Shelter Design

Reduction of energy consumption in buildings

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1- Shelter Situation Analysis:

The national housing strategy in Tunisia has focused on the concretisation of the slogan “Decent shelter for all” by:

- Reinforcing the existing housing stock by building new units by public and private developers and families too,
- Improving housing levels in ancient (medians) and informal quarters through the state intervention,
- Eradication and replacing of all rudimentary building by new and adequate units through the national programme of eradication of rudimentary dwellings.

Basic General Data:

Geography and administration

Officially name: Tunisia
Capital (and largest city) : Tunis 1.897.000
Total Area: 164.418 km2
Coastline (Km): 1300
Climate: well-watered north with Mediterranean influence (an annual average reading of 18 ° c) semi-arid. The temperature still can get below 0°C (32°F). In the summer it can get up to 32°C (90°F).
Main cities: Monastir, Nabeul, Sfax, Sousse, Tunis.
Official language: Arabic
Religion: Islam

Health, Demography and urbanization:

Population:

- July 1, 2008 estimate 10.327.800 (79th)
- 2004 census 9.910.872
- Density 63/km2 (133rd (2005)) 163/sq mi

Literacy rate: Total 76.2% (women 66.7%, men 85.7%)

Urbanization:

Tunisian towns are characterised by the juxtaposition of two urban units:

- The old town "the medina", harmonious layout and morphological and architectural specificities, and presents a number of problems such as degradation of buildings.
- The modern town constructed in the 19th C, characterised by its European style. it is noticed that 66% of the population live in the urban areas (in 264 towns) and particularly in the north-East and centre-East,
- Population density average of 60 person/km^2.
- the population isn't equally distributed on the Tunisian territory
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	1966	1994	2004	Increase rate
Total population	**5483200**	**8785700**	**9910872**	1.21%
Urban population	**40.1%**	**60%**	**65%**	
Population density (inh/ km^2)	**27.7**	**56.5**	**60 (4-400 inh/ km^2)**	

Health:

Health conditions have improved significantly in recent years. Epidemics have virtually disappeared and contagious diseases have been considerably reduced.

	1966	2004
Life expectance in birth	51 years	73.2
Mortality rate	15 ‰	5.8 ‰
Mortality rate at birth	138 ‰	22 ‰

Expectations of life: total 74.9 years (women 76.7, men 73.2%)

Economy

- Currency : Tunisian dinar (TND)
- Exports: agricultural products (olive oil, citrus, dates), phosphates and phosphoric acid
- Import: consumer goods, raw materials, equipment
- Main export and import partners: France, Italy, Germany, Belgium, Luxemburg, United States
- GDP (PPP) 2008 estimate
  - Total $ 82,226 one billion
- GDP (nominal) 2008 estimate
  - Total $ 40,348 one billion
- Gini (2000) 39.8 (medium)
- HDI (2007) 0,766 (medium) (91st)

In 2007 it had a GDP of $35 billion (official exchange rates), or $76.07 billion (purchasing power parity). The agricultural sector stands for 11, 6% of the GDP, industry 25, 7%, and services 62, 8%.

In recent years, a gradual diversification of the Tunisian economy is noticed. Ranging from agriculture, mining (crude oil and phosphates), manufacturing, petroleum products and tourism are the leading source of foreign exchanges.

The industrial sector is mainly made up of clothing and footwear manufacturing, production of car parts, and electric machinery.

Agriculture: agricultural products engage about 22% of the labour force.

In the recent years, it is noticed:

- A growth in architectural, industrial and services,
- Improvement in the sector of tourism,
- An increase in the manufactories exportation.

1.2 Shelter Related Fact and Figures

Access to Shelter

Housing stock

Housing in Tunisia is characterised by:

- An increase in the number of dwellings which exceeds the number of households in fact about 15% of the whole housing units are not occupied,
- A decrease in overcrowding dwelling due to the increase in the size of the dwelling ranging from 50 to 90m^2 for 40% of the hole of dwellings.

- A decrease in the number of rudimentary dwellings from 44% in 1966 to 0.8% in 2004
- There is no Housing shortage. However there are difficulties to satisfy all the housing needs of low and medium-income groups.

Housing standard:

About 2000 social dwellings per year are financed by FOPROLOS for low and medium income citizens
The public sectors offered about 5000 economic dwellings, 8000 social buildings and 600 high standing.
An average of 15 m^2 floor area is offered by public and private sectors per person.
Tenure of households
Tenure of households the problem of illegal occupation of land is restricted to some old districts occupied without legal deeds of ownership. In this context, the State axed its projects on:
Generalise and speed up the process of land registration,
The introduction of a number of structural reforms for organizations.

Ownership and Rental:

dwellings and Households in 2004		
Owning dwellings	**Renting dwellings**	**House price**
77.4%	**22.6%**	**ranges from 385 to 925 US$/$m^2$ House price is 6 times household income**

	1994	1999
Ownership		
Median house price (US$)	**31 500**	**37 850**
Median annual household income (US$)	**6 967**	**7 226**
house price/ household income	**4.52**	**5.16**
Rental		
Median rent (US$)	**1 150**	**1 800**
Median annual household income (US$)	**6 967**	**7 226**
house rent/ household income	**0.17**	**0.25**

Land (formal/informal)

The government made rules for the intervention of public and private actors in order to satisfy the national demands in land and to give equal access to it by:

- improving of the production level of constructible land by public actors such as the Housing land agency AFH which produces about 150 ha par year

- adjusting the tariffs of constructible plots produced by public actors according to plot area in the development, situation, occupation mode and services offered in order to reduce the prices of social housing (which is about 20.000 US$ for an individual dwelling of 50m^2 and 30.000 US$ for a collective dwelling of 75m^2.

