The Services: Energy Research

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The understanding of the design and construction of the Spanish Pavilion by Francisco Mangado in Expo Zaragoza requires a second look at concepts of construction energy and maintenance energy.

The strict initial requirements of the competition demand that the winning building have energetic content in materials of under 1100 kWh/ m2. This quantifying of the energy embedded in the construction materials is not widespread among architects when creating projects. Nevertheless, the concept of construction energy is one of the generators of this project as it implies the choice of recycled and recyclable materials like steel, wood, ceramics, glass, or cork. An initial decision opts for materials that allow a mostly dry assembly and, if necessary, would allow the reconstruction of the pavilion at another location.

Once the materials were chosen, a series of logical measures was developed to reduce high thermal loads foreseen during the Expo. A large roof provides shade to the Pavilion and the surrounding outside area, reducing heat transmission to inside areas in the summer. A perimetral pool of water greatly reduces thermal fluctuation around the main areas of the pavilion. The density of the pillars is increased on the west facade to avoid undesired direct solar radiation from this direction in the summer. There are also motorized windows on opposite facades to allow night ventilation, so that the pavilion ejects more heat from the inside at night and thus requires less energy to cool the next day. For the design of the window idea, a scale model of the pavilion was tested in a wind tunnel to confront and confirm the data obtained by computer simulations of fluid dynamics regarding the resulting pressure on each of the pavilion facades, with different wind speeds and pillar densities.

After reducing the initial energy demand with physical architecture, the facilities system was designed. As a consumer of maintenance energy, it was designed to work with high efficiency and to achieve a low level of consumption. Two concepts guided the implementation of this system: the container of the roof and the energetic membrane of the structure.

Most of the services are grouped together on the roof, making management and maintenance much easier. There are other smaller technical areas in the semi-basement, the areas that hold necessary energy supplies that are connected to the roof facilities by a vertical volume. From this space, located in the energetic center of the pavilion, pipes are distributed horizontally through a slab from which both the upper and lower floors are served. One is served by a raised access floor and the other from the surface between wood beams.

Based on these approaches, the essentials on an architecture-facilities level, the description of the maintenance energy network components should do nothing more than highlight the features of active systems regarding buildings of similar characteristics. Production and extraction of heat does not happen inside the Pavilion, but at a common power station for the entire Expo site, which provides energy to the Pavilion by way of the heat exchangers located on the semi-basement floor.

In addition to a conventional electric supply, and given the exhibition space requirements, there is also an irreligious network service with its own transformer, for the Expo's audiovisual equipment. On the roof, machines are protected from excessive sun exposure by a metal structure that supports photovoltaic panels with an installed peak power of more than 60 Kw.

Regarding the air conditioning system, air treatment units of the air conditioning system have enthalpic heat exchangers and motorized floodgates to allow free cooling when outdoor conditions are favorable. Besides these savings, there is a centralized control system which not only manages temperature and humidity regulation in air treatment units, pumps, fans, ventilation systems, access safety and control, etc., but also allows the monitoring of energy consumed in real time.

On water management, rain is collected on the roof by means of drain pipes inside some of the pillars, and is directed to the tanks that provide water to the pavilion’s ponds. This accumulated rain water can also provide the water necessary for the functioning of the “generating supports of microclimates.” This baroque definition refers to one of the pavilion’s minor elements when compared to the whole, but one of the elements that has had more media impact.

Evaporative cooling is the origin of the solution used for these supports. This is an effect that has been used to lower room temperature for centuries in climates with dry summers, like the Mediterranean, and was used to alleviate outdoor spaces from the heat at the Expo in Seville. In this case, at the International Expo, with water as its main theme, the pavilion shows, as an exhibition on its own, the air conditioning possibilities of the liquid, occurring here as air movement with water is forced on the inside of several of the pillars located in the entrance area.

At this point, it is evident that to describe the pavilion, the concept of ‘bioclimatic’ architecture was not even necessary to use. This is simply architecture dedicated to making the most of today’s available resources to solve the worries of society.

The Spanish Pavilion exemplifies how architects and engineers involved in construction processes should be committed, as society demands, to building properly, with maximum technical rigor, renouncing merely theoretical prototypes when those prototypes cannot be applied in reality.