respect tolerances, in order to avoid errors and to make an easier installation.

REFERENCES

[1] J. Tejera. *CFDtex*: “Textile roofs improvement through aerodynamic analysis combining computer fluid dynamics simulation and textile architecture software”, PhD in UPM (Universidad Politécnica de Madrid), published in “Coinvedi” Congress, Madrid 2009, Escuela de Arquitectura Técnica.
[2] Simulations made in www.textinergie.org
[3] J. Tejera. Tectónica magazine, number 36, 2011.