Analysis of the Riacho Fundo health centre project implementation under the light of energy conservation – Distrito Federal – Brazil

Eliete de Pinho Araujo¹ and Eric Silva²

¹ Teacher / Master’s Candidate / Architect - elietepa@uol.com.br
Course of Architecture and Urbanism, FAET, SEPN 707/907 – Cep 70790-075, Brasilia DF Brazil, Telephone/fax 55 (61) 344-2116

² Student, Course of Architecture and Urbanism, FAET, UniCeub

ABSTRACT: Energy consumption is an important project criteria and a parameter to evaluate a building’s performance. Because of its operational and usage needs, a building’s internal environment conditions can be controlled without restrictions with the production of warmth during cold weather, light during darkness, acoustic privacy, etc. Therefore, there must be an efficient methodology for the building’s project from an energy consumption point of view such as: - identifying the parameters interfering in user comfort and the level of comfort required (environmental: air temperature, humidity, wind speed; and functional: type of clothing, activities carried out, age); - identifying the climatic conditions for which meteorological data evaluations will be carried out; - characterizing the building by means of its internal and superface air temperatures and air renewal rates. The building chosen for this study is the Riacho Fundo Health Centre at Riacho Fundo, 17th Administrative Region of the Distrito Federal.

To begin with, all important factors, parameters and criteria to be used in the preparation of an energy-efficient project were set out. Actions to rationalize energy consumption have their outset in the architectural concept. Cultural and physiological parameters are considered together with the physical environment where the building is located since it has a significant impact over the project as it defines the behaviour of internal environmental conditions. The assessment of temperature and light performance is an important instrument of energy efficiency. Temperature performance considers several aspects including the climate (wind, solar radiation, air temperature, relative air humidity and insulation), the vicinity (location in relation to other buildings, typology of surrounding buildings, features of the landscape-vegetation, water mass, soil recovery, topography), the building itself (implementation, thermal characteristics of construction materials, morphological features of the building and its internal environments) and its occupation (period of occupation, number of persons and activities carried out, number and nature of equipment installed).

Energy conservation is not only about saving electricity. Conference Topic: Reflections on sustainability
Keywords: energy, comfort, sustainability.

THE SITE

Distrito Federal (Figure 1) climate and the requirements for internal thermal comfort.

Riacho Fundo is situated near Brasilia at latitude 16 degrees South and 1,100 meters altitude, almost at the geographic centre of Brazil. Local air temperature combined with relative humidity generally falls within thermal comfort limits during the day period, for individuals at rest and in the shade. At night the temperature is slightly below comfort limits.

The local vapour pressure of 5 to 8 mm/Hg defines a semi-dry climate for the region, with two well-defined periods: a rainy season from October to April, and a dry season from May to September, when four to five months with no rain is very common and relative humidity levels can fall below 25 percent. The sky is generally clear, with intense direct solar radiation. The city is well ventilated in general.

Buildings in the region are expected to have appropriate shading devices and to be designed to allow access to natural ventilation for thermal comfort.

Riacho Fundo is situated within the 17th Administrative Region nearby Núcleo Bandeirante. It is bordered by the EPNB-DF 075 road that connects Brasilia to Goiania, Sucupira Ave. (West) and Placa Mercedes Sector (East).
Figure 1: Map of Distrito Federal - Brazil

THE SELECTED BUILDING AND THE DATA COLLECTED

The building

The building chosen for this study is the Riacho Fundo Health Centre (Figure 2) situated at QN9 AE8 of Riacho Fundo, with a required occupancy rate of 60%, minimum setbacks at front 5.00m, lateral and at back 3.00m, maximum elevation allowed 9.00m and vehicle access from any side bordered by a public road.

The building has one floor with 390.62m² of constructed area in mortar in natural concrete colour and some façades and compartments painted in white, making internal environments dark (grey) and clear (snow white). The dark environments have little natural light and need artificial light during the day, a few have openings (windows) with vertical sun blinds.

Other environments do not have façade openings but ceiling openings, called vertical sheds. As to wind conveyance, there is a small entrance opening in the East-Southeast direction and a bigger exit opening facing West bearing vertical sun blinds and causing increased wind speed. Sun blinds are alike on all façades, the same 90 degree angles, painted white and standing at half way between floor and ceiling.

The building is typical and different from the surrounding buildings.

The Health Centre border is its own plot limit, marked by differences in level. There is no fence.

As to urban furniture there are 5 external lighting posts, 3 benches and one news stand.

The Health Centre Programme is made up of 4 basic surgeries, one dental surgery, one room for injections, preparations, nebulization, wound dressing and immunization, an administrative area with its usual services and a communal room for public talks with the community.

Air temperature and luminosity measurements in the various internal and external environments

A few of the procedures carried out on the site are shown in Table 1. It was verified that direct radiation is of greatest incidence, air and surface temperatures are very high and milder outdoors than indoors, the albedo is high and there are areas with no shadow or vegetation.

