THE RECOVERY OF A MODERN BUILDING IN THE MEDITERRANEAN BASIN BY USING SUSTAINABLE APPROACH

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ABSTRACT
The paper reports the first results of research carried out at the Department of Design and Building Construction of the University of Palermo analysing the problems related to the design of sustainable building envelopes in the Mediterranean Basin. The paper shows the design strategies adopted by a group of students in their graduation thesis on the recovery of Mazara del Vallo city hall in order to investigate the issue of existing buildings and sustainability. It represents a useful simulation of a design experience developed in a research context to investigate ventilation and the energy conservation problems in contemporary buildings.

KEYWORDS
Sustainable Architecture, Modern Building, Mediterranean Basin, sunshading device, natural ventilation

INTRODUCTION
Mazara del Vallo is a little town located along the south coast of Sicily, in front of the Sicily’s channel. The city hall is a modern building built in the 1967 in the most important square of the city centre, in front of the old cathedral (built by the Arabs in the XII century) and two very important historical buildings of the Baroque Age. Obviously the building is completely different from the context around it both for its shape and for the building material used to build it.

One of the most important problems is related to the insufficiency of its installations and, in particular, of its ventilation systems that are unable to answer the user’s requests (particularly in summer) and to follow the contemporary building rules and the sustainable criteria.

With the aim to improve the building performances related to the appearance and the comfort of the inner space it has been designed a new sustainable building envelope that take advantage of wind and sun in the way to define a passive ventilation system derived from the analysis of the passive systems used in the traditional architecture of the Mediterranean Basin. Actually, from the traditional Iranian architecture, or from the Spanish and Italian architecture too, have been derived some of the design strategies that we have adopted to define a new kind of sustainable contemporary building.

In this paper the original situation of the existing building and its conversion into a museum are discussed. The climate and the environmental situation are described in relation with the building in the way to underline the possibility to improve its “natural behaviour”. Finally, the traditional design strategies joined to the innovative technical solutions and materials that are used to improve the performance of the new building envelope are presented.

THE EXISTING BUILDING
The existing building is 18 m tall with 5 storeys. The storeys height is 3.36 m, except the second floor that is taller than the others (5.76 m) and project itself over the square.
The basement is under the level of the square of about 70 cm; the main entrance is placed at the first

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The façade presents rhythmic openings with frames made of aluminium. The bearing structure of the building is made by reinforced concrete. The external vertical dividers are made of local limestone with a thickness of 30 cm.

The five storeys of the building are linked by a circular staircase and one elevator. Each storey is organized into small offices for the municipality workers. These offices are divided each other by using internal vertical partition made of limestone with a thickness of, about 10 cm or, like at the second storey, by aluminium frames with sand-blasted glass. Each office has openings in the southeast and southwest direction.

Fig. 1, 2. Plans of the existing building at the basement level (with the large square in front of it) and of the 2nd floor.

Fig. 3, 4. Views of Piazza della Repubblica and the Mazara City Hall.

Fig. 5. The existing building: the façades on the southeast, the southwest and the northeast directions.
THE CLIMATIC CONTEXT

The geographical position of the city, that faces the Mediterranean Sea, is very typical. The climatic context is characterized by a warm-damp climate for the longest part of the year. The winds wind through the alleys of the Mazara historical centre as in a labyrinth. The circulation of the air winds the buildings at the road level, enclosing them in a system of continuous movement of air that generates thermal insulation; this mechanism, however, is insufficient to guarantee the circulation of fresh and healthy air in summer.

The buildings reciprocally protect themselves from the winds and they reduce wind speed at road level, for this reason, the usual windows is, often, inadequate in order to ventilate the buildings. From the analysis of the meteorological data, from the climatic station of Birgi Airport (located at a short distance from the city, nearest to Trapani) and from local reliefs, we have derived the parameters to use to understand the characteristics of the wind and of the exposure to the sun in relation to the building chosen as a case study.

By using special software we have been able to study in deep the micro-climate in which the building is located.

Fig. 7 shows the prevalence of the winds during the year. You can note that the winds blow with rather low speed (15-30 km/h) and it is not possible to identify a prevailing direction; nevertheless a light prevalence of the Southeast and Southwest winds (warm-damp wind of Sirocco, with a moderate speed and wind of Libeccio, often violent) can be observed. These two winds are typical of the northern areas of the Mediterranean centre.

We have also investigated the diffuse and direct solar radiations; these last ones are more harmful than the others for the overheating of the building façades.
From the analysis of fig. 9 it is possible to note that the direct solar radiation that produce an increase of the temperature is concentrated in summer, with high values from 11:00 a.m. to 3:00 p.m. The temperatures graphs confirms that: the temperatures increase during the central hours of the day, particularly in summer; in this situation even the air moisture is high, as you can see in the fig. 11.

