GR06_HW02: Vernacular and climate sensitive architecture in Punta Arenas and Jerusalem

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Chapter 1

A *brief* introduction:

Vernacular architecture is a concept that really inclusive: everything that is built with local materials by and by someone that's not a professional can be considered vernacular architecture; for this reason there is a continuity non always well defined among these buildings, because there is no code but only tradition to sustain the shape and the technology. The common line among these examples is that the approach is almost always bioclimatic, the evolution of shapes and technology goes towards the thermal comfort for the users, also there is the strong element of tradition, because architecture learns always from the past examples.

The architectural regionalism can be really inspiring for the professional because it's the natural answer to the climate and concept like surface/volume ratio, thermal inertia, dispersant surfaces, ventilation, cooling by evaporation and shading systems are used since thousands of years.

Punta Arenas:

Figure 1: View from *Reserva Nacional Alacalufes*

The Southern part of south America has an oceanic climate, this means that summer (which is from the end of December to March) is rainy and slightly fresh and winter is long, humid but never too cold.

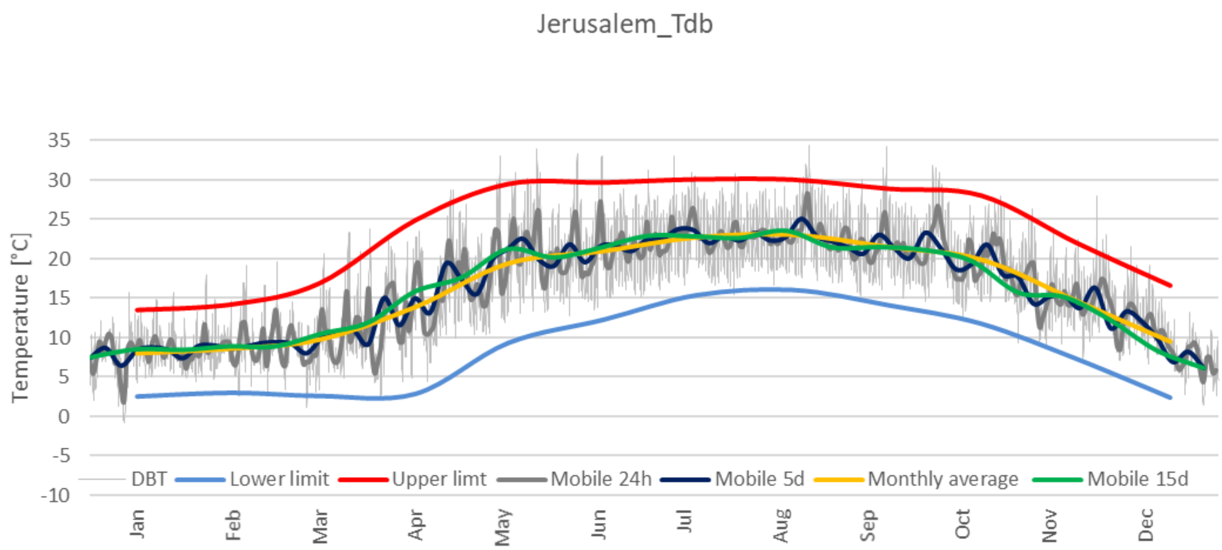


Figure 2: Punta Arenas' temperatures

Selk'nam People, also called Onawo or Ona people, are the Indigenous bands of hunters-gatherers that lived in the Tierra del Fuego, are today considered extinct.

The bands were victims, in the early '900s, of European explorations; gold prospectors and Estancieros (landlords) launched a campaign of extermination against indigenous people in order to stop the sheep hunt that the Selk'nam were carrying on.

The fact that the Onawo were nomads influenced greatly on their architecture and general knowledge of private property and animal domestication. Simplicity although a key factor of their movable homes, was also a disadvantage in terms of climate coexistence. The difficulties this indigenous band faced were mostly due to the rigid climates they encountered, the scarcity of animal and unfertile soils.