Table 1: Measurements carried out during September at 14:35

<table>
<thead>
<tr>
<th>ENVIRONMENT</th>
<th>TEMPERATURE (°C)</th>
<th>LUMINOSITY (Lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>39.5</td>
<td>5</td>
</tr>
<tr>
<td>Bathroom</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Kitchen</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>Circulation with shed</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Circulation without shed</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Injections room</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Medical Clinic – at window</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>Medical Clinic – wall opposite window</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Waiting room with shed</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Surgery</td>
<td>40.0</td>
<td>7</td>
</tr>
<tr>
<td>Bathroom</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Outside area (West)</td>
<td>37.9</td>
<td>15</td>
</tr>
<tr>
<td>Main façade (sun blind)</td>
<td>38.3</td>
<td>15</td>
</tr>
<tr>
<td>Left side façade (white)</td>
<td>33.5</td>
<td>-</td>
</tr>
<tr>
<td>Elevated water reservoir (concrete)</td>
<td>35.0</td>
<td>11</td>
</tr>
<tr>
<td>Communal Room</td>
<td>39.9</td>
<td>10</td>
</tr>
</tbody>
</table>
RECOMMENDATIONS

How to improve internal thermal and luminosity comfort while saving energy

Based on the results obtained, it was proposed (Figure 7) and suggested:

SOIL:
The soil of the plot under study has no vegetation cover and is impermeable as a result of compaction; all that is left is clay. The area was deforested to allow for the implementation of the Health Centre and has since not been recovered or treated to minimize the dust and mud found at various times of the year.

The suggestions implemented were a Green Pharmacy divided into various beds of medicinal plants, a parking lot for vehicles and an ambulance paved with hexagonal blokrete and paving the numerous accesses to the Health Centres and other areas such as the Green Pharmacy, the newestand the playground with cement, pebbles and grass.

There are elevation differences by the borders of the plot at North and East. A bed of grass and trees was arranged whose function, apart from holding rainwater coming down from the lots above, is to provide shadow for the parking lot and the Health Centre façade.

TOPOGRAPHY:
The plot is situated on level curves 1165, 1170 and 1175 and in order to build the centre, it was levelled and covered with earth and it now rests upon a plateau of dubious safety depending on the type of foundation used. This plateau can collapse with rainfall and there is a difference in elevation of some 1.20m between the Northern and Eastern borders, being higher in the area outside the Health Centre. In order to protect it from rainwater cascading from outside, an adequate retaining wall was planned. It was suggested that high grass should be planted by this wall to absorb rainwater, pebbles and sand.

Within the plot, the Health Centre was built upon a plateau with differences in elevation of 0.60m. The area is very delicate and should be protected from rainwater both inside and outside the Health Centre as serious damages such as erosion already occur in lower elevations of Riacho Fundo. The area surrounding the Centre should then be treated so as not to cause such damage to the environment: roads, residences and avenues.

VEGETATION:
There is presently no vegetation at the Centre as mentioned above. As a suggestion, the Green Pharmacy was planned between a line of taller trees, one of which is by the building where it receives the morning sun and another for the protection of the medicinal plants. Another sequence of these trees was placed by the parking lot and the West façade of the building, which receives the full afternoon sun, in order to minimize the heat inside the building and afford greater comfort to users. On the plot’s Northeastern border there is also a line of trees to protect the Centre from dust-bearing wind. On the access to the Health Centre there is a playground paved with grass and beside it there is a rest area for the elderly with benches under shadow-providing trees.

The vegetation will have a key role here because it will absorb part of the rainwater flux that will run through the whole area of the Health Centre and its surroundings. The vicinity will then be treated with vegetation and alternative gutters that will conduct the water to the rainwater catchment network.

According to statistics by the Ministry of Aeronautics, over 70 percent of all the rainwater accumulated during the year usually falls between November and March and during the rainiest trimester in the Federal District, during the months of December, January and February, it rains 45 to 55 percent of the annual total. During this rainiest trimester, at the rainy season, there is enormous rainwater excess, the soil is saturated with humidity and there is a lot of river flooding. The intense superficial rainwater drainage would cause the soil running down from the lots above the Health Centre to end up within its plot.

So the vegetation will contribute a lot as a local factor in the control of rainwater. It will absorb some 20% of the water.

The justification for this alternative is presented in Table 2, which compares both seasons.