In fact, the price of m^2 of developed land for building is about 85% of the monthly median in-come, whereas the rise of raw land is about 10% of the monthly median income. Consequently, the recent years have an increase in the unplanned self-built quarters.

Building materials

The construction is based on the use of local materials and especially stone, reinforced concrete for supporting structure and brick, wood, concrete and glass.

The major architectural forms (vaults, domes, arcs, pergolas...) are built using local building materials and techniques in order to preserve Tunisian architectural characteristics and to offer a thermal comfort during the year.

Access to and cost of Basic Services/Infrastructure:

Tunisia is noticed an improvement of living conditions during recent years

Basic services	**1987**	**1994**	**2004**
Electricity (%)	**32**	**86.9**	**99**
Drinking water (%)	**28.7**	**84.9**	**95.6**
Sewage (%)	**51.5**	**59.8**	**78.3**
Telephone connection (%)	**3**	**15.2**	**75**

Access to and cost of Education

- It’s noticed a qualitative improvement of the education system and an increase in the number of students
- The rate of literacy of adults increased thanks to the program for reducing adult illiteracy (between 15 and 24 years old) launched by the state

Education level	1966	2004
Primary school (%)	59	99
Secondary school (%)	17	75
University (%)	2.1	26.4
Rate of adult literacy	44.7	95

Housing and Urban Development Policy

The political situation in Tunisia is based on a policy of direct housing; the government provides basic services and infrastructure. A number of public institutions have been created.

Since 1995, this policy has increased to a policy of citizen-centred and self-help.

To support local authorities, the state founded several "urban development projects" to cover the needs of the population.

1.4 Actors in Shelter Delivery and their Roles:

The Housing in Tunisia is characterised by the participation of different public and private actors.

Public actors

- **The National Estate Company (SNIT): until 2006, the SNIT built about 260000 housing units (60% social, 35% economic and 5% standing),**
- **The Housing Land Agency (AFH): the AFH, covers about 25% of the national needs of developed land for housing,**
- **The Social Housing Promotion Company (SPROLOS): until 2006, the SPROLOS built about 20000 units for low-income social categories,**
- **The Urban Rehabilitation and Renovation Agency (ARRU): created in 1981 and was in change of renovating and rehabilitating old dwellings and unregulated self-built housing in urban areas,**
- **Housing Corporations: transferring land and building house to adherents (military housing office, ministry of education housing office, ministry of Interior housing office…).**

Private actors:

- **The number of developers increased form 150 developers in 1988 to 1380 now.**

1.5 Shelter Design:

Physical Planning:

Planning is regarded as the ideal framework to define the direction and priorities according to a long-term vision. It takes into account the economic, social and environmental

the objective of a legislative framework is to adapt the legislation to the requirements of urban growth and the new policy in the field.

Population Density:

- 29 dwellings/ha (about 140 inhabitants/ ha) in the new operations of building, the popular quarters and the ancient towns (medians),
- 35 dwellings/ha (about 185 inhabitants/ ha) in the big towns,
- However the average of the population density in the rest of the territory is about 15 dwellings/ha (about 75 inhabitants/ ha)

Shelter Quality

The Shelter offers an acceptable quality of the interior space by using good building materials as well as providing connection to electricity, drinking water, sanitation system, phone, central heating and air-conditioning.

Social Inclusion:

In the recent years the new housing operations tried to design housing projects including both high standing and social dwellings in order to assure the cohabitation of different social categories in the same quarter.

Gender Issues:

Tunisia succeeded to offer equality between men and women in all he fields (education, work, land and house property, credit access and job).

2 Organisation

The Regional Directorate of Equipment and Housing and Physical Planning is a public institution responsible for:

• Monitoring and control of road projects

• Research and monitoring projects of civil buildings

• The organization of the housing sector by permission of Building

• Review and development plans for towns

The management includes the following services:

• Bridges and Roads

• Civil Buildings

• Urban Planning

• The administrative and financial

Regional management of equipment and housing and land use planning plays a crucial role in the design of housing and development. Indeed the two services, urban planning and habitat are reserved only for housing projects, from conception to regulation through the evaluation of building permits submitted by developers, individuals and public sector (SNIT, AFH).

This mission is carried out by a technical staff consisting of architects, engineers and technicians to better control the housing sector on the technical and regulatory development and enhancement of the landscape and social space.

3 -Shelter problem:

The problem of homelessness is a large complex program. In our design of the shelter and development issues that may arise is a space, how to provide land to build? What are the means of spatial management? But also an economic one: what are the procedures for access to home ownership for the class to the middle and lower revenues? And finally to conceptual, how to reduce the consumption of energy in buildings

FEATURES OF CLIMATE IN TUNISIA:

The Tunisian climate is mild and temperate, so it is fairly easy to obtain a comfortable indoor climate all year round, subject to compliance with certain principles and use moderate-to-energy for heating and cooling. But unlike other latitudes, a climate which has a double problem: Need to avoid the harsh winter cold, but excessive heat during summer. Regarding the choice of design, requirements winter and summer are sometimes in agreement, sometimes in contradiction.