THE COMFORT OF THE EXSTING BUILDING
From the analysis of the exposure to the sun of the building we have noted that the façade more exposed to the direct solar radiation is that on the plaza, exposed to Southeast. Actually, because of the particular urban location of the building (on the boundary of the historical city centre, along one of the short sides of the biggest square of the old city) three façades are almost constantly shaded by the surrounding buildings while the main façade, because of the large space of the rectangular square in front of it, is shaded only for a small part on the left corner.
Microclimatic analysis has been performed inside the building through the new model of
We have interpolated the thermo-hygrometric data acquired by using a BABUC/A station (made by
L.S.I.) with the adaptive model obtained by using a questionnaire filled up by the municipality staff.
From these data have been possible to identify a clear mapping of the building discomfort.
Nowadays the evaluation of the microclimate in confined environments has assumed a great
importance because, unfortunately, people spend more and more time in them. In the case of
temperate environments, the ASHRAE Standard 55/1992 and the ISO 7730/1994 give the limits and
the recommendations that have to be followed in order to achieve the comfort conditions.
The evaluation of the conditions is carried out through given indexes that are called “global comfort
indexes”, based on six different parameters such as: air temperature, air speed, hygrometric degree,
radiant average temperature (physical parameters of the environment) and the energetic metabolism
and the clothes thermal resistance (parameters related to the building users).
We have analysed the data derived from 36 questionnaires filled up during the morning in a day of May
with a temperature of 25 C°.
Over heating within the building represents the main cause of discomfort. Differences have been noted
among the five floors of the building and, also, among the different work spaces on the same floor. It
can be seen that the comfort of the basement gradually changes into discomfort on the upper floors of
the building.
The data have shown the difference of thermal comfort felt by the workers in the offices near the main
façade on the square and the workers in the offices on the opposite side, where there is a small
courtyard. The first group of people have judged, from the thermal point of view, their offices “tolerable
with difficulty”, the second have judged their offices “more tolerable” because of the presence of the
courtyard.

![Fig. 13. Direct Solar Radiation on the southeast and on the southwest façades.](image)
The chromatic scale goes from 0 watt/h (blue colour) to 1500 watt/h (yellow colour)

![Fig. 14, 15. Graphs related to the “adaptive analysis” of the basement and the second floor.](image)
The analysis carried out by using suitable instruments have given, in general, the same results as above. The instruments have also indicated an insufficient air exchange.

THE RENOVATED BUILDING
The results of the analysis synthetically reported above have pointed out the necessity to improve the natural ventilation inside the building and to screen the main façade, in particular, from direct rays of the sun by improving, at the same time, the natural lighting. With this aims in mind we have designed the recovery actions that should be able to renovate the old building by transforming it into a new sustainable building. In order to do this we have studied the traditional architecture of the countries that face the Mediterranean Basin to derive from it the criteria to naturally ventilate the inner spaces of the new building that we want to change in a museum for “only one piece of art”: the “Satiro Danzante”, a Greek bronze statue of the 4th century BC, probably made by Praxiteles that have been recovered from the sandy sea floor at a depth of 1600 ft. off the southwestern coast of Sicily in 2003.

We have studied the Iranian towers of wind and the sun shading systems of the Arabic architecture but also the double skin façades of the contemporary architecture and the solar chimneys in the way to design a passive cooling system.

The traditional architecture of the Mediterranean Basin has been strongly influenced by the particular climatic and environmental conditions, by respecting in an unconscious way the sustainable criteria, which many contemporary architects tend to. Actually, the “Sirocco’s Room” typical of the old villas in the countryside of Palermo, the “Covoli” of Costozza as well as the Iranian “Towers of wind”, were able to guarantee the comfort inside the buildings without energetic consumption. So, the sun and the wind have become the “design materials” that we have used in order to renovate the building.

We have decided to maintain the original bearing structure made of r.c. by demolishing, at the same time, both the internal and external vertical partitions and the 5th floor. Friction dampers are foreseen at the bearing surface level, in the way to respect the Italian seismic roles.

The new building is developed on four levels. The entrance is brought at the basement level, 0.80 m under the level of the square. A great staircase has been arranged in parallel to the main façade in the way to allow the access to the different floors of the building. This façade is made of glass, shaded by a large sunscreen made of marble and steel perforated plate. On the back of the building, we have foreseen two terraces connected to each other and to the new roof level through open staircases. The last terrace that corresponds with the roof of the building is partly covered by a curved screen made of photovoltaic panels that represent the new covering.

Fig.16, 17. The PMV Index (Predicted Mean Vote) and the second floor plan in which are located the points of relief.
The new building is 16 m tall. Its building envelope is made of a triple skin: a double skin that are jointed to a sunscreen that in relation to the staircase is made only of steel perforated panels while, in the remaining parts, it is made of the same panels casually alternate to panels made of marble in the way to more reduce the direct solar radiation on the double skin.

We haven’t arranged any windows at road level. The freshest wind, that flows to a higher level than the buildings of the historical city centre, is captured by a modern tower of wind located behind the building, inside a small court.

The channels inside the tower allow the outside air to enter into the building. In the original wind towers wet cloths or wet carbons were used to cool the air by evaporation. We have chosen to put a water atomizer to cool the air, as we have seen in some wind towers in Israel. The operation of the passive cooling system that we have designed foresees a point where the air enters the wind tower and a point of discharge correspondent to the southeast façade. Actually, this last one exploits the “chimney effect” by capturing the warm air accumulated in the building and extracting it using the façade as an air pipe.
CONCLUSIONS

We have shown the criteria that we followed in the renovation of an existing building of the 1970s to convert it into a contemporary sustainable building. At present we are developing the technical solutions related to the triple skin of the new building envelope. It joints together different materials in a manner to optimize natural lighting inside the museum while defending it from direct solar radiation that produces an increase of temperature. We hope to reduce the energy consumption by integrating, in the building envelope, a system of solar panels in a way to contribute to the energy production, according to the Italian D.L. 311/06 that provides -in the cases of renovation of buildings that are more extended than 1000 sq ft- the installation of solar cell panels.

REFERENCES