The materials used to build the huts were wood and turf, with a shape similar to the one built by the northern Navite Americans, but with a big difference: there is no use of animal skins. As it was previously mentioned, the lack of "big" animals in the entire continent of South America (i.e deers and bisons) made impossible for them to take advantage of this resource.

The cone-shaped shelter has five main advantages:

- A good surface/volume ratio, that means a space with less dispersants surfaces
- A decent resistance to rain and snow given by the pointed roof-top
- A relative ease in shelter reconstruction (as already said the population was nomad)
- A simple structure: branches and turf don't allow complex nodes or stiffness. Furthermore, metals weren't used, so there was not the technological idea of nails
- The cone-shape and the opening at the top enhance ventilation and smoke's flow to the upper part of the hut allowing a fire in the center during cooler months.

Moreover the materials have some advantages too: turf has an important insulating power and thermal inertia and wood is resistant and versatile.

Figure 3: Punta Arenas position

There is little information about the culture and the traditions, since vernacular architecture reflect the needs and possibilities among the bands, we can affirm without doubt that every group had less important modification of the cone-shaped structure or the materials that were used. For example, a shelter can be adorned with skins in case of a lucky hunt (some groups, which established southern, found seals colonies and used their skins to improve the thermal properties of the hut), or can have materials that are quite rare in the area thanks to trade with the europeans.

The strongest element that influences the vernacular architecture is technological level, which is often conditioned by the geoclimatic situation, the Ona people have a lot in common with the northern America indigenous, who lived quite far but had a similar organization and architecture.

Jerusalem:

In the Jerusalem's area we have a quite different situation: this area is one of the richest in terms of history, tradition and cultures. The climatic band in which it is located is also much different, being affected both by slightly cold winter and very long summers.

This difference affected the way civilization developed, in fact, on the contrary with respect to the Onawas, here the populations were mainly sedentary and specialized in agriculture and breeding.

The area is inhabited since 1000 B.C. (colonized by the Philistines), and the nearness to the Mediterranean sea played an important role in terms of influence and cultural exchange with other cultures; for this reason its vernacular architecture is elaborated and rich of characteristics coming both from the Middle East and from the Greek and Roman cultures. The presence of florid cultures, to which correspond a pyramidal society, has all over the centuries enriched the architectural diversity among the different social status: we

Figure 4: Example of Fuguinos' shelter

Figure 5: Ona people

can find a simple peasant house (composed by one or two rooms), a complex peasant house (often more than one story in height) or a courtyard house (complex plan).

Figure 6: Ona people's shelter

Figure 7: Wiew of the Palestinian Mountainous Region

The main material used are sandstone (arenaria), limestone (calcare), mud (and mustone) and gypsum; obviously the characteristics of the stones vary within the areas, being limestone used most likely in the mountain localities while sandstone along the coast.

One of the oldest technologies is the one of the mudstone (sun dried bricks) use in the Gaza area and in Jordan: it is a molding stone that is formed in wooden molds; mudstone is prepared from local mud (red soil) mixed with sand and water to be dried in the sun. The material obviously has a short life and for this reason the use, when still used, is for inner partitions.

The common element that we find in every house is the need to protect the users from summer overheating: this problem was solved taking advantage of the thermal mass of heavy materials (as previously mentioned) used to build the shelters, small opening were applied to enhance ventilation and, in bigger constructions, courtyards were built.

As mentioned, overheating is the most frequent discomfort index to face: the first populations living in this area realized, inspiring from caves, that the heavier were the shelter's materials, the longer they would take to heat up and, when a good ventilation was free to flow through the openings, the envelope components would cool down during night. The result of thermal mass discovery was the construction of walls 80-120