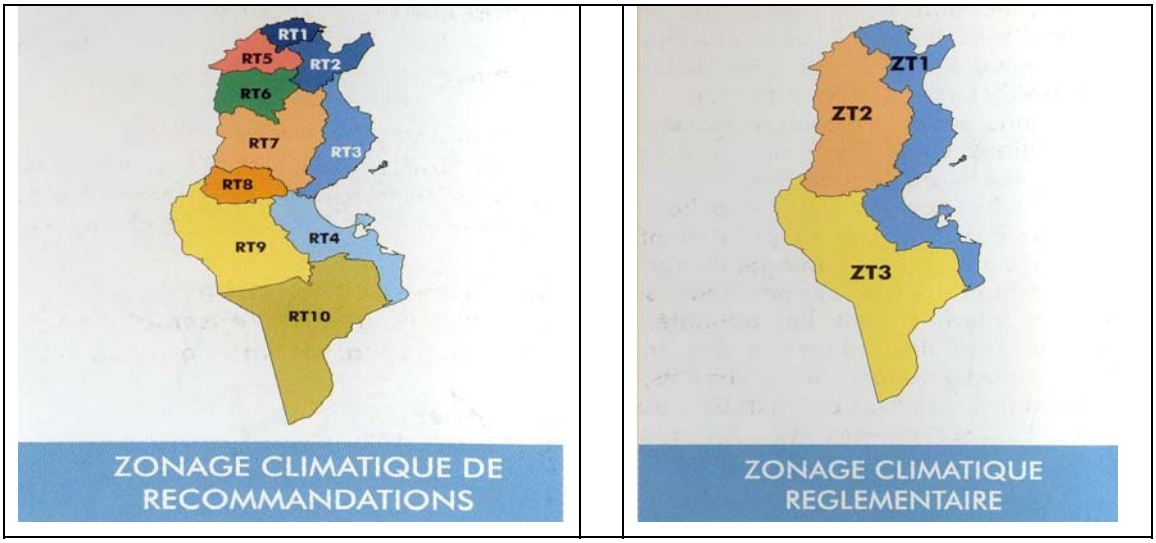
It must then be cautious about recommendations for other latitudes.

This dual requirement of comfort required to understand the benefits of each solution technique to select the best compromise with respect to your specific criteria.

- The Mediterranean ZT 1
  The highlands of North ZT 2

The Southern Highlands ZT 3

The plateaus of North-East
Bizerte Governorate RT 1
The plains of North-East
Governorates of Tunis, Ariana, Ben Arous, Mannouba, Zaghouane and Nabeul RT 2
The plains of East Cenre
Governorates of Sousse, Monastir, Mahdia and Sfax RT 3
The plains of South-East
Governorates of Gabes and Médedine RT 4
The plateaus of North-East
Governorates of Beja and Jendouba. RT 5
Mountains Northwest
Governorates of Kef and Siliana RT 6



Winter Issue:

The comfort temperature depends on many factors including the activity of the occupant and the nature of his clothes. For a residential activity and winter clothing, it is between 18 ° C and 20 ° C.
The outside temperature is generally below this value during the winter season. It follows a flow of heat from inside (warmer) to the outside (coldest). The heating function is to provide a quantity of energy equal to the loss, allowing the maintenance of set temperature.

In winter, the contributions called "free" are beneficial and reduce the need for heating. These inputs and internal solar gains. The internal contributions are the amount of heat produced in the home: heat generated by occupants, lighting, cooking or appliances. Solar gain enters the housing, either through the glass walls, or through the opaque walls.

We know from everyday observations that during the winter, the sun is never very high in the sky (even in broad daylight) and its rays are near horizontal. In Tunis, the height of the sun) noon TSV (True Solar Time) is about 30 ° only December 21. It follows that by midday when the sun is to the south, the sun's rays strike the southern facades (and close to the South) with a low incidence angle because they are vertical. These facades are then much more solar radiation than a horizontal surface. They therefore support the placement of windows that could capture this beneficial solar gain.

Capturing solar energy:

Create openings for side sun widely and receive energy

Stoker mass:

The heavy materials placed inside the building provide a thermal inertia which allows it to store energy.

Keep the insulation:

Thermally isolating all of the walls surrounding the heated volume to keep the heat stored in the air and walls.

Distributing:

Divide the accumulated heat in the air and the heavy walls at night.

Summer Issue:

The practice is to allocate as much as possible overnight accommodation, seeks to build, very wisely, the cool night.

For a residential activity and summer clothing, the comfort temperature is between 26 ° C and 28 ° C. The outside temperature is generally greater than this value during the day, heat (Junk) will then enter the housing through its walls.

This heat will heat the air inside, but also the walls of the building and his structure.

The function of air conditioners is to provide cooling to reduce air temperatures lower than you want. There is an advantage during the day to "isolate" the building of its environment. But during the night, the situation is different. For most regions of Tunisia, the temperature outside during the night is usually below the comfort temperature you want (it is around 23 ° C).

During the night, this is not the external environment which heats the air inside, but these are the walls of the building that the warming by releasing heat they have accumulated during the day! There is no question in this case to try to isolate the environment. Quite the contrary, the practice of breaking down the possible housing during the night, trying to build, very wisely, the cool night.

Unlike the winter free flows are undesirable warmer and contribute to increased needs of refreshment. In summer, the sun's path is longer during the day and rises higher in the sky (The height of the sun at noon TSV in Tunis is close to 70 ° June 21). By midday, a horizontal surface is so heavily exposed to solar radiation more intense this season. But because of the almost vertical rays at midday, they do not hit the front vertical surfaces South (and nearby South) to whom they are the radiation that these surfaces are then very moderate.

In contrast, mid-morning and afternoon when the sun is to the east and west, it is low on the horizon, its rays strike so front vertical surfaces East and West. We must remember that summer, horizontal surfaces, vertical East and West are exposed to sunlight and must be protected. Vertical surfaces are much less south exposed summer and winter much better and they sound so good. .

STRATEGY IMPLEMENTATION IN THE COLD SUMMER:

Protect from sunlight

Protection of berries by shutters and blinds

Deciduous vegetation in South

Cooling:

By night ventilation

Factors affecting the quality of your home:

The major choices you'll be asked to do and have a significant impact on the energy performance of your home affect the following aspects:

- The building design
- The materials and construction techniques

- Facilities

  The management of the building and equipment.

Following this guide includes four parts providing explanations, advice and recommendations on each of these aspects. The advantages and disadvantages of different solutions are presented, often in comparative tables.

DESIGN OF BUILDINGS

This section aims to give you essential knowledge about designing a building. You will always benefit you to contact a professional (architect, heating engineer), which will help you find the right compromise between a set of criteria and requirements of different, sometimes contradictory.

The information presented below should help you understand all the factors that affect the quality of thermal comfort of your home and your energy bill. You can then discuss with professional knowledge.

The technical design of the buildings here is envisaged under the temperate environment of Tunisia, it will adapt the advice given to the geography of the location, its microclimate where appropriate, s topography and all parameters a specific physical site.

General principles:

Sustainable architecture is designed to take advantage of the characteristics of external environment to achieve a comfortable indoor climate. It is therefore reap the benefits of sun, wind, light …

But beware! Taking advantage of natural elements does not mean to be their thank you. We must therefore exploit these elements through controllable components. For example, to enjoy the winter sun, do not favour the irradiation of opaque walls
(Walls, roof), because we cannot act on their sun exposure during summer.

The role of solar will be dedicated to the window and windows, because the handling of shutters and blinds allow sunlight to admit at times when it is desirable and hide when it is not.
Similarly for ventilation. Do not accept a bad seal doors and windows pretext ventilation housing. Aeration should be done deliberately through controllable openings.

The location of the frame:

* First step:

The first stage of the proposed building is to choose the field. Wherever possible, you choose a field to have a main facade facing south, and quite clear. A land whose east-west route is longer and better because it allows a southern facade larger area.

* Second step:

The second step is the choice of location of buildings from the ground. This choice of location should be well thought because it directly affects the thermal comfort of the building because of its impact on the relationship to the sun and prevailing winds, and on the overall shape of the building.

Although the flexibility to implement a building is fairly small town, it is advisable to always keep in mind some basic principles governing the choice of location. They must be based on knowledge the finest possible climatic and topographic characteristics of the site, such as the height of the site, the percentage of slope, level and temperature changes, hours of sunshine, fog and mist, masks and proximal elements (vegetation, urban) or distant (mountains, sea) to reduce the insulation of the building.

You will place the building in some of the ground in minimizing the influence of the masks in winter in order to take full advantage of solar energy. For example, it is preferable to locate the building on a slope where the sunlight (for winter) and air (summer) flow naturally in a bottom of bowl. A building on a sloping portion can also enjoy the coolness of the soil in summer to reduce temperature variations in the parts, achieving a semi-underground building, like the traditional houses of the South (Matmata). .

But beware: A basic rule to follow is that we must adapt the house to the ground and not the contrary! For example, if during the winter because of masks on the site, you have loss of sunlight the early morning, he will guide the building of a few degrees to the west.

You should also protect the building from the effects of prevailing winds, which are a major source of heat loss (by convection effect and infiltration). The protection may be provided by the relief of the terrain (natural or artificial), with winds breezes plants, or by annexes built. Thus, if for example you plan to establish a garden, you prove the place of the side where the warm winds whistle in the summer, so that the screen formed by plant trees filter the air temperature and decrease in the moistening.

Orientation of buildings:

The choice of orientation of the frame is crucial for thermal comfort and directly affects the energy bill habitat.

Therefore the choice must be designed with the most care so as to reflect the conflicting demands of summer and winter, and the path of the sun and the nature of prevailing winds in each season.

In summer, it is to limit solar gain and remove heat, while winter, it should take maximum advantage of solar gain, and protection from prevailing winds.

In general, you prefer a main exhibit in any other South exposure, because only to be advantageous to both summer and winter: We have seen that it allows for better sunlight in winter and reduce solar gain

in summer. In addition, an orientation course provides south adequate lighting; the house is naturally lit during the hours most "interesting" of the day, noon and afternoon, ensuring more saving heating saving lighting.

The main exhibits its west and east to avoid, because the sun's rays have hit (with a small angle of incidence) apertures, which are then difficult to protect. This is particularly derogating the summer, especially for the exhibition west because the sun's rays arrive at the hottest time of day.

The orientation of buildings should also be thinking of ways to have walls as tight as possible to the air, and minimize the adverse effect of winds (cold winds of winter and hot summer winds).

Tips:

So what to do when the most beautiful view is located on an unfavourable direction (that is - to - say no South)?

To take advantage of this exhibit while enjoying the beautiful view, you should opt for living rooms double orientation (south side and beautiful view), while keeping the front facade as South Main.

Shape, colour and volumetric building:

The architectural form and size of the building determine the overall loss of energy and also solar gain.

Will you opt for a building drawn or compact?

The form factor of the building is the ratio of its surface by its volume (S / V). The higher the coefficient is smaller, the energy loss during winter is low, over consumption of heating is reduced.

Indeed, for a given quality of insulation (see following section), the heating costs will be proportional to the wall surface in contact with the outside.

Thus, given the requirements of heating during the winter it is advisable to have a form factor less than 0.70. From this perspective, one-story house performs better than a house with only a ground floor.

To increase the compactness and reduce energy losses of winter, we may also consider taking advantage of construction, within the limits of the possible twinning with neighbours.

However, the situation in the hot season is different. During summer days, the building envelope tends to penetrate the heat inside.

In this case, a weak form factor is as favourable for winter. But during the summer nights, the walls allow the evacuation of heat to the external environment.

And more of convection, by which they give heat to the outside air, they emit significant thermal radiation to the sky. In fact, on clear nights of summer, in a semiarid climate, the temperature of the sky is very low and the nocturnal radiation wall skyward cool very efficiently! In this case, a coefficient of lift (large envelope for a given volume) is very interesting.

This is one reason why the houses are cool patio in the summer: they have a large area of housing, much of which is shaded during the day (mutual shadow of the wings of the patio).

You'll need to find a specialist with a good compromise for the form factor taking into account the specific course in your area: you do not choose the same form factor in El Kef (relatively small) than Tataouine (largest).

Do not multiply the angles on the walls, because each represents a thermal bridge, somewhat isolated area and instead of high energy losses.

Pitched roof or roof - terrace?

For a Mediterranean-type climate of Tunisia, it is preferable to a roof terrace. These roofs are better adapted to our specific, but they are sometimes harsh climatic constraints. Hence the importance of adequately isolate, to make them watertight, air and sun.

Interest of vaults and domes:

These roofs have very good thermal performance in hot weather. Indeed, at midday when the sun is intense and high on the horizon, they rarely receive more solar radiation than a roof - terrace. In contrast, during the night, they provide an outer surface much larger, enabling them to better heat removal by convection and radiation primarily to the sky.

Exterior Colour:

A coating of dark promotes absorbed solar radiation; a light colour will reflect sunlight preventing them from entering the building. The dark walls may seem beneficial for the winter, but they will be penalized in very hot weather! If we recall the principle that ought to be able to control the admission of sunlight in the apartment, one quickly realizes the right choice is a white exterior walls. This is the choice of traditional architecture throughout the Mediterranean basin.

Organization of Spaces:

Organization of interior space:

We now exploit the choice of orientation of the building and adapted to best suit your lifestyle in order to have liveable spaces.

The south facade is the most enjoyable point of view thermal (warm in winter, cool in summer) and the more enlightened, it is best to place parts live, such as living rooms leading to the advantage Best of all the benefits of this approach.

The main rooms can also be oriented to the southeast and east, to enjoy the sunrise while resulting in cool afternoon.

The direction of the kitchen depends on your lifestyle. If it is for you a living room where you take most of your meals, orientation south is advised. Guidance South East you will take your breakfast and enjoy the morning sun. However, if you cannot stand the intense heat of summer, it is preferable to place the kitchen in America: indeed, it is a piece that gives off much heat because of cooking appliances. The bathrooms are rooms that require few or no openings, nor sunshine. It is therefore advisable to place them in North. The utility rooms, where it is not necessary to have a comfortable temperature (entry, garage, workshop, garage ...) will preferably be arranged on the north side. These little spaces or unheated areas called buffers behave as thermal insulation and reduced heat loss and therefore energy expenditure during winter. During the summer, they also behave as thermal insulation, because mitigating the sunlight during the day and help remove heat at night.

Outside:

If you cannot change the general climate data, external works (buildings, vegetation) can still change the microclimate of a site by creating shade, slower trade winds, modifying the degree of 'humidity, storage and distribution of heat, creating noise barriers. Your goal here is to control the interactions of microclimates and facilities to minimize climatic, visual and acoustic in each season.

During the summer, even in a narrow street, because of the high position of the sun, the shade of buildings is reduced and thus may have impact on thermal comfort. In contrast, trees planted in front of house will have a more positive effect. The deciduous plants are particularly well adapted to the temperate climate because they provide shade was appreciated, while not decreasing the winter sunshine, because during this healthy they lose their leaves. In winter, they also protect residential prevailing winds. The presence of plants (trees, bushes, grass) absorbing solar radiation photosynthesis be a major source of reducing the temperature of the environment.

The presence of water as a fountain, pond, also contributes to reduced the temperature of the ambient air. Moreover, a secondary building located on the side of prevailing winds also play an important role in reducing infiltration have the habitat.

Design of natural ventilation:

The breakdown of local addresses several key requirements:

- Meeting the needs of health and comfort of the occupants, they must provide oxygen, remove odors, smoke, carbon dioxide and carbon monoxide, and revenue generated by the furniture or structures building.
- Improve thermal comfort in hot weather; a stream of air contributes to improving the feeling of comfort by eliminating sweat.
- Reduce cooling needs and improve the quality of the interior environment in hot weather. In summer, ventilation of the premises when the outdoor air is cooler than indoor air (especially at night) associated with high thermal inertia, can remove heat stored in the structure of the frame. The reduction of ventilation to a minimum during the hottest hours will however maintain that freshness.
- Ensure the conservation of built, this is achieved by the "elimination of the water vapour produced by the occupants (about 2.5 I / d p), which generally condensation and degradation.
- Facilitate the safe operation of combustion appliances located inside the housing.

The need for ventilation is undeniable, but my contribution to the energy balance is important, especially in the case of well insulated homes.

Means and control of ventilation:

We must ensure a minimum rate of ventilation, ensuring that it does not vary too widely depending on external conditions (wind and temperature). You can achieve this in two ways:

Natural ventilation through windows:

Relying on the discipline of the occupant to control the ventilation opening windows regularly, but without excess (ten minutes to renew the air). This is the easiest solution; it is generally accepted in the homes.

Controlled mechanical ventilation.

Is the most reliable, but more costly, both in investment in energy operations. In addition, installation of VMC will not actually control the air flow if it has been correctly calculated, dimensioned and carefully balanced. Without this balance, we will ineffectiveness of ventilation system, an occupant dissatisfaction and wasted energy.

A minimum rate of ventilation is essential, but should not be provided by windows inétanches. It is essential to control airflow.

Reduction of infiltration:

Improve the tightness of the building at the joints and materials construction.

* Use more airtight joinery for doors and windows.
* Put as much as possible openings on the facades exposed to the least wind.
* Reduce stack effect by incorporating into the building walls inland

Strategy ventilation Winter:

* Minimize the incoming air, taking into account the occupancy and activity to calculate the minimum required rate.
* Pre-heat the incoming air when possible (taking air in a greenhouse, recovery on exhaust air

Ventilation strategy summer:

Cool the mass of the building, assuming ventilation important during the cool hours, and minimized during the hot hours. The first objective requires a local organization that promotes natural ventilation.

* Cool air before admission: by wetting (no water, vegetation ...) or by circulating in a pipe buried (well Canada).
* Stir the air to give the sensation of comfort during the hottest hours (fan). For a good feeling of comfort, the air velocity must not exceed 1m / s.

Factors of good natural ventilation:

The organization of the local: A dual approach of local will have a positive impact on ventilation. Conversely, the partitioning, the single orientation or even a double orientation adjacent the brake (see figure)

* You can advantageously use vegetation to slow the external prevailing winds in winter, creating areas of amber in the summer, generating drafts, and moistening the air exterior.

Design openings:

Openings providing several functions in one building, which are often in disagreement or conflict, you must be especially vigilant about their choice of location.

The openings affect the energy consumption through four aspects:

It penetrates through them that most of the sunlight. They must be designed to make the most of this radiation in winter, while avoiding overheating in summer. Because of their thermal resistance lower than that of the walls, they generate significant heat loss. They must be designed to minimize losses during the winter. They only provide a fresh air of the house; they must be thought to allow good ventilation while rejecting infiltration (pollution, noise ...) that accompanies them.

They are a source of light, which should be sufficient to hound artificial lighting during the day.

Good roof design must take into account all these parameters. The size of windows should be as small as possible to the east, west and north, because these openings, especially on the north side, resulting entries of cold air in winter and leave little or poorly penetrating solar radiation.

However, it is advisable to place large windows in the south, as these windows will capture more energy during the winter than they will lose. For the same reason, the book also windows on the south wall. To draw an example of a larger glass area south of 15% to 50% of the facade, you will reduce your heating bill by 20% (in the north of Tunisia) 30% in the sunny region (Gabes, Gafsa ...)

If the blinds are kept closed at times of sunshine during the summer, the impact of the enlargement of windows on the cooling load is negligible. You've got to have the windows with low heat leakage (See next chapter) to the north, east and west. You will also provide protections night (shutters, blinds,) insulation placed outside over the windows. A key factor in the comfort of summer is to have openings to enjoy the shade. To shade the openings, shading needed. They prevent the opening of direct sunlight while letting in light. They may be small, movable or steerable (blinds, adjustable sun shade). Folded the winter, they can enjoy the sunlight when it is needed most. The sunscreens may also be part of the building itself: sunscreen, screens, awnings, balconies, roof overhangs. An opening in the South this is also a definite advantage, since it is fairly easy to protect, a store or a sunscreen enough to shade.

MATERIALS AND CONSTRUCTION TECHNIQUES:

The objectives:

* In winter, make a new acceptable comfort without equipment. For a high level of comfort, reduce heating costs.

* Keeping a house cool in summer without air conditioning, or a premium comfort, minimizing air conditioning costs.

* Reduce the length of seasons heating and air conditioning (to ensure the comfort of a natural way during the half-seasons).

* In short: having a comfortable home and saving the entire season.

Isolation and inertia:

Thermal resistance and insulation:

Metals conduct heat well, so that air and insulators inhibit transmission by conduction. The coefficient of thermal conductivity. Y (lambda) indicates the ability to transmit heat by contact between the molecules of a given material. It is expressed in W / m ° C.

A body of a given thickness at least more resistant to heat flow. For m², the thermal resistance R expressed in m² ° C / W, obtained by the ratio of thickness (in meters) on Y. The thermal resistance of

an insulating material will be much higher than its thickness is great and its low conductivity. U, produced for the housing sector is regarded as a thermal insulator when its conductivity is less than 0.065 w / m ° C and thermal resistance R at least equal to 0.50 m². ° C / W.

One of the best insulators is still air (= 0.024 W / m ° C), so most insulation materials have to function to stop air cavities or fibrous structures. We often speak of the coefficient K of a wall (W / m ° C). It is simply the inverse of resistance R. We seek to reduce, since the heat flux passing through 1 m2 of wall is equal to the product of this coefficient by the temperature difference between inside and outside.

The role of insulation

A well-insulated wall can:

- Reduce heat loss in winter and heat penetration in hot weather during the day and thus save energy conditioning.
- Avoid condensation on walls and on walls, by maintaining the temperature not too low
- Compensate for the reduction of the total thickness of the walls in the techniques of modern construction.
- Avoid feeling cold (winter) or feeling hot (summer) that we feel close to a wall too cold or too hot, because of radiative exchanges

It is not enough to heat or cool very well (which can cause discomfort and unhealthy) to feel a sense of comfort. It must rather ensure that each piece in the desired temperature is evenly distributed and is the same, or nearly so, either near the walls near the source of heat or cold …

However, during summer nights when the air temperature is cooler outside than inside, and that the temperature sky is very low, the presence of insulation in the walls can hinder evacuation calories through the wall to the external environment. What then is the net balance of insulation in summer? It depends on the component, as discussed below.

Thermal inertia:

When building thermal equilibrium is subjected to a change of surrounding conditions, he earns a new equilibrium after a certain time.

The thermal inertia characteristic slowness of that balancing. The inertia of a building depends mainly on the heat capacity. Qs materials that compose it, and resistance R.

* The thermal inertia of a building determines its ability to store heat.

* The thermal inertia dampens temperature fluctuations and thus contributes to the stability temperatures of air and walls; it helps prevent overheating due to solar gain in winter.
In winter, the heat stored during the sunny hours will be during the evening resituated. In summer, the heat stored during the day can be evacuated the night, through the cool night air. This mechanism is very effective in cases of night ventilation and reinforced strong enough inertia. This pet permits the establishment of an acceptable comfort day and night in summer and avoid the use of air conditioning in residential buildings.

Theory – Heat Capacity

Any building material absorbs a certain amount of heat when the ambient temperature rises. This amount of heat absorbed by a material m2 and per degree rise in temperature is called thermal

$Qs = c.\ p.\ e\ [J / m^2 K]$

With Qs = heat capacity
c = specific heat J / Kg K
p = dry density in kg / m²
e = thickness in m

Cooling time

The cooling of a wall depends on the relationship between capacity and Qs thermal insulation coefficient.
Thus, we have:

$$A = \frac{Qs.e}{Y.3600}\ [h]$$

A: cooling time in hours
e: wall thickness in meters
Y: thermal conductivity of the wall

The greater the factor A, the more the wall will need time to cool. The external temperature fluctuations will also experience the latest within.

Depreciation and thermal dephasing:

During the summer months, buildings are subjected to hours of hot external temperatures, relatively large due to solar radiation. The outside temperature increases may lead to increases in internal temperature unpleasant for the occupants of the building.

A good heat sinking of the wall and a large phase shift will help to reduce, within a structure, the influence of rising temperature outside. The inertia will be high, particularly in the following cases:
1-With intermittent injections of winter heat, for example when the glass surface is large, or when heating is used intermittently (radiators used in the evenings only).
2. Sunscreens ineffective or summer opportunities ventilation reduced.
Factors influencing the inertia are:
1. The intrinsic qualities of materials (density and heat conductivity), the materials most suitable for heat storage are dense materials with high specific heat: concrete, stone, solid brick.
2. The dimensions of building elements;
The thickness of inertia increases with the thickness of materials. But in reality, only the first 10 cm are effective for everyday inertia, the inertia that allows storage for a few days being obtained by the following 10 cm.

The exchange area, more than the thickness of this surface exchange which determines the inertia useful. Thus, an interior bearing wall with two faces of heat exchange, will present more inertia than external wall which has only one face. Inertia can be achieved mainly through:
1. The exterior walls or partitions
2. Exterior walls
3. The ceiling and floor.

When the walls contain insulation specifically, only those parts of masonry between the interior of the space and the insulation will intervene in the internal inertia. On the effects of a well-insulated wall more resistant to the passage of heat flux than another. Insulation reduces heat flow through between the local and outside. Inertia for its opposition to change but reduces fluctuations in temperature and flow

In terms of the materials:

The most insulating materials usually contain air cavities; they are not dense and cannot store a large amount of heat per unit volume. At affixed, the more inert materials, which exhibit good storage of heat, are dense materials: concrete, stone, solid bricks.

On the dimensions of the walls:

Increased thickness causes greater isolation and a greater inertia, but only the two first tens of centimetres are really useful. Regarding the surface, a large outer surface reduces the total resistance of the building and is therefore not desirable in cold climates. A large surface for walls and interior partitions is very beneficial in terms of inertia.
Usefulness of isolation and inertia:

"The strengthening of insulation does the inertia represent an additional investment. It is therefore essential to understand the situations in which their use is a priority.

Thermal bridges:

These discontinuities induce areas of lower thermal resistance than the parts covering, they called thermal bridges, since they let heat pass through more easily than others. There are two types of points:

The thermal bridges due to materials: The result of the presence in some parts of the building materials with higher thermal conductivity; external insulation can remove this type of thermal spots.

The thermal bridges due to geometry: In heating situations, they appear when a small area of warming (interior) corresponds to a large area of cooling (external). This situation occurs in the angles, corners and other discontinuities which are then lower heat resistance than other elements of the same material.

Insulation system inside:

1 - Mould

2 - Thermal Insulation

3 - For Steam

4 - interior finishing.

System for Exterior Insulation

1 - Thermal Insulation

2 - layer coating

3 - Reinforcement

4 - plaster finish

5 - Profile Bank

6 - Mechanical mounting of the insulation.

Roofs:

Flat roofs

They can be constructed:

- Hollow block, topped by a concrete shell. In the hollow body can have blocks of concrete aggregates heavy, or hollow blocks of terra cotta.

- Reinforced concrete slab:

1 - Sealing + Protection

2 - Thermal Insulation

3 - Slope Form

4 - slab hollow

5 – Filler

"The roof is the element that receives the most solar radiation during summer and should therefore be strictly isolated! This is particularly important that non-insulated roof has a coefficient μK much larger than d an uninsulated exterior wall. Moreover, in winter, the lighter warm air rises and becomes lodged under the roof, making it a factor of significant heat loss. "

The technique used most: hot roofs. The term "hot roof" is used when the insulation is placed between the sealing and support. Today is the technique most used. Given its position, the insulation protects the surface against severe fluctuations in temperature and therefore reduces the risk of movement and cracks in the support /

Another advantage of this technique, particularly helpful in cases of heavy roof structure (concrete or slabs), is increasing the thermal inertia of the local heating, which means that the mass of the structure, when temperature keeps making it and therefore makes the room more favourable in summer and winter. In this technique, which requires a flat surface and regular, a delicate issue is the choice of waterproofing membrane. Indeed, it is placed directly on the insulation; it suffers all the thermal variations. The waterproofing membrane must be especially resistant.

For better protection of these membranes sealing a ballast (e.g. consisting of pea gravel) is often implemented on the seal. There is actually some membranes are able to withstand ultraviolet clouds.

WHY ISOLATE A ROOF?

The thermal insulation of a roof offers several advantages:

Reduce building energy consumption

The savings compared to an uninsulated roof depends on the thickness and type of insulation, the tenure of the building and performance of heating.

This economy has a significant impact on overall consumption of the building given the importance of the contribution of the roof at all heat loss from the walls.

Improve occupant comfort:

In winter, the temperature of the ceiling under the roof is seen through increased insulation. This has an immediate impact on occupant comfort by removing the effect of radiation to the cold ceiling.

Also in summer, insulation protects roofing in local overheating caused by the sun roof.

Reduce risks and condensation:

Increasing the temperature of the inner surface reduces the risk of condensation at the ceiling space under roof.

Protect the roof structure

Insulation can reduce the influences of changes in daily and seasonal temperatures on the complex roof. Less heat insulating the roof is already involved in environmental protection.

An interesting alternative: Replace concrete slope composed traditionally composed of heavy aggregate, sand, cement and water, lean concrete or cellular concrete. The concrete has a regular slope own considerable weight, this self-weight is taken into account is imperative for the design of the structure. The lightweight concrete composed of cement, sand and lightweight aggregate can contribute substantially to a thermal insulation. Aerated concrete: sand, lime and cement constituent materials bases. These are intimately mixed in very specific proportions, after which we add water. The addition of a small amount of aluminium powder will result in the appearance of air bubbles. The final product will be heavily honeycombed. Aerated concrete is a material that fits perfectly into a sustainable development approach.

The financial results of roof insulation:

The annual savings can be estimated by means of theoretical calculations, and compared to gross or net additional costs of thermal insulation. Studies show that the additional gross insulation pays for itself in just over 3 years. The net additional cost of insulation, in turn, pays for itself in one year. This theoretical calculation has yet to be confirmed in practice, but if we take into account the investment in equipment (boilers, piping and radiators for example), and then the investment is repaid in less than a year! This is a great result but other parameters should ideally be taken into account when the decision. Too often, only the initial investment is taken into account.

We may also consider the lifetime of the system, maintenance costs, repair costs, heating costs, the likely evolution of energy prices ... Not to mention the interest rate applied to the any borrowing required to finance the work and the effects of inflation ... It is obviously not easy to integrate all these data.

TO CONCLUDE

We hope that after reading this paragraph, you also will give you more attention to the flat roofs that protect you. Indeed, it is time that these surfaces are the fifth facade of a building are no longer treated as a poor relation. Because they play an important role in the "overall comfort" that can provide a building's occupants, they should now be the subject of serious study when it comes to invest in refurbish and special care both for their maintenance for any repairs to be done.

You may have noticed firstly that the problem is complex and deserves to be taken very seriously and, secondly, that the variety of products and techniques available, the result of rapid changes in the field of chemistry. Used to provide an adequate answer to every problem. Also, before you make your choices, compare different solutions and call to various trade contractors. For their part specifications clear and comparable, it must first have correctly identified the solutions that you deem interesting. This is where the advice of an architect or engineer competent in this area can be very valuable. They can help you address the problem holistically and to choose techniques and compatible products.

We note also that, at the same time of this writing, the regulatory body has launched a study for the establishment of financial mechanism to absorb the costs of the additional costs related to improvements in new residential buildings.

Composition of the facade walls

The walls in front of traditional single wall consists mostly (the worm inside out)

- On the wall plaster made of lime and / or cement from 1.5 to 2 cm thick.
- In a masonry brick with 12 holes laid flat. For older buildings the bricks can be replaced by natural stone quarried in this case, the wall thickness is often greater than that of brick masonry.

On the exterior potential formed by a paste containing lime or cement pressure on both sides of the outer walls.

- The slide filled the function of capillary rupture and decompression chamber. It prevents the water that went through the outer wall is transported to the interior and allows the water to flow on the inner surface of the outer wall.
- The outer wall coated (outer side of housing) or siding: It acts as a screen against the driving rain, but does not provide total sealing.

TIPS

The insulation should never be placed on a wall showing signs of moisture. The causes of moisture are generally difficult to identify.

- We must protect the insulation with a vapour barrier: some insulation (fibre minerals) vulnerable to water vapour is fitted on one of the two sides of a vapour barrier Kraft paper. It is intended to prevent water vapour from condensing within the insulation and stagnate.
- In case of double wall, the heavier of the two partitions must be placed on the inside; it increases the inertia useful wall.
- In case of double wall with air space, it is essential that the air space is really empty.

Alternatives

Wall insulation distributed:

These are walls made of aerated concrete block and prefabricated autoclave. This concrete factory is obtained by adding aluminium powder to mix cement + lime + sand + water in contact with lime powder aluminium produces small bubbles of hydrogen which have insulation. Because of their light weight, the aerated concrete blocks are large making them easy to mount. The coefficient of thermal conductivity through the walls of concrete block cell is about 0.2 W / m ° and their inertia is moderate or high what is interesting in case of continuous heating and summer. It is the building block masonry with the best thermal resistance. It is very hydrophilic and permeable to water vapour. It must be covered with a waterproof coating waterproof.

Walls insulated integrated:

These blocks consist of three interconnected layers:

- A masonry unit interior
- An extruded polystyrene insulation
- A masonry exterior thinner

The interior walls:

The interior walls do not cause heat loss or loss of cold because they are not in contact with the external environment. However they can be used to store:

- The solar gains that enter through the windows during the winter.
- The cold penetrates through night ventilation in summer.

Therefore, we do not seek a quality of thermal resistance for these walls, but soon a good thermal capacity. We must see both sides of these walls are in contact with ambient air, which is equal to heat capacity; they are more effective than external walls for storage-stocking of cold and hot.

The walls commonly used in Tunisia are:

- Hollow bricks

- The gypsum blocks.
- Plasterboard cardboard and assembled with cardboard honeycomb.

The Floor:

- The lower floors are not the seat of heat transfer surface on their part, because in the long run, the full land on which they are raised tends to place himself at the same temperature as housing. By cons, there may be lost to the external environment due to thermal bridges located at the crossover between the low floor and walls.

The intermediate floors are either not registered loss of heat or cold surface parts for the same reasons that interior partitions. But as the bottom floor they can pose thermal bridges in conjunction with the walls. The external insulation they can