<table>
<thead>
<tr>
<th>SEASON</th>
<th>PRECIPITATION</th>
<th>VICINAL AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>20 mm</td>
<td>348,000 m2</td>
</tr>
<tr>
<td>Rainy</td>
<td>350mm</td>
<td>348,000 m2</td>
</tr>
</tbody>
</table>

MATERIALS:
The materials used are as follows:

Decorative element:
- The retaining wall is made of mortar; its height is at the level of the plot and it surrounds the Health Centre. This wall has a few openings that allow the passage of rainwater falling into the concrete gutter built along the retaining wall outside the Centre. These openings also serve to irrigate the internal garden placed at the plot border, along the wall (Figure 3).
Floor:
1- The floor is composed of:
   . access sidewalks made of mortar slabs measuring 60 x 60 cm.
   . gardens planted with low and high grass and various trees. These trees have different heights and their tops are different in form and dimension. Different heights allow North-eastern wind to pass through the trees (Figures 4 and 5).

Figure 4: Wind to pass through the trees

Figure 5: Trees and gardens.
   . the parking lot is paved with hexagonal blokrete, a pleasant material permeable to rainwater;
   . the Green Pharmacy consists of planted medicinal plants distributed throughout beds;
   . the water mirror is 60 cm deep and has a decorative panel that will conduct wind towards the best direction. Its location is a function of the water mirror and it is important to cool the air inside and outside the building (Figure 6).

Figure 6: The water mirror

2- the building’s internal floor has been maintained. It is made out of korodur.

Walls:
- all walls are made of mortar;
- sun blinds are made of metal and pieces of wood veneer painted White;

- side lighting: windows are created on the Southeast and Northeast Windows to allow increased ventilation in the environments. They are made of metal and are identical to the existing lighting with see-through glass and a height of 1.50 m. Tall windows are also created and these communicate with the consulting rooms’ waiting room of the Southeast façade to offer better lighting inside them. The windows improve thermal conditions.
- external façades with blind walls painted in white acrylic enamel. The painting improves thermal conditions by 10%.
- wet area walls (kitchen, bathrooms, preparation of materials, dental surgery, immunization, wound dressing, consulting rooms and nebulization) are painted in snow white acrylic enamel to afford better lighting. The painting improves lighting conditions by 15% according to calculations.

Ceiling/roof covering:
- the roof covering is made of mortar;
- the roof covering is changed. It has been proposed to have its outside painted in snow white acrylic enamel so as to reduce heat inside the building. The painting will improve thermal conditions by 20%. Existing sheds are made of transparent glass with an opening for air passage and open and closed spaces in glass for better illumination and ventilation. These improve lighting conditions by some 40%;
- in order to reduce heat coming from sunlight striking the roof covering, an insulating material will be used in Internal Circulation, Management, Secretariat and Consulting Rooms and it will improve thermal conditions by 50%;
- 16W and 32W economic fluorescent lamps will be installed.

Table 3: Improvement of thermal and luminous comfort

| WALL                | WALL | CEILING/RO 
|---------------------|------|-------------------
| Internal paint      | 5%   | 1%                |
| External paint      | 0%   | 2%                |
| Windows             | 5    | 0%                |
| Dome                | -    | 4%                |
| Insulating material | -    | 5%                |

Page 4 of 5
CONCLUSIONS

The building of a retaining wall at both borders of the plot where there are elevation differences improves conditions because the plot is covered with earth and rainwater would cause earth from lots above to fall into it.

Putting plants in the site will also improve conditions since they will absorb 50% of the rainwater, retain dust and provide improved thermal comfort to Centre users.

The opening of windows makes it possible to work with natural light.

In order to have an energy-efficient project, knowledge of internal and external phenomena caused by the building has become the starting point. By controlling such phenomena, thermal loads originating in the impact of the outside environment over the building could be worked to rationalize energy consumption making it available to acclimatization and artificial lighting. In order to have an efficient performance, the project’s first item is made up of a series of actions.

Thus, glass surfaces determine the heat flux penetrating the interior, increasing internal temperature; opaque surfaces and their heat-retaining properties; trees of different heights and types minimize heat and direct the wind, and the garden adjacent to the external building walls cool down internal environments. These aspects determine the need for removing of keeping thermal loads to obtain comfortable conditions. All proposals in the “materials” test improved thermal comfort conditions by 60 to 70%.

Saving energy is not only about saving electricity. It is about thinking of Architecture, Urbanism and Building projects that take into account wind, light, sound and noise accesses.

Improved natural lighting and ventilation, less heat in the building’s interior, plenty of vegetation to avoid dust, noise and to increase the provision of shadow, environments painted in light colours and the use of efficient architectural elements will provide the necessary comfort, rationalize energy consumption and, reduce building and maintenance costs.

In a country such as Brazil, much is yet to be done in order to make the rationalization of energy consumption a part of our everyday life. There must be an effort to increase the knowledge already accumulated in the field of architecture technology and to disseminate technical information. Economic resources are scarce and the presence of light is dominant. The kind of Architecture that maximises the use of its own resources in order to explore the potential of light, for example, is the most indicated solution for both environmental quality and energy saving.

REFERENCES