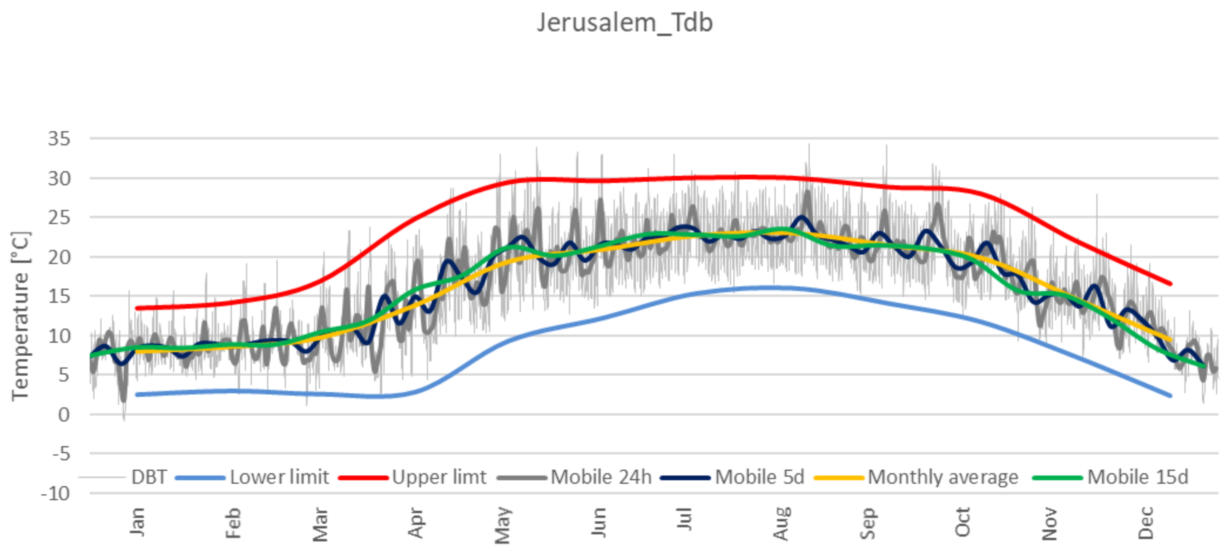


Figure 8: Jerusalem's Temperatures

Figure 9: Jerusalem postion

cm thick, whose core was filled by small stones and mortar.

An element of distinction among the different cultures that lived in Jerusalem's nearby is the roof's shape, which evolved from plane to sloped or dome. In the first case the structure was in wood and covered in clay, this allowed to make it walkable but, in terms of thermal mass, this wasn't the most efficient option.

The most traditional in mountainous regions of Palestine was the dome roof, whose particular shape is the

Figure 10: A Palestinian house excavated in the rock

Figure 11: Another axample of Palestinian house excavated in the rock

result the a lack of wood, whose use was limited to the scaffolding. The materials used to lighten it were mainly bushes, corn stalks, grass and old drapery, covered then by soil and a double layer of mortar. Inclined roofs are more typical in the Jordan valley area, the coastal plain or other sites where mudstone was the main building material and, due to its weakness in compression, didn't allow the dome realization.

Figure 12: Inside view in which the dome can be seen.

The **courtyards** are an archetype that can be found in the more complex examples of vernacular architecture: can be found as a court in common between more houses or in the center of a single one.

The courtyard is the result of adding more and more rooms around an open space in order to maintain the air circulation, also it's a space used for day and night activities due to the balance of temperature in the court itself; in rich family's courtyards or in the large complexes **fountains** can be found, these are not only decorative elements but also a good way to cool the area due to evaporation in summer time.

A filter area between a house and the space outside is called **Riwaq** (a portico) and usually is built between some of the main rooms and the sides/angles of the building. The open part is often built with archs and it's used in houses and in public buildings like schools and hospitals (can be seen a similar architectural tradition in most of the Mediterranean areas) and it prevents the sun to hit directly the rooms and keeps the ventilation to reach the comfort zones.

The last element used to regulate the temperature inside the houses is one of the most important: **openings.** There are cases in which for different reasons we can't find them at all as in the peasants' houses (for security reasons), though in some cases small openings placed in the highest parts of the house can be found.

Openings are they are the most efficient and simple way to have dispersion of the heat by ricirculation. The technology is really simple, seldom glass is used, often it's a simple hole in the wall with some fabric to cover the view.

Figure 13: An example of Riwaq

Chapter 2

Watson&Labs matrix has allowed us to analyse two different climates from a common point of view, underlining the main differences that are characterized from.

The two examples that we are studying are quite different over some aspects: Jerusalem is torrid in summer but has some needs also in winter, on the contrary Punta Arenas has a constant need for heating.

This situation is given not only by the different latitude but also by the kind of climate affecting those areas: in Jerusalem we have a hot climate near to Mediterranean Sea, although in Punta Arenas we have a steady oceanic climate, in which in summer we have more precipitation decreasing the yearly thermic excursion.

Punta Arenas:

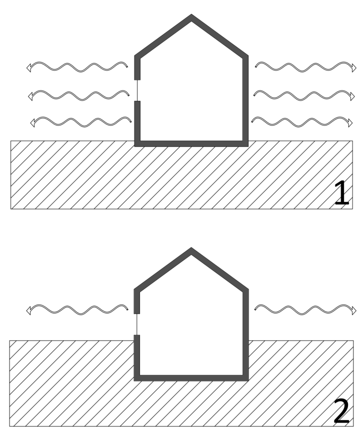
Emphasizing the only aspects we need to work on:

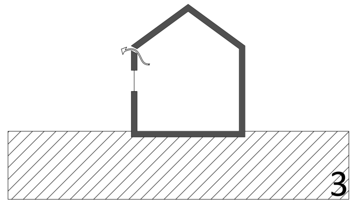
Conduction

As the Onawa population already discovered, the surface/volume ratio deeply affects the thermal dispersion of a closed ambient; in a similar way, in the northern side of the world, the Inuit discovered that the semi-spherical shape was the best approximation to the s/v ratio perfection. Hence, in such a climate, it is

Punta Arenas	Temperate zone	Heat sources			
	Main strategies	Conduction	Ventilation	Radiation	Moisture transfer
Winter (cold season)	Increase heat gain	-	-	Improve solar gains	-
	Reduce heat loss	S/V has to be hoptimized, reduce dispersant surface increasing the area in contact with the soil	Minimize the openings and reduce the infiltrations	-	-
Summer (hot season)*	Reduce heat gain	-	-	-	-
	Increase heat loss	-	-	-	-
	sources	Earth	-	Sun	-
	sinks	-	Atmosphere	-	-
* Being the summer temperature under 25° C we decided to not find solution to counteract the heating					

Table 1: Punta Arenas' Watson&Labs matrix





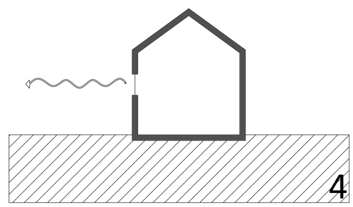
important to lower the dispersion surface, this condition can be satisfied by also creating a building that is in part buried (fig.1 vs fig.2), which reduces the area that loses heat to the external air (soil has a constant temperature of 12°C, while air can reach -10°C).

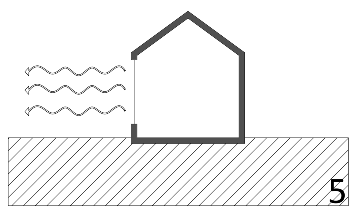
The technological improvement in buildings has allowed to consider the effect of thermal bridges (fig.3) and prevent their presence.

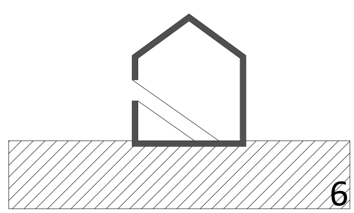
Ventilation

In the case of a well insulated wall the leak could be characterized by small air infiltrations that would determine non negligible thermal dispersion.

Ventilation due to the necessity of air changes has to be controlled in time and limited to the warmer hours of the day to avoid wastes of energy.

