

Establishing, Adoption, and Implementation of
Energy Codes for Building

Architectural Styles Survey in Palestinian Territories

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INTRODUCTION

This survey is intended to define different architectural styles that existed in different locations in the West Bank and Gaza Strip, studying the traditional and contemporary architectural details, materials, and elements, figuring out the common things in between and the differences as well. Exploring the architectural elements and techniques can lead us to any considered elements that served climatic and energy saving concepts.

Climate and environment challenges the designers from many years, owners and the masons can always come over the building materials by local affordable materials, and can solve structural problems depending on the previous experiences and in some cases by inventions, the main problematic and challengeable exercise is to save energy and to safeguard the environment. in other words to reach the comfort zone in the building, By using different materials that meet the energy saving requirements.

Scope of work

This survey is intended to locate any architectural elements or solutions that could be considered while designing the construction that meets energy saving requirements. And to draw attention towards the problem of the energy loss and the absence of the energy efficiency in the building process in the West Bank and Gaza Strip, in terms of materials, techniques and codes.

Through survey in traditional and contemporary architecture in West Bank and Gaza Strip, different climatic zones was taken in consideration, to explore if there is any architectural element being considered during construction or after construction, that served climatic and energy saving. And to make recommendations depending on this study any ideas, materials, architectural elements, or solutions that could be considered while designing and constructing, that meets energy saving requirements.

Methodology

To achieve our goals the following methodology was followed:

- **Data Collection**

Search for local architectural solutions for thermal comfort in Palestinian building through:

- A. **Literature survey**

- 1- Search books, references, information resources, and NGOs working in the field
- 2- Interviews and exchange experiences with local professionals, in both fields of climatic design and building regulations.

B. Field trips with the camera to the different zoning in the West Bank and Gaza Strip communities: cities, villages, and refugee camps under the classification:

The southern mountains area (Hebron and the surrounded areas)
The central mountain area (Jerusalem, Ramallah, Bethlehem areas)
The Jordan valley area (Dead Sea, Jericho, and Tubass areas)
The Nablus mountains area (Nablus, Salfeet areas)
The semi Coastal area (Jenin, Tulkarm, Qalqilia areas)
The coastal plain (Gaza Strip)

- **Challenges and Obstacles**

Due to the difficult and unstable circumstances on ground, there were many obstacles to deal with in addition to the following barriers:

- *Lack of expertise and knowledge in designing and constructing energy efficient building.*
- *Limited access to appropriate technologies in the field of energy efficiency in buildings.*
- *Unavailability of studies, guidelines, and software for the designing and construction of energy efficient buildings.*
- *Unfamiliarity with methods and tools for measuring energy efficiency in buildings.*
- *Checkpoints and blockades affected field trips and mobility to reach some villages and cities.*

1- Climatic Design Consideration In West Bank and Gaza Strip

Climate of West Bank and Gaza Strip

The climate of the Palestinian Territories is influenced by the Mediterranean climate where long, hot, dry summer and short, cool, rainy winter climate conditions prevail. Climatic variations occur in the different topographical regions. Though relatively small in area, the West Bank enjoys diverse topography, soil structure and climate conditions (ARIJ 1994). The West Bank is relatively arid, with about 50% of the land having a rainfall less than 500 mm/year, including hyper-arid area with a rainfall less than 100 mm/year. However, the remaining land has a rainfall range of 500-800 mm/year and 100-400 mm/year in Gaza. Most Palestinians live near the wetter more moderate western slopes in major cities.

“Early climatic classifications were based on vegetation, which is more apparent than climate. The division between climate and vegetation classifications became more pronounced with the development of climatology and physics as scientific disciplines...Vegetation based classifications are especially useful for identifying arid environments when soil characteristics override climatic conditions such as in glades and coastal beaches, or when extreme climatic variability is not captured by climatic classifications”(http://ialcworld.org/soils/URL:http://ag.arizona.edu/OALS/IALC/soils/classifarid.html).

Climate classifications range from simple annual precipitation classes to those that incorporate precipitation and its variability, length of humid and growing seasons, precipitation-temperature relationships, evaporation, and precipitation-evaporation relationships. In other words, climate can be classified into zones according to a variety of criteria such as rainfall, temperature, humidity and vegetation. The classification procedure of the climatic zones is determined according to the purpose of zoning. For example, climatic zoning is carried out based on rainfall in the water management studies, while temperature and humidity are the main criteria of building design. Generally, climate averages including annual temperature, annual rainfall, annual humidity and annual cloudiness of an area reflect its climatic conditions and characteristics. In this study, the classification of Palestinian climatic regions or zones is based on the averages of annual rainfall, annual temperature, humidity and the cloudiness of the West Bank and Gaza.

1.1. Climate Zones of West Bank and Gaza Strip

The distribution of built-up areas according to climatic zones in the West Bank and Gaza Strip were set in different five Zones in West Bank and three Zones in Gaza Strip.

Climatic Zones in West Bank:

- Zone1: Located in the Eastern slope, the dead sea area, and part of the Jordan Valley area. The Southern part is Almost with no built up area due to the steep slope of the mountains. The northern part has some communities in which most of the buildings were built by concrete hollow blocks and external plaster. Zone 1 is hot dry in summer, and mild in winter. Mechanical cooling systems were used in some building in summer time.
- Zone2: The northern part of Jordan Valley and the Southern mountains areas. This Part is not heavy populated especially in the very steep sloped mountains. Most of southern villages in zone 2 are facing the east and protected from the direct wind from west, the building materials are stone in most of the cases and the northern part is concrete hollow blocks with external plaster. Zone 2 is hot dry in summer and has temperate winter.
- Zone3: Started from Hebron Mountain in the South and ends in Jenin north of West Bank, this zone is well-populated zone. Most of the buildings in this zone were made from stone except in some rural area where concrete hollow blocks and external plaster is cheaper. This zone is hot semidry and sub-humid in summer and temperate in winter.
- Zone4: A narrow strip to the west of Zone 3 and some island in the northern part of West bank is known for its warm sub-humid climate in summer and temperate in winter. Most of the buildings in this zone were made from stone except in some rural area where concrete hollow blocks and external plaster is cheaper.



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- Zone5: The larger climatic zone in West Bank, and a heavy populated area, this zone is warm sub-humid in summer and cold in winter. Most of the buildings in this zone were made from stone except in some rural area and refugee camps where concrete hollow blocks and external plaster is cheaper, and the stone is not local materials. Some mechanical cooling and heating systems were used in buildings.

Climatic Zones of Gaza:

Along the Mediterranean coast the winters are short, mild and rainy and the summers long, hot and dry. Gaza (365 km²) is a coastal area along the eastern Mediterranean Sea, 40 km long and between 6 to 12 km wide. The area forms a transitional zone between the sub-humid coastal zone of Israel in the north, the semiarid loess plains of the northern Negev Desert in the east and the arid Sinai Desert of Egypt in the south. According to the Koppen system for climatic zoning, Gaza has a Mediterranean dry summer subtropical climate with mild winters. This climate is classified as Csa indicating that the warmest month has a mean temperature above 22 °C.

The average daily mean temperature ranges from 25 in summer to 13 in winter. Daily relative humidity fluctuates between 65 % in the daytime and 85 % at night in the summer, and between 60 % and 80 % respectively in winter. The prevailing winds during the summer come from the northwest with a pronounced daily fluctuation of the wind speed indicating daily average maximum wind velocity of 3.9 m/s in the afternoon. At night, the wind speed declines to reach the half of this figure. In contrast, during winter the most frequent direction is southwest and the average wind velocity is about 4.2 m/s with no distinct daily fluctuation. Nevertheless, storms have been observed in winter with a maximal hourly wind speed of up to 18 m/s mainly from the southwest.

In Gaza the amount of rainfall decreases from 450 mm in the north to 200 mm per year at Rafah in the south. Due to orographic effects (i.e. influence of rising altitudes) the yearly rainfall amount increases land inward. There is a distinct yearly fluctuation in the mean monthly values of solar radiation during wintertime as they reach one third of the summer months' values. The total incoming radiation is relatively high, which is a great advantage for agriculture and greenhouse cultivation (PEPA, 1994).

The discussion above describes the major climatic characteristics and highlights the three different climatic zones in Gaza that are influenced by other surrounding zones. For example, the northern climatic zone of Gaza (zone eight) has climate properties of the sub-humid coastal zone of Israel with mean annual rainfall of 370.14 mm and mean annual temperature of 18 °C. This zone has a population of 531973 persons that is 53.2 % of total population of Gaza. Climatic zone seven can be categorized under the semiarid loess plains of the northern Negev Desert in the east with 282.1 mm mean annual rainfall and population of 329987 persons. This indicates 33 % of the total population in Gaza. Finally, the Gaza climatic zone six represents the climatic characteristics of the arid Sinai Desert of Egypt in the south with mean annual rainfall of 189.9 mm and mean annual temperature of 18.1 °C. The population residing in this zone represents 13.8 % of the total population residing in Gaza.