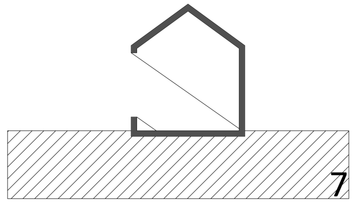






Radiation

The main free gain we can obtain is represented by the solar radiation, therefore glazed surfaces on the northern façade (the most irradiated one) have to be placed to improve this aspect (fig.6 vs fig.7), always taking into account that their thermal transmittance is lower than the one of the opaque technologies (fig.4 vs fig.5).



Jerusalem:

Emphasizing the only aspects we need to work on:

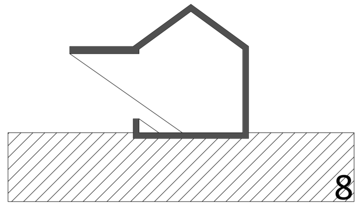
Jerusalem	Temperate zone	Heat sources			
	Main strategies	Conduction	Ventilation	Radiation	Moisture transfer
Winter (cold season)	Increase heat gain	-	-	Openings in the right direction	-
	Reduce heat loss	Improve the insulation	Small openings	-	-
Summer (hot season)	Reduce heat gain	Thermal inertia	Small openings, clocking hot air	Color the outer surfaces in white (reducing solar gains), block the direct radiation	
	Increase heat loss	Surface in contact with the ground (which is at the steady T of 12° C)	Improving ventilation dispersing hot air and introducing cold air	-	Evaporative cooling
	sources	Earth	Atmosphere	Sun	-
	sinks	Earth	Atmosphere	Sky vault	Atmosphere

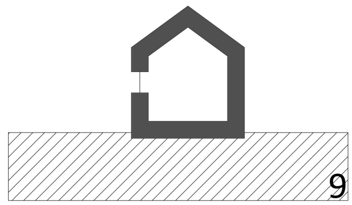
Table 2: Jerusalem' Watson&Labs matrix

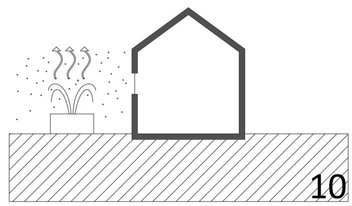
Conduction

Having already discussed about the improvements to apply in order to reduce the heating energy need, in the case of Jerusalem we concentrate on the summer season, which characterises the most critical situation.

The constant temperature of the ground can, in this tropical band, help keep the temperature low during summer period (fig.1 vs fig.2). However a more effective way is represented by the thermal inertia of some







materials, which store heat during the day avoiding overheating and, with an effective ventilation of the indoor ambient, release it during night (fig.9).

Ventilation

In summer case, ventilation has to be scheduled in order to release the heat stored during day, hence it is suggested to allow it only during night, or to enhance stack effect.

Radiation

Direct radiation, differently from Punta Arenas, has in this case a negative effect and, as seen in the vernacular architecture examples, a way to avoid it is represented by sunscreens (fig.7 vs fig.8).

Moisture transfer

As it is known, the presence of water is a efficient way to cool down the ambient, this phenomenon is due to the evaporation of part of the water, providing a sensation of freshness.

Chapter 3

Case study: College Hill Council complex

The degree College and Hill Council Complex is located in Leh, at an altitude of over 3500 metres above the sea level.

The main problem is the cold and long winter, although there are pleasant summers, there are few precipitation but we found that the climate can be compared to the one of Punta Arenas, although the thermal delta is much higher and there are fewer precipitations.

The structure of the building is made by timber frames and robust steel cross-bracing in order to protect it from earthquakes and mud slides.

Figure 14: Degree College and Hill Council Complex

The whole building is made in order to minimize the heat loss during winter and promote the heat gain; the following strategies have been used:

- Decrease exposed surface area
- Increase thermal resistance
- Increase thermal capacity
- Increase buffer space
- Decrease air exchange rate
- Increase surface absorptivity
- Reduce shading
- Utilize heat from appliances
- Trapping heat

These objectives has been reached by:

- orientation and shape of the building
- Use of trees as wind barrier
- Roof insulation, wall insulation and double glazing
- Thicker walls (thermal inertia)
- Air locks/lobbies
- Weathers stripping (reducing thermal bridges losses)
- Darker colours
- Wall and glass surfaces (to promote heat gains)

- Sun spaces/ green spaces

In the complex each structure has been treated specifically depending on its orientation, all the building in the northern side have thicker walls to minimize the heat losses, while in the south side have been designed in order to maximize heating by radiation and daylight distribution.

Also the glazing system is organized in order to minimize the losses: the disposition goes to prefer the south surfaces and every window is double glazed and designed in order to prevent condensation. The ventilation problem has been solved connecting all the spaces and exploiting the thermal buoyancy in order to have a zero energy system during normal hours of operation (using the heat produced by users) also the water is obtained from a near snow sites for drinking and irrigation purposes.

The building is a former college so it includes every type of space like courtyards, dining hall and kitchen, computer and science lab, art studios, a medical clinic and resident blocks.

Case Study: California Academy of Science

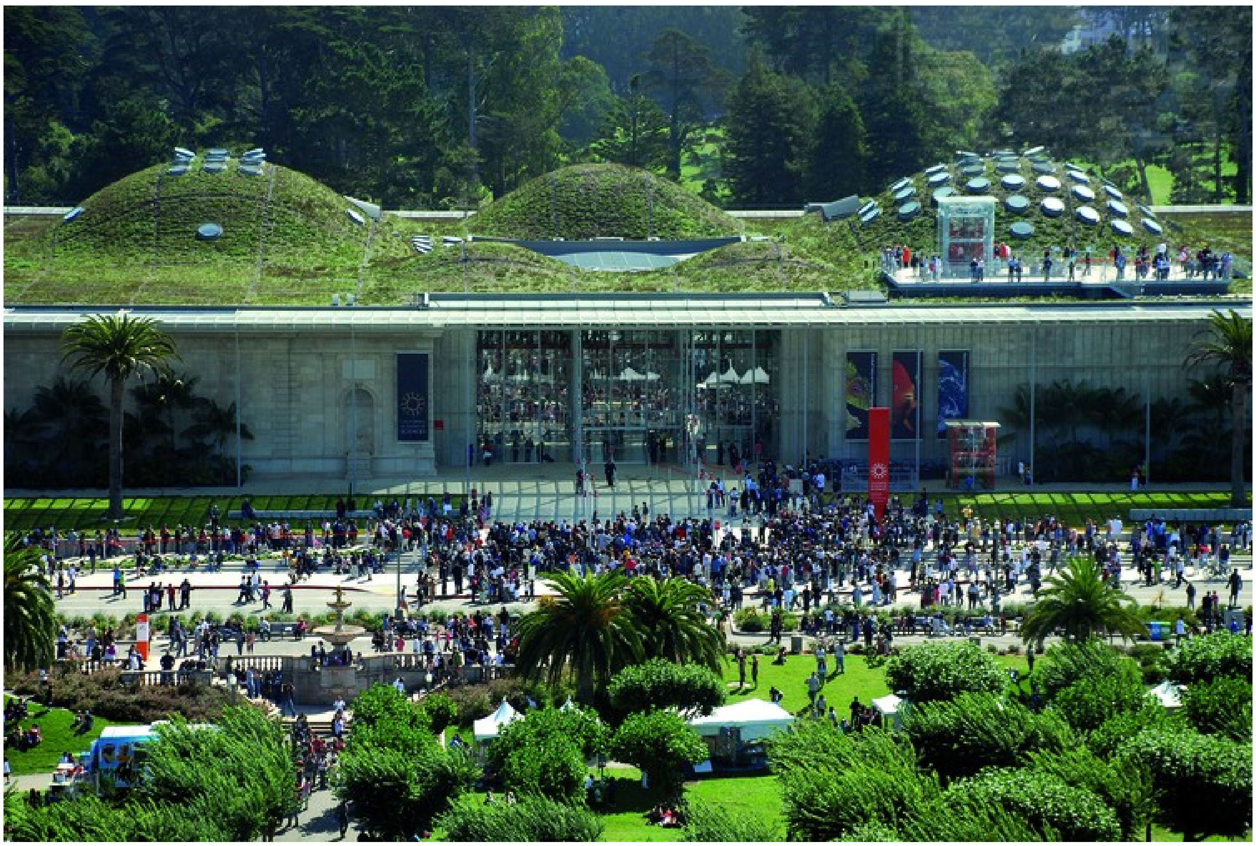


Figure 15: California Academy of Science

The California Academy of Science is a natural history museum in San Francisco, California, that is among the largest museums of natural history in the world, the project was developed by Renzo Piano.

The new building is at the forefront of environmentally friendly design, in keeping with the Academy's focus on ecological concerns and environmental sustainability. The new design, which features a living planted roof, integrates the Academy more sensitively into Golden Gate Park and make nature a part of the building's structure; with its environmentally-sensitive design, the new building is an expression of the Academy's mission to understand and protect the natural world.

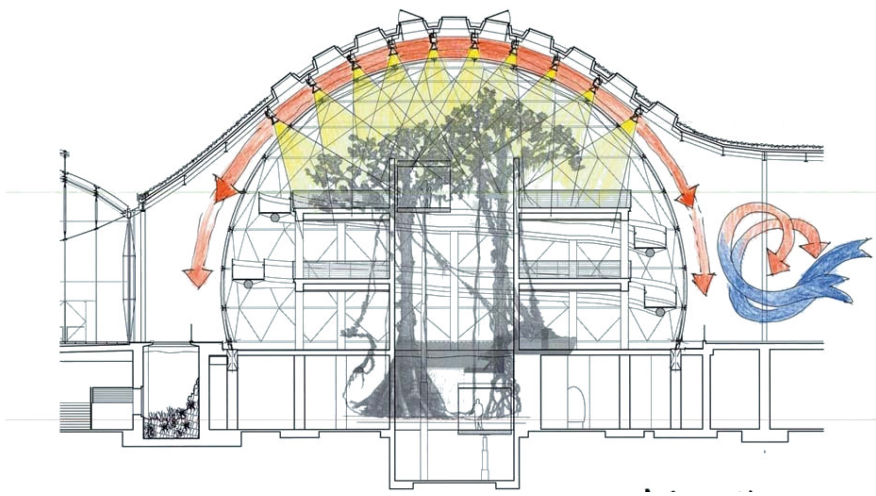


Figure 16: California Academy of Science : a scheme for passive ventilation

The new Academy consumes 30% less energy than required by federal code. The planted roof provides a thermal insulating layer for the building that help prevent overheating during the summer months and reduce energy needs for air-conditioning.

While the Academy uses new "green" technologies, it also takes advantage of simple, traditional engineering techniques involving use of natural light and ventilation.

At least 90% of regularly occupied spaces have access to daylight and outside views, reducing energy use and heat gain from electric lighting, whose controls are included as automatic dimming linked to external light levels to ensure that a minimum of electric lighting is used any moment; also openings in the roof domes creates a stack effect on the exhibit floors, drawing in cool air from below and exhaling warm air out the roof meanwhile operable windows are employed in staff offices.

The roof is a green roof which has all the benefit linked to this technology indeed soil moisture, combined with the phenomenon of thermal inertia, cools the inside of the museum significantly, thus avoiding the need for air-conditioning in the ground-floor public areas and the research offices along the facade.

The choice of materials, recycling, the positioning of the spaces with respect to the natural lighting, natural ventilation, water usage, rainwater recovery and energy production: all of these design issues became an integral part of the project itself, and helped the museum obtain LEED platinum certification.

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Architectural Conservation Ramallah, 2000