1.2. Statistical Data for Climatic Design Considerations

Since antiquity, man has reacted to his environment, using his faculties to develop techniques and technologies, whether to bake bread or make brick, in such internal psychological balance with nature that humanity historically lived attuned to the environment. Man's creations were natural when built of the materials offered by the landscape.

A. Average Rain Fall

First, the Jordan Valley region extends along the western bank of the Jordan River from the Israeli border in the north to the northern tip of the Dead Sea in the south. Its elevation ranges from 200-300 m below sea level, and the climate is semitropical characterized by hot summers and warm winters. Annual rainfall ranges from 200 mm in the northern parts of the valley to 100 mm in the south. Second, the Eastern Slopes region extends along the eastern side of the west bank, east of Jenin in the north to eastern hills of the Hebron district in the south. The elevation ranges from 800 m above sea level to approximately 150 m below sea level. The climate is semidry with a very low rainfall varying between 200-400 mm

. Third, Central Highlands is the largest region in the West Bank including the hilly area that extends from Jenin in the north to Hebron in the south. This region is predominantly mountainous with some areas exceeding an elevation of 1000 m above sea level. It has a good average annual rain fall ranging from 400 mm in the southern foothills to about 700 mm in the mountainous areas. Fourth, the Semi Coastal region is an extension of the Palestinian Mediterranean coastal in Israel. It is limited to the northwestern part of the West Bank and comprises parts of Jenin and Tulkarm districts. Its elevation varies between 100 to 300 m above sea level with relatively high average annual fall about 600 mm (ARIJ 1994).

B. Average Temperature & Average Humidity

The climatic characteristics of the five climatic zones derived for the West Bank

Zone One: Hot dry summer, mild winter – steppe climate

This zone with an area of 987.2 km² includes hyper-arid and arid regions. It has annual mean temperatures in January (coldest month) and in August (Hottest month) around 15 °C and 29.5 °C respectively. This zone has a wind speed of about 3.4 km/h around the year where the maximum wind speed is measured during spring to reach approximately 4.3 km/h in average. The zone sunshine is about 12 hr/day in July and 5 hr/day in January. This hot dry zone has a violent and short duration of rainfall showers to have an annual mean rainfall about 136 mm. This zone has the climatic characteristics of the Jordan Valley and Eastern Slopes regions.

Zone Two: Hot dry summer, temperate winter – steppe climate

This zone has an area of 1222.2 km² and lies within the arid region. The measured mean temperature is slightly lower than those in the hot dry zone with mild winter, but still over 18 °C, having approximately 8.5 hours of sunshine per day. It has annual mean temperatures in January (coldest month) and in August (hottest month) around 13 °C and 27 °C respectively. The zone's region has hot, dry summers and moderate, rainy winters with about 274 mm annual mean rainfall. The mean wind speed of the region is about 5 km/h with southwest and northwest prevailing wind direction

Zone Three: Hot semidry, sub-humid summer, temperate winter – Mediterranean climate

This zone occupies 1094.4 km² of the total area of the West Bank in a semi-arid region. The mean annual temperature measured for this zone is about 17.7 °C assigning 11.1 °C in January and 25.6 °C in August. Its winter experiences a variation in rainfall from year to year to measure 396.4897 mm as annual mean rainfall. The wind prevailing has a speed of about 4.7 km/h and is western, northwester and southwester directed.

Zone Four: Warm sub-humid summer, temperate winter – Mediterranean climate

This zone occupies the smallest area among zones, which is 719.6 km² and lies in the semi-arid region. The annual mean temperature reaches 17.3 °C with an annual mean temperature of 10.8 °C in January and 24.7 °C in August. The zone's region is characterized by rainy and cool winter with an annual mean rainfall of 504.4 mm.

Zone Five: Warm sub-humid summer, cold winter – Mediterranean climate

This zone is about 1636.75 km² in area with population of 542764 persons, which represents 30.7 % of the West Bank population. Zone five enjoys temperate annual mean temperature of 16.9553 °C, annual relative humidity of 60.8255 and 715 mm of maximum annual rainfall. According to the aridity index of the West Bank, part of this zone is within the sub-humid region to have a maximum humidity of 64 %. Most the climatic zones three, four and five areas are found within the climate of the West Bank Central Highlands region and share the same climatic properties, while the northwest parts of these climatic zones represent the climate of the Semi Coastal region.

1.3. Urban Fabric

The urban fabric is the physical form of towns and cities. This theoretical explanation is valid in West Bank and Gaza Strip, with exceptions in some parts here and there. The urban fabric may have different characteristics from a small village than a city or a refugee camps, but all cities, villages, and refugee camps have a common elements and components forming an urban fabric.

Downtowns and neighborhoods are the two main types of development for urban areas; others may include educational institutions, industrial areas or individual buildings. Downtowns are the hub not only of a town or city but of the region, they are the primary location of retail, business, entertainment, government, and education. But they also include residential uses. Neighborhoods are primary residential areas, but also include commercial uses such as grocery stores, restaurants, and small offices. Educational (elementary schools) are located in some neighborhoods in Palestinian cities, and in residential areas in villages and refugee camps, they small enough that most students can walk to school.

Downtowns are more densely developed than neighborhoods; commercial and public buildings are attached to each other that form a continuous row of buildings, with no set back line in most cases, while residential uses in downtowns mostly take the form of apartments or huge buildings. Neighborhoods have many types of



Photo (1) Al-Remal Neighborhood - Gaza

buildings: detached houses, villas, and apartments; all buildings must have a set back line (few meters) from the sidewalk. A Greening and natural landscape is part of neighborhoods, especially in villages and some areas in cities.

Urban fabric in most Palestinian villages is formed from traditional architecture with some modern additions, traditional architecture is the hub (the center) of the village, and all recent development were made around this hub. Contemporary architecture in villages surrounds the center and expands horizontally in any direction depending on availability of land and its use.

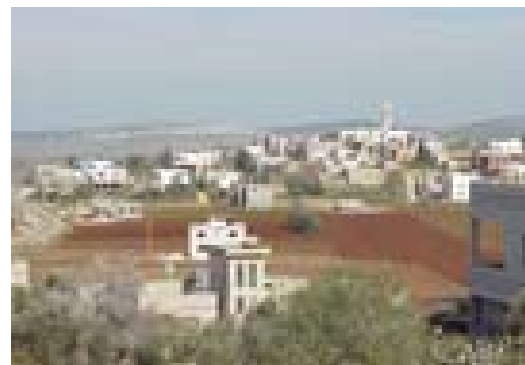


Photo (2) Arabeh Village - Jenin

Urban fabric basic elements

In order to understand Palestinian urban fabric, and to be familiar with classification of buildings and different zoning, urban fabric elements must be studied as followed:

Pathways: these are the major and minor routes of circulation, which people use to move about. Cities, villages and refugee camps has a network of major routes and pathways. Scale of pathways varies from a place to another; neighborhood network has minor routes than in downtown, and a refugee camp has smaller pathway than in a village. A building has a several main routes, which people use to get in and out of it.



Districts: cities and some villages are composed of component neighborhood, industrial areas, downtowns or districts. Sometimes they are distinct in form and extent especially in cities, like the Al Remal neighborhood in Gaza city, it has special characteristics and could be distinguish as new developed area, identifying districts is the most important element to study architecture and functions of buildings.

Edges: the termination of a district is its edge. Some districts have no distinct edges at all, but gradually taper off and blend into another district. When two districts are joined at an edge they form a one unit; Ramallah and Al Bireh is a good example. In some cases residential building is built at the edge of an industrial area, it is hard to distinguish the function of this building the same applies on edges of commercial areas.

Land markers: The prominent visual of the city are its landmarks. Some landmarks are very large and are seen at great distance, like the radio poles in cities or major squares. And some landmarks are very small and can only be seen close up, like a street clock, a fountain (*Sabeel*), or a small statue. Landmarks are an important element of urban form because they help people to orient themselves and buildings in the city and help to identify an area.

Nodes: a node is a center of activity. Actually it is a type of landmark but it is distinguished from a landmark but virtue of its active function. Where a landmark is a distinct visual object, a node is a distinct hub of activity. Vegetable markets in Palestinian cities are good examples for nodes.

These five elements of urban fabric alone are sufficient to make a visual survey of the fabric of a city. Their importance lays in the fact that people think of the cities spontaneously from these basic elements. Beside these urban elements orientation and views are very important; the view to the west is one of the determent elements in orientation of buildings especially in Gaza Strip area and some cities and villages in West Bank, where in mountain area the orientation is mostly to the open view,(the best view), those who have clear vision to the Mediterranean coast.

***Survey in
Palestinian Architectural Styles
(Types)***

2- Palestinian Traditional Architecture

Palestinian Traditional Architecture is the term set for the architecture that had been erected in a traditional way, materials, and techniques. Mainly with affordable local materials, the owner and mason reacted to the nature and climate*. Palestinian traditional architecture varies from a place to another; regions that have common climate and source materials developed and used the same details and elements, stone was the main building materials used in the mountain areas and in the coastal plain area, but were rarely used in the Jordan valley area not only because it is not available in the nature there but also it can react against the climate as well, as a result two different styles in roofing developed.

Palestinian traditional architecture had been affected by other cultures, although some techniques and building materials are still in use since the pre history time. A series of details and mutual components have been developed, and a set of common elements and details started to be known and used as typical ones. Other techniques materials and details were taken from different cultures. Roman, Byzantine, Crusaders, and many other cultures left their footprints in the traditional architecture, most of what survived from the traditional architecture in Palestine was built in the Ottoman period while we still can see some of the Mamluk architecture and rarely Umayyad and other different periods.

By the end of the first half of the 20th century new materials and techniques started to change the traditional way of building, still there is no edge time to make a distinction between the traditional and the modern architecture.

2.1. Traditional Architectural Styles

Social and economical life played a role in the traditional architectural styles, for economical reasons low income people were not able to build the same houses as those of rich people. The function of the building was to determine the buildings area and style. Climate, environment, and location made different styles in the same materials and techniques, studying the rural and urban areas helped in sitting a classification as:

A. Simple Peasant houses

Until the beginning of the 20th century the traditional way of building in most villages and rural areas is the peasant house. A simple peasant house is a cubical room (*oodah*, *ghurfeh*) very simple in its form (cube), varies in its dimension and height and could be attached to other rooms of the same family. Peasants could not afford to buy wood (which is rare in Palestine) to serve windows shutters, this affected the opening which were very



Photo (3) Simple Peasant House-Beitonia

small openings turned the house into badly lighted rooms. But small-unsheltered light-holes were very practical since they kept out the rain in winter and the burning rays of the sun in summer.

The interior space of most simple peasant houses is divided into two parts. Three-quarters of the inner space is raised. The family lives in this part, figure 2.1 part b & c the (*mastabeh*), while the animals are stabled in the lower part, as in figure 2.1 part g, the (*rawieh*). It is interesting to note that the expression (*rawieh*) is used in some villages (Bet Ikksa, Bir Zeit) as a synonym of (*mastabeh*) while the place for the animals is known as (*qa' el bet*). Other type of the interior peasant house is a one-space room. Peasants created Courts (*housh*) by building several rooms adjacent to each other and may add other rooms on top of the roofs.

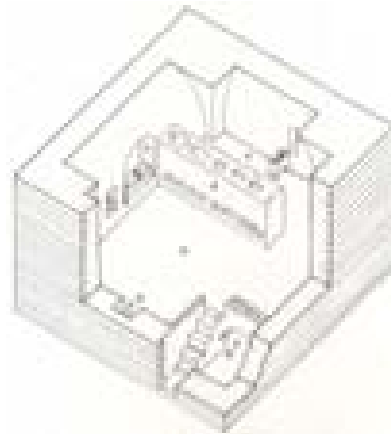


Figure 2.1 simple peasant house

Such houses were oriented in different positions, but they all belong to their environment and climate; they do change the size and number of openings with changing the orientation so to fit to the climate and not to react against it. Different forms (envelops) can be found by adding rooms adjacent to each other; social life beside domestic activities like cooking, cleaning, treating the crops from the fields, all were in the courts and in some rooms. Due to the comfort zone in the traditional houses, peasants were using the rooms as storage for foods. It is cool in summer and warm in winter with neglected humidity effects.

This style could be found in all villages in the west bank areas. In Gaza strip it is called (*skeefeh*) and were built from mudstone in most of the cases with one space from inside and a sloped roof.

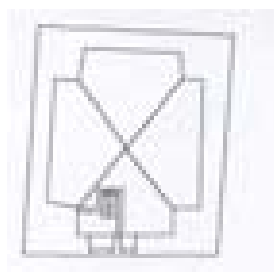


Figure 2.2 simple peasant house plan
One room

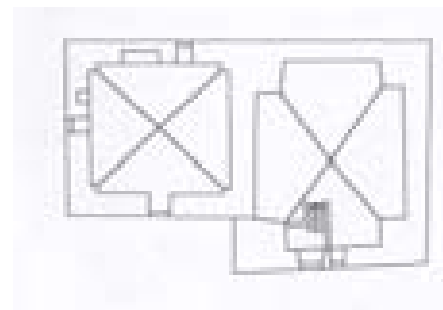


Figure 2.3 simple peasant house
two rooms

B. Complicated Peasant houses

Some houses in villages and rural areas specially those of leading peasant and merchants are large and more complicated; Large and elaborate houses were made with one, two or even three stories which, served as private family compound built (in

villages) side by side, or one above the other (in towns). These larger buildings are usually arranged around a courtyard. Stone flights of steps on the outside facing the courtyard lead up to the several apartments. Such a buildings in time grew into complicated labyrinths of rooms. Their plan is wholly lacking in regularity and symmetry. The several rooms in the same storey often differ in height and floor-level necessitating one or more steps between one room and another.



Photo (4) Complicated peasant house- Rass Karkar

In some rich villages such as the “Throne villages” very complicated castles were built with a larger scale rooms and space that were more developed than other places. Throne villages were distributed in West Bank mountains such as Rass Karkar, Deir Ghasaneh, and Ne’leen in central area, and Kur, Arabeh, Deir Istia in the north and Dora in the south.

C. Town Houses

Towns in West Bank and Gaza Strip were more developed than villages. In towns, a simple peasant house and the complicated one is found beside other developed styles like the courtyard house and the Liwan house.

1. A **courtyard house** was built usually to give more privacy, and easy access to rooms surrounding a court open to sky. In some cases the court is not fully surrounded by the same house but by additional fence walls that separate the building and the court from outside. Courtyard houses specially those with portico (riwaq) were efficient in saving energy and interplay with local climate; rooms opened to the court weren’t directed to sun in summer and were isolated from the direct rain in winter, in addition to the court itself which is open to the fresh air and shaded most of the time. Jacer Palace in Bethlehem is a good example of a courtyard houses.

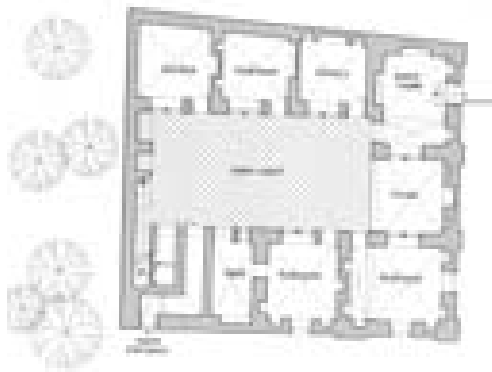


Figure 2.4 Shahwan house ground floor- Gaza

2. **Liwan house** consisted of more than one room, most of the houses entrances lead to a hall (*liwan*), on both sides of a hall are the living rooms, and the hall is used as a sitting room. The hall is as deep as the whole building and shows two and occasionally three cross vaults. In its furthest wall as well as on both sides of the entrance there are windows. Such a house sometimes but not always opens into a courtyard. Al Imam house in Hebron is a good Example.

Orientation in some houses was taken into consideration in town, but in some cases the access to the lot of land affected the orientation.



Figure 2.5 Imam House ground Floor-Hebron



Photo (5) Liwan House - Ramallah

D. Public buildings

Public buildings in villages were built in the same techniques of residential houses, the same building materials and details. In villages most of the cases one can't differentiate between a house and another building except in religious buildings. The attic in most cases is the highest place in the village, but still built in the same way a large single room or double space room. Olive oil press in rich villages is a very similar to the houses from out-side and very different from inside with its facilities and huge rooms, in some cases the olive oil press is part of a peasant house.



Photo (6) Old Market-Nablus

In cities public buildings were more developed in design and function. Public buildings vary from religious buildings, Turkish Baths, caravansary, soap factory, commercial compounds, olive press, schools, shrines, etc. In Jerusalem Mamluk schools, Tiqueih, and Ribat were very known for their courtyards in the middle and the large scale rooms around, while Turkish baths had different layout for special function (hot and cold rooms), and Commercial shops were built in traditional materials and details, but with different openings, the door in most cases were large and it had no other openings, shops were built in rows to form the market of the city, like Hebron old city, Nablus, Gaza, and Jerusalem. On top of the shop there is a houses that usually can be reached from the back of the building to give privacy to the houses.



Photo (7) Hashem Mosque-Gaza

2.2. Traditional materials

Before the second half of the 20th century, stone was the main material in traditional buildings, except in Jordan Valley. All buildings built in West Bank had lime-based (gypsum-based) mortars. Cement and reinforced concrete, a new techniques invented in the 19th century in France, were not available here before World War II. Therefore all traditional building in the West Bank and Gaza Strip were built without cement. Lime, mud and gypsum were the traditional binders used by masons for centuries, in the West Bank and Gaza Strip.

More than 50,000 buildings have been registered in the National Register for the traditional architectural buildings done by Riwaq – Center for Architectural conservation – shows that stone was the main buildings material in West Bank mountains and in some Gaza's buildings, While mudstone was used in Jordan valley and in the costal plain of Gaza.

Palestinian Stones

In the West Bank and Gaza Strip areas, three main kinds of stone were used for building a stone house:

- *Limestone (used in the central mountains areas)*
- *Sandstone (used in the coastal plain)*
- *Mudstone (used in Jordan Valley and the Coastal plain)*

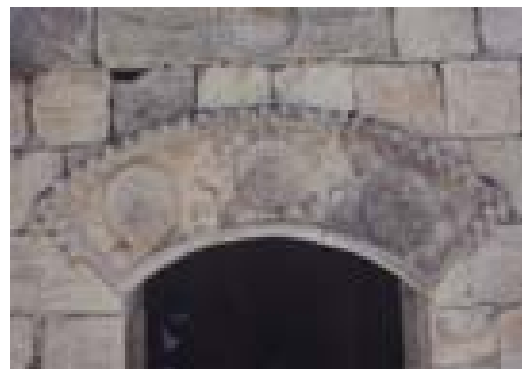


Photo (8) Stone Detail Typical in Villages

Lime Stone

The characteristics of the stone in the central mountains vary with localities. The traditional classification of limestone in the area is based on used rather than the origin.

The soft stones are:

Ka'kuleh: soft whitish stone (mainly Calcium Carbonated)

Nari: a very inhomogeneous white stone, lighter than other chalks and limestone, is not a good quality stone for general building purpose.

The hard stones are:

Malaki: when quarried it is pure white and easy to work. It hardens on exposure to air and may become yellowish. This stone is considered as the best for building purpose.

Mizzi: it has three different varieties (weight 2480 kg/m³)

Mizzi Ahmar: it is hard, light yellow and irregularly streaked by red bands.

Mizi Hilu: whitish and yellow veins.

Mizzi Yahudi: it is a gray limestone, the hardest and the best building stone.

Sandstone

The sand stone is found in outcrops along the coast. The coastal cities were built on these outcrops using the sandstone, as building materials. Kurkar is porous, inhomogeneous, relatively young sandstone. It is easy to quarry and dress, but behave badly to weathers; this is the reason why they used to plaster the exterior walls. Sand stone built all of those buildings made from stones in Gaza Strip

In addition to these kinds of stones, Basalt (black stone) a third kind is available in the Galilee area. And was used there with very rare elsewhere. They're also a number of decorative stones, such as the Mizzi Akhdar, and the Hajar Musa they are denser and more compact and can be polished.

Mudstone

Mudstone (sun dried bricks) was used in the Gaza area and in Jordan valley specially Jericho. It is a molding stone that was form in wooden molds after grading; it was used in ancient cultures and found in many areas in Palestine like Gaza and Jericho. Mudstone was prepared from the local mud (red soil), mixed with sand and existing chemicals in the soil, it was mixed with water and dried by sun. It was prepared in molds usually 20*20*40 to form a stone that was used in the building courses (row of stone) the inner partition were in smaller thickness.



Mortars

Mortars are composed of two distinct elements: the binder (lime, hydraulic lime) and the aggregates (sand, gravel, brickdust, ashes, straw or other organic elements).

Lime

Quicklime (Calcium Oxide-CaO) made by burning limestone (Calcium Carbonate-CaCO₃), was slaked by adding water to create hydrated lime (Calcium Hydrate-Ca(OH)₂).

Lumps of fresh quicklime were added to water, the mixture was stirred until the chemical reaction was complete; it was strained through a mesh and finally stored for at least two weeks under water in sealed containers. Since World War II, pre-hydrated lime, a powder form that can be mixed immediately before use, has replaced quicklime in many parts of the world.

Sand

Sand gives mortar most of its characteristic color and texture. In traditional buildings sand was not screened and graded as today and had therefore different size of grains. Natural sand is much better than manufactured one for binding with lime. Other aggregates like brick-dust usually make up a small proportion of the total. Other materials like animal hair, clay particles and partially burnt lime are commonly found in old mortars.

Wood

Wood had been used in traditional building in doors, windows and niches, local woods was expensive building material used. In addition to the openings, wood was used as a structural element for roofs in the mudstone houses in Jordan valley and the coastal plain.

2.3. Traditional Details

In traditional architecture, typical techniques were used no matter the function of the building. Walls, cross vaults, domes, are the most traditional details used in most of the stone buildings.

Walls

In Palestinian villages and cities, traditional stonewalls were built in a typical way. Good walls used to have a thickness that varies from 80-120cm, not only to support the weight of the roof, but also to support the thrust of the vault, and the lateral loads. Traditional houses owing to their very thick walls remained cooler in the summer and warmer in the winter. The core of the wall, the gap between the outer and the inner courses, is made of small rubble stones and mortars. The stones are built in such a way that the joints of one course will not fall in the same line with those of the upper or lower ones.

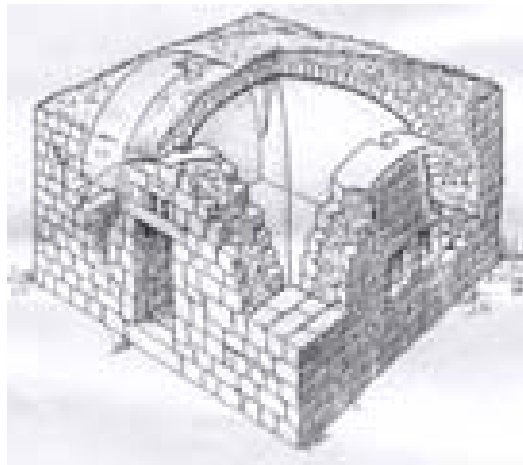


Figure 2.6 Typical Walls and Cross Vault Detail

Roofs

1. Vaults and Domes

The traditional Palestinian buildings in the mountains regions, both in towns and in villages, used to be vaulted. Cross vaults were built in traditional materials and a typical way; the masons acquired the know-how and techniques and managed to have long span structure that reached 10*10m.

The fram-work for the vault was started with a strong piece of wood placed perpendicularly in the center of the room. This supported four transverse beams, more or less horizontal, each running to the center of the side-walls, and fore slanting beams to the corners. The wooden frame was covered with smaller beams and branches. Old mattresses, thorn bushes, corn stalks and palm leaves were placed on top. The



Photo (10) Traditional Domes-Kur

surface was covered with earth and with two layers of mortar. The upper was smoother and gave the vault its final shape. When the mortar was dry, the stones of the vault were laid, the gaps between the unevenly cut stones being filled with smaller pieces of the same stone. A cylindrical keystone was used to close the last part of the vault. After the vault was completed, the side-walls were continued upward and the pyramid-shaped spaces were filled with rubble and mortar.

Domes were built by a similar method. In the Turkish baths domes were often built in bricks, probably to facilitate the construction around the terracotta pipes let into the thickness of the domes and used to light the rooms.

The thickness of the highest point of both domes and vaults is not more than 30cm, and was covered with a lime mortar layer or tiled with stones.

2. Inclined Roofs

In Jordan Valley areas and in the Coastal plain where mudstone was the main building material, the roofs were not vaulted the same way as in the stone building. Due to the characteristics of the mudstone it cannot be used in compression. Climatically, water can penetrate through mudstone and so the heat from the sun. To solve these miscellaneous inclined roofs made from wood and clay.



Photo (11) Typical Roof - Jericho

Floors

Stone tiling was the main common material in building tiles, for economical reasons some houses and buildings were left with no stones, clay or lime mortar were used in some cases instead of the expensive stones. At the beginning of the 20th century color tiles have been used in towns and those rich peasants. The main reason for the tiles was to protect the building from the humidity came from the ground; the tiles were used as isolation for the building.

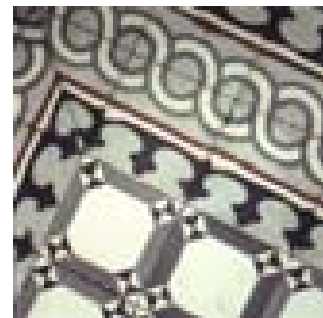


Photo (12) Colored Tiles

2.4. Traditional elements

Courtyards

In traditional architecture there were mainly two types of courts; the first type is the court that belongs to one building, in which the building is surrounding a court open to the sky. In some cases the court is not fully surrounded by the building but by additional fence walls that separate the building and the court from outside. The second type was the court that had been created by adding up rooms (usually for the same family), around an open space (for circulation). This type is called the (hosh), it is often found in the villages and towns. The main concept of the court was to create an open space for circulation and a mutual private space. In summer and winter it was the best place for day and night activities due to the balance of the temperature (comfort zone) in the court itself and the surrounded rooms.



Photo (13) Jacer Palace-Bethlehem

The Iwan and Fountain

The Iwan is a feature of a large houses and a rich owner and so on the fountains, the traditional Iwan room is constructed between two or three rooms with three of its sides closed and the fourth, the front side, is left open. Usually the open side is facing a courtyard. In some rich families a fountain is constructed in front of the Iwan, the fountain is a decorative element, but also a good cooling system in the summer time. The best orientation for the Iwan is to be open to the north elevation since the direct sunlight cannot reach the Iwan room.

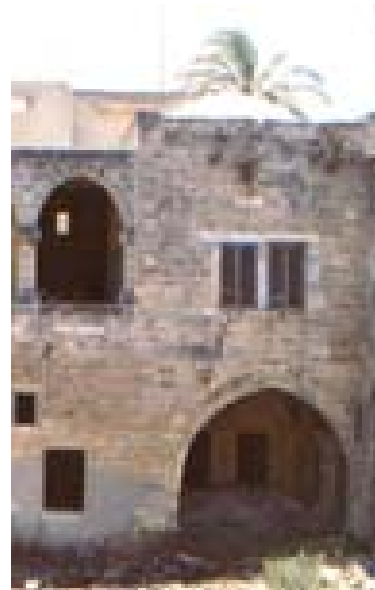


Photo (14) Typical Iwan-Gaza

Portico (*Riwaq*)

The Portico (**Riwaq**) is an element of the larger houses or buildings; it is constructed usually in the corner of the house or at the ends. The *Riwaq* constructed between two (or three) rooms with two (or three) of its sides closed and the fourth, the front side, left open, the open side usually constructed with arches. It was used in houses and in public buildings such as schools and hospitals. The *Riwaq* is very useful in the summer months; it creates a space that can prevent the sun to go directly to the rooms and keeps the ventilation in its perfect performance to reach the comfort zone.



Photo (15) Typical Riwaq-Beitounia

Openings

The openings in the traditional architecture is the most significant elements, reading the opening in some cases can tell the estimate year of the building and the type of use. In villages and peasant houses they had few or no windows (for security reasons); they were small and set high up in the wall. By time they are larger and placed lower down. The doors are set in the middle of the façade in most cases, they are lower than the human scale and by time they were larger and wider. In cities and towns openings were larger and wider and they were set in a lower position in walls, more than 40 types of openings are documented in traditional architecture. The wood was used in both doors and windows as the shutter materials, and the glass was later used to let light in buildings.

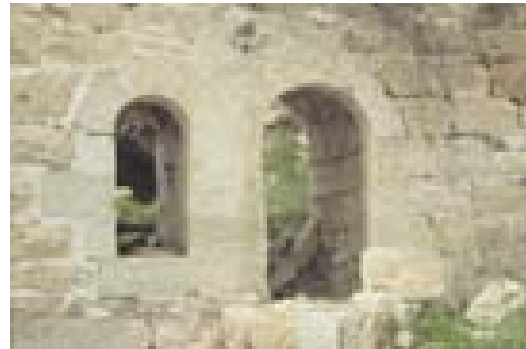


Photo (16) typical Arched Window and door

Some opening were made in walls by pottery, these small openings in walls created a privacy to the inner side of the wall, the openings were made to let the fresh air pass to inside the open space (usually). These kinds of openings were used in some villages and cities like Jerusalem and Bethlehem.

Plaster and Lime washing

Plaster is the final touch in the building process, in most of the traditional buildings in Palestine, plaster were used in the interior spaces only the ceilings and the walls, in the coastal plain plaster were used for the exterior walls as well in order to protect the sand stone and to reduce the temperature inside the building. The traditional plaster was made of lime mixed with flax-threads cut in small pieces, brick-dust, sea sand and ashes. Lime washing or whitewash was part decorating and protecting the plaster as well. The use of lime in plaster and whitewashing is to let the building breathing and keep it cool in summer and warm in wintertime.

3- Palestinian Contemporary Architecture

Palestinian contemporary (modern) architecture is the term set for architecture that had been erected in new materials and techniques. By the beginning of the 20th century dramatic changes in building materials occurred, the binding material, which was the lime, had changed to cement, Steel (I Beams section) was used for the first time. West Bank and Gaza Strip areas were still using traditional materials and techniques turned to use modern techniques that had changed the forms of buildings, as well as the building details. The stone continue to be the main element in modern materials as well but in different structural behavior.

West Bank and Gaza Strip passes through many political periods in the last 50 years, this affected the building process and caused chaos in the planning and in the development of the architectural styles (types). During the occupation period the main concern of so many people was to build a shelter in a very economical way regarding the form, shape, or style (types). Building was part of the struggle and was patriotic even with no building permit. The architect until late 1980s was not the only designer and building process can pass even without the architect's signature. These facts were behind the reason of the static development in the modern architecture style (types)s.

Studying the modern architectural “styles (types)” is a difficult task in West Bank and Gaza Strip due to many reasons and facts. The fact that there is no previous studies or researches done before made this study hard, especially to study the architectural styles (types) relatively and accordingly with the regional and international style (types).

3.1. Palestinian Contemporary Architectural Styles (types)

In order to get better result a “house to house” survey must be done to register all types of buildings and then set the classification according to similarities and differences, this could be done at a national project level. In order to solve these obstacles and to avoid arguing the definition of architectural styles (types), a classification to form, function and climatic behavior was used in a big challenge to find the similarities and differences between the different types of buildings. The classification is set as:

3.1.1. Residential Buildings

Residential buildings is mainly divided into two parts:

I. Separate House

According to the function of the houses it is divided into two style (types)s:



Photo (17) Single House-Jericho

A. Single House

A single house style (type) is one of the popular styles (types) for growing up families, different designs can be found for the same functions; 2-3 bedrooms, 1-2 bathrooms, kitchen, guest room, setting room, and balconies. The circulation in this house is horizontal movement; the staircase is the vertical movement to an additional floor on top, with almost the same design. In some cases the stairs is external element and especially for the two-floor houses.

The design and form of such houses are simple; the upper floor is usually gaining much heat in summer time, this happened because its roof is exposed to the sun directly with no insulation materials for the roofs. While in winter the upper floor is again, behave opposite to the climate for the same reason. Ventilation of such house is very good since four elevations exposed to the natural environment.

This style (type) can be found in all of villages and cities and some refugee camps in West Bank and Gaza strip. These types of houses mainly build in two materials mainly, either the concrete and stone external walls, which are found in all cities and villages in West Bank, or the concrete and hollow blocks walls, which are mainly used in the coastal plain, Jordan Valley, and villages. The concrete and hollow block walls are plastered and painted from both sides with light colors.



Photo (18) Single House-Gaza

B. Villa

A villa house is a well-known style (type) for rich families, different designs can be found for the different functions. The area of such a style (type) is variable starting from 200 m² up to 500 m². The circulation in a villa is horizontal and vertical movement; the upper floor(s) is for sleeping and family time (private part), while the lower floor is for kitchen and guest and living spaces in daylight. The staircase is in its interior space lead to the upper floors.



Photo (19) Typical Villa- Al Bireh

The design and form of such villas are complicated; it is eclectic architecture, a combination of many elements; decoration in stone, arches,.. etc. the roofs of most of the villas have red brick tiles, this red tiles can turn the building into a solar collector if not isolated well. Ventilation of such house is very good since four elevations exposed to the natural environment, and because of the forms that can create shades on the elevations.

This style (type) is found in all cities and in villages in West Bank and Gaza strip, and is well known for wealthy families. Villas are built in one building material mainly stone external walls in West bank, and in Gaza cities some examples where made from concrete and hollow blocks, with external plaster.

II. Apartments Buildings

Residential apartment is a new concept in the Palestinian society, since living in a house was always related to the land surrounding the house and the environment around. After the second half of the 20th century the changes in the social and economical aspects of life affected the architecture, the needs of housing increased especially in cities and some villages, which turned from agricultural communities into an industrial or administrative societies. For regulation reasons and political ones the areas for building purposes is small comparing to the demand of housing needs, especially in cities, this is another reason for the vertical expansion in apartments which can be classified as followed:

A. Low-Apartment Building

The areas of apartments vary from 80m² up to 180 m² with the same functions as in the single house functions. A staircase with elevator in the middle (in most cases see table No.1) leads to different levels and apartments, the design and form varies depending on number of apartments in the same floor. In most of the low-apartment buildings, 1, 2, or 3 apartments in the same level is the typical example, while the number of floors can reach 6 floors (in some cases) above the street line. In such buildings at least one mutual wall separate two apartments from each other; this leaves each apartment with three facades open to the natural environment in the best cases for ventilation and natural lighting.

Major cities in West Bank and Gaza Strip are famous of such style (type), which is an “investment building”, and rarely found in villages. The building material is a concrete and stone external wall in West Bank, while both stone and concrete façade can be found in Gaza Strip.

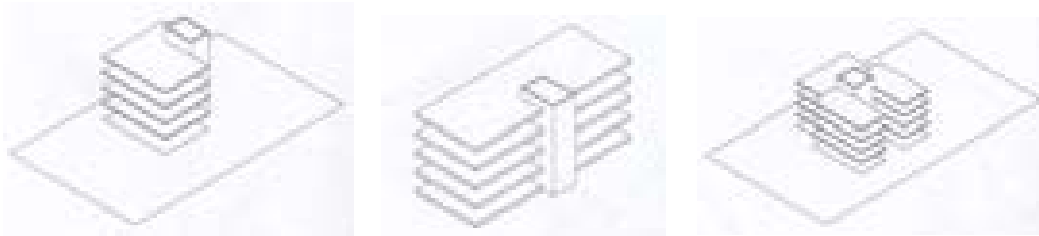


Fig. 3.1. Different No. Of Apartments on the same floor



Photo (20) Apartment Building – Jericho
Two Storeys



Photo (21) Apartment Building – Ramallah
Five Storeys

B. Block-Apartment

This style (type) of apartments does not have differences than the previous layouts except that it is continuous in its form, and that it behaves as one building with expansion joints every 35-50m depending on the location and the climate. The functions in the apartments are the same as before, but with two mutual walls between a series of apartment. This wall leaves each apartment only with two façade for ventilation and natural lighting. This decreases the heat loss in winter but increases it in summer time.

Major cities in West Bank and Gaza Strip are famous of these styles (types), which are an “investment building”. Many Housing projects use this style (type) to save land and to build more apartments in the same land with no set back line. The building material is a concrete and stone external wall in West Bank, while both stone and concrete façade can be found in Gaza Strip.

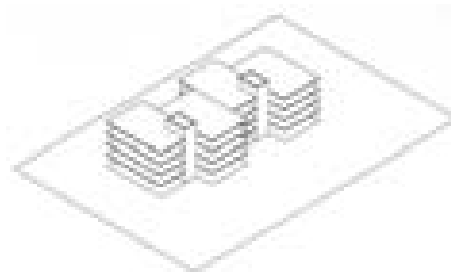


Fig. 3.2. Attached Apartment



Photo (22) Housing Project - Ramallah

C. Tower-Apartment

The tower apartments style (type) only exists in Gaza Strip cities, and has the same functions as any apartment from the interior space. The form of the building is different than any other apartment building; it is tower with one or two vertical access staircase and elevators leads to the upper floors that can reach more than 15 floors. Depending on the design and number of apartment in the same floor the natural ventilation in tower buildings vary, but in general in summer time they are cool (with humidity) and windy (open to the west – the sea), and in winter they are cold. The building material is mainly concrete façade painted with light colors.

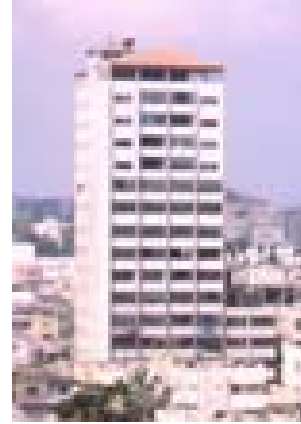


Photo (23) High Razed Building - Gaza

3.1.2. Multifunctional Buildings

A multifunctional building is usually a commercial (shops) in the lower levels and apartments in the upper floors, these apartments are for both residential and offices as well. This style (type) is considered one of the best investments in building in West Bank and Gaza Strip. It is allowed to build this building in commercial areas and main streets and industrial zones (according to the building law). The height of the shops in the lower floor varies from 3 m up to 6 m with mezzanine level, while the upper apartments have the same layout and design of residential apartment that can be converted into offices. A staircase leads from the main elevation to the upper floors that can be symmetrical and have two apartments or just one.



Photo (24) Shops & Apartments - Jericho

This style (type) is very popular in all cities, villages, and refugee camps. The building material is stone in West Bank cities and villages at least for the main elevation and can be from concrete for the both sides and back elevations, especially in the commercial areas, while both stone and concrete façade can be found in Gaza Strip and refugee camps.



Photo (25) Shops & Apartments - Gaza



Photo (26) Shops & Offices – Al-Bireh

3.1.3. Commercial Buildings

Commercial building is a type developed from the multifunctional buildings in most of the cases. It can be a separate building or attached to others with no set back line, and can take the shape of the land and follow up the street line with shops in the ground floor open to the street. This type of building is found in the commercial areas in all cities and some villages in West Bank and Gaza Strip.



Photo (27) Commercial Area - Nablus

Commercial building is divided into two main styles (types) in addition to the multifunction buildings these two types is:

A. Linear-shop building, in which the shops follow up the street line and form a series of shops in the main streets and in the commercial areas, this style (type) of building is a one floor with a height that can be reach up to 6m and have in most cases a mezzanine floor. This style (type) is found in cities and villages and refuge camps in West Bank and Gaza Strip.



Photo (28) Linear Shops – Ramallah
One Storey

B. Office Building, the main function of these buildings is shops and offices with some facilities, there are many forms and layouts for commercial buildings; some have court in the middle of the building go through all of the floors with a skylight on top, while some have partially court in the first two or three floors only and then it is covered to be used as interior space. In some cases there is no court at all, the vertical movement goes through staircases and elevators, while the horizontal movement passes through corridors that leads to the offices and different spaces.

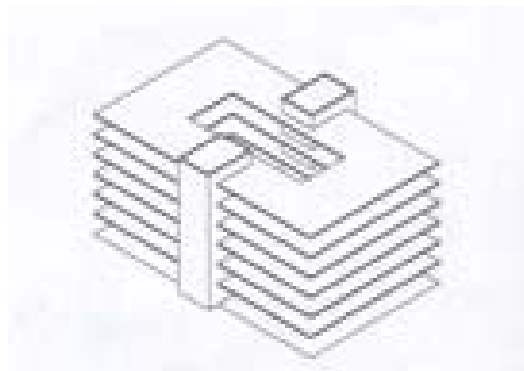


Fig 3.3. Commercial Building with Court

In commercial buildings and especially in the offices (the upper floors) lack of natural ventilation and lighting is a common problem. This happened because of the small spaces created for offices (20m² in some cases). And for the bad effect of having two facades only (rarely found one façade) exposed to the natural environment especially in the center of the cities where there is no set back line for commercial buildings and all of the commercial buildings are attached to each other. . In some cases an air conditioning unit is installed in the external elevations to solve these problems. For those buildings that have courts it is a solar collector in summer time especially in the upper floors and those who are not treated (isolated) in a proper way. The building materials are stone in the West Bank (with a percentage of concrete) and both stone and concrete in the Gaza Strip.

In most of the Palestinian cities in the West Bank and Gaza Strip a Portico (*Riwaq*) is found in commercial buildings especially on the east or south-west elevation in front of the shops, this Portico has a double effect; in summer time it can prevent the sun from entering the shops without any temporary external element, this reduces the heat and creates a shade in front of the shops. In winter it creates a sheltered place safe from the rain and wind.



Photo (29) Commercial Building - Nablus



Photo (30) Commercial Building with Court
Al-Bireh



Photo (31) Commercial Building with Portico
Jericho

3.1.4. Public Buildings

A public building varies from governmental, educational, hospitals, recreation, etc. They are designed (in most cases) for special functions, with different form and spaces. Some have special climatic elements and component such as portico (*riwaq*), lobby, complicated form, curtain walls, window's shelters, etc. and some are

simple in its form and functions as a rectangular shape or the L shape especially in schools. Building materials are stone in West bank and both stone and concrete in Gaza Strip.

In public buildings HVAC unit is designed for the building in order to have cooler temperature in summer and to heat the building in winter, this is especially in health centers and hospitals. In some cases an air conditioning units is installed in the external elevations



Photo (32) School Building - Ramallah



Photo (33) Hospital Building - Gaza

3.1.5. Religious and Cultural Buildings

Mosques and churches are found in each Palestinian community, they have a very specified function for a group of people, in large communities more than one religious building could be found, the orientation of such buildings is very important. Electrical fans is found in most of the Mosques to help in ventilation in summer time, because of the large number of prayers, but in winter no need for heating systems. Cultural centers (cinemas, theaters, exhibition halls, etc.) have a special design for special functions as well. In most of the cases special treatments for ventilation, heating and cooling systems is found.

3.1.6. Industrial and agricultural Buildings

Industrial buildings are found (according to law) in industrial areas around the major cities and some villages, in West Bank and Gaza Strip. Such buildings have special laws for the height, building material, the set back, etc. in order to fulfill the functions needed in the factories. The main building materials are stone external wall, some are concrete hollow block with external plaster, and Some of these industrial buildings have a very new building material (aluminum corrugated sheets) which is found in different colors and have special building details, while the rest have a very simple forms and a very typical materials and building details with a special interior functions.



Photo (34) Industrial Building with contemporary materials - Ramallah

Agricultural buildings are minor buildings and could be found in rural areas more than in cities, they could be described as a temporary structure (light structure) that can be removed to different places.

3.2. Contemporary Architectural Elements

In the second half of the 20th century, critical architectural changes took place in West Bank and Gaza Strip. These changes led to replacement of many traditional architectural elements, especially after the widespread use of modern building materials and techniques. The use of new building materials and techniques made the possibility of having different contemporary elements, and gave the designer more freedom in dealing with forms, function, interior spaces, elevations, height, etc. and the building started to be more obedient to have different elements.

Complicated forms and massing in Palestinian contemporary architecture is one of the main elements in creating shade and shadow in exterior walls, and prevent the direct sun to enter the inner spaces. Simple form is the main characteristics of Palestinian architecture, especially the residential apartment and houses especially those who have duplicated function in different floors, where the form follows the function in most cases. Villas that have different function, layout, and area in different floors is well known for its developed forms and recess in mass that creates shade and shadows in the elevations, some villas have free standing wall at the entrances to break down winds (the west and east wind).

In public buildings massing started to be a demand for the clients, in order to have a unique building that is not similar to any other building. This demand affected the form of the buildings, but minor buildings made a great benefits from forms to reduce the heat loss or to be efficient in energy saving. The Peace Center Building in Bethlehem is an example of using the forms in

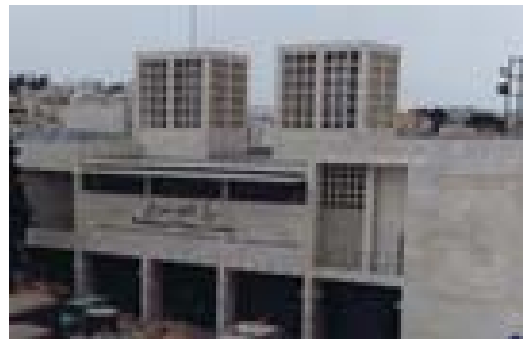


Photo (35) Bethlehem Peace Center Building

architecture and some elements to reduce the direct sun to enter exhibition rooms, with a natural lighting and ventilation, but it was not design for energy saving.

Contemporary architectural elements vary from a tiny detail up to a huge one, minor buildings have unique elements or detail to prevent the direct sunlight to reach inner spaces. These unique elements or details can be hunted from exterior in deferent places especially in places with vernacular (popular) architecture. Such elements were done with no calculations or scientific methods but fulfill the purpose of it, and no doubt the south-west elevation is the most elevations that could have such elements in summer time.

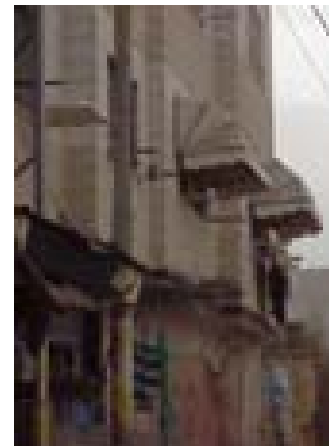


Photo (36) Temporary Shading Elements - Tulkarem

The most important contemporary architectural elements that affected the indoor climate can be classified as exterior elements and interior elements as followed:

3.2.1. Exterior Elements

A. Balconies

Balconies were found in the traditional architecture before the new building materials and techniques took place, they were acting as an outer space element in summer time. The new concept for balconies is that it is part of the building (interior space) and can be in different designs, and layouts. Balconies reduces the direct sun and heat from entering the inner spaces of the buildings, and closing a balcony turns it from a cool place in summer time (especially in west elevation) into a solar collector, while can be very comfortable indoor climate especially in autumn and spring time and reduce the heat loss in winter for the inner spaces. Different Shapes of balconies can be found in contemporary architecture as followed:

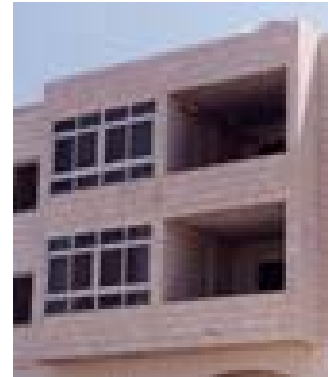


Photo (37) Typical Balcony found in contemporary

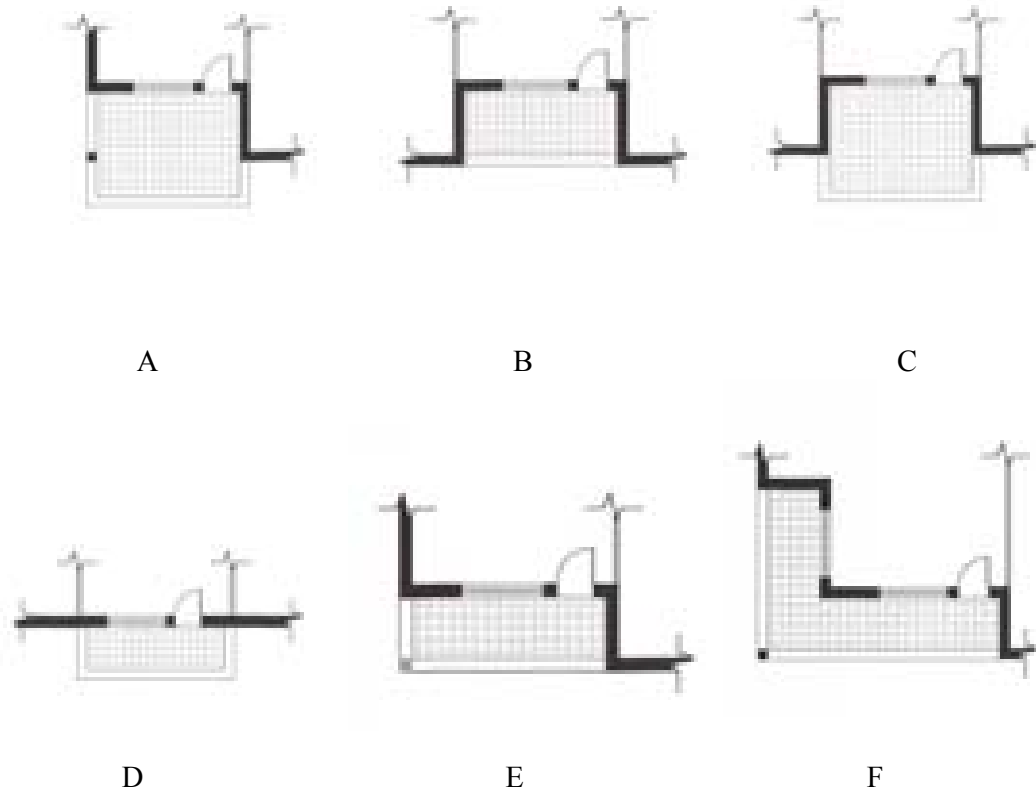


Figure (3.4) Types of Balconies

Type B, C, D and E were used more in residential apartments and single houses, type F is more used in Villas and in Jordan Valley area (Jericho), type A is used in villas and in single houses. This is not a rule where to use the Balconies, and combination can be found. Type d is the most used balcony; this cantilever is not included in the built up areas for licensing process, but it is an add to the area of the apartment.

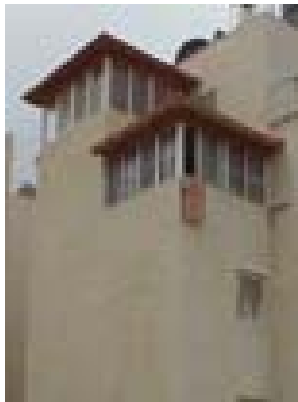


Photo (38) Balcony A
Tulkarem



Photo (39) Balcony E
Gaza



Photo (40) Balcony C
Tulkarem

In Jericho a unique type of balcony is found; the balcony surrounded the house from its 3 elevations to prevent the sun from entering the inner spaces of the house. This type is found in many houses, the orientation of the three elevations is taken in consideration since the north elevation is not exposed to the direct sun.



Photo (41) Balcony F
Jericho

B. Openings

Arches and lintels were used as structural elements for openings in traditional architecture. The use of reinforced concrete and steel in beams as a new technique in the last 50 years, changed the structural behavior of the window, and the opening shape from small vertical openings in Traditional architecture into a horizontal (wide) and large opening with a span can reach up to 4 meter for an opening. Openings (doors and windows) are the main thermal

conductivity element in buildings, the orientation, size, shape, depth, and material of the openings can change the heat loss and the comfort indoor climate in all seasons.

In contemporary Palestinian architecture, openings (windows and doors) have no standardization. Sizes, shapes, proportions, heights, depths, etc. varies from one building to another, and in the same building. There have been no rules set for the minimum height of an opening or the minimum size for lighting and ventilation, no modules or molds for the Aluminum, which is the most used material for windows and doors. In stone buildings the height of a stone coarse is the only determinate of the height of and opening by any multiple of the stone coarse height but not for the width. For these reasons and another there is no special characteristics for the contemporary Palestinian architectural openings. But there is always something in common between the same groups of buildings.



Photo (42) Typical Openings

Openings in residential building are more restricted than in other buildings; the function force the designer and the owner to minimize the opening sizes to get more privacy and to set furniture in rooms. In most of the cases the differences is clear between a residential building and any other buildings.



Photo (43) Residential House Openings

In public and commercial buildings many types of opening found in different sizes and orientation. Small, large, long horizontals openings, long vertical openings, Curtain walls, etc. or any combination can be found. For large opening two building techniques are used the curtain walls; which can reflect the direct sun and reduce the heat up to 80% (according to dealers), while the normal way is the regular aluminum which turns the building into a solar collector and uncomfortable indoor temperature.

Glazing

Windows, glass doors, panels and skylights play a crucial role in admitting heat and light, and can have a significant impact on energy consumption. They are also the most difficult parts of the building envelope to adequately insulate. Care needs to be taken to ensure that windows are positioned, sized and

protected so as to get the most benefit from winter sun while avoiding overheating in summer and heat loss in winter. Different types of glazing are found in West Bank and Gaza strip; single glass, double glass, reflected glass, and colored Glass, each one acted in different way for energy consumption.



Photo (44) Reflected Glass



Photo (45) Curtain Walls

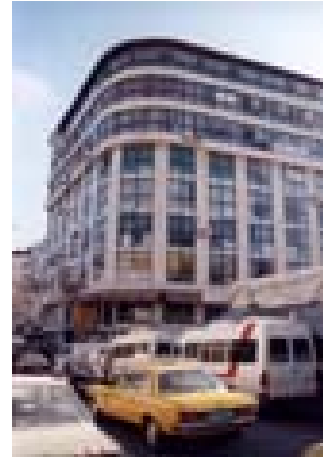


Photo (46) Typical Glazing

C. External Walls

Walls are the most thermal conductivity elements in building, they exposed to the climatic changes and have variable thermal efficiency depends on the techniques of buildings. In West Bank and Gaza strip two methods mainly for building walls:

- **Concrete with stone external face**

This type is mainly found in West Bank cities and villages while rarely found in Gaza Strip area, stone walls have different details and thickness varies from 25 cm up to 40cm depend different layer and insulation as in detail A,B,C (fig. 3.5)

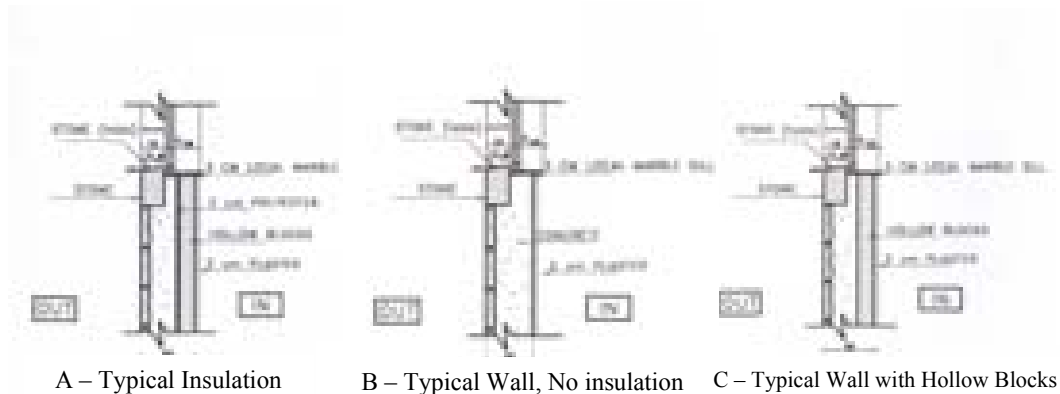


Fig. 3.5. Different Wall Sections

Different layers and materials acted as an insulation layer that resisted the heat flow and helped effectively reduce condensation, which usually occurs in winter.

- **Concrete hollow blocks with external plaster**

This type is mainly found in Gaza Strip, Jordan valley, refugee camp and villages, hollow blocks are cheaper than stone, this type of walls can reduce the total cost up to 40% (according to personal study). Such type of walls can be found with one layer of hollow blocks with external and internal plaster and paintings, or can be found with two layers, with insulation. The efficiency of this wall is less than the stone-walls, humidity and salt layers can be found on walls in Gaza strip area, and the plaster needs maintenance every now and then, depends on the orientation of the elevations and the exposure to the salty wind coming from the sea.



Photo (47) Concrete Hollow Blocks House - Gaza

D. Colors

In concrete hollow block walls painting for both sides of the walls is always found in Gaza Strip area, Jordan valley and refugee camps. An exceptional cases no colors on external walls that leave natural color of the plaster (concrete color), as the final layer. Light colors are most colors used in painting such as: white color is the traditional color for external and internal, it came from the color of lime, new colors are taking place last years but still in the range of light color with different reflection effects. In Palestinian architecture there is no calculation or scientific methods that recommended the light color but it is known spontaneously that light colors do reflect light around and can help in reducing heat gain in summer.



Photo (48) Exterior Wall Paintings - Qalqilia

The amount of heat storage depends on the amount of exposed thermal mass within the space and its color. Light colored surfaces will reflect light around within the space, distributing it over a greater number of surfaces. Dark colored materials will absorb most of the incident energy as soon as it strikes. Dark colors can substantially increase heat flows within a building. Obviously, lighter materials reflect more solar radiation than darker colors. The less reflected the more transmitted or absorbed.



Photo (49) Exterior Wall Paintings
Al-Jalazon Refugee Camp

When the surface of a material with a high thermal mass heats up, a significant proportion of the thermal energy is quickly conducted deep into the material. This means that, instead of the first couple of millimeters heating up 5-10 degrees, the entire wall heats up only 1-2 degrees. When the internal temperature of the space falls at night, there is then more energy stored within the walls to be re-radiated back out.

The **surface color** of the material. Light colors reflect much of the incident radiation whilst dark colors absorb more. Using light colors on the external surfaces of a building is generally a design option that does not incur any additional cost penalty.



Photo (50) Two Colors showing Structural Elements - Jericho



Photo (51) Natural Color of White Cement With minor paintings - Gaza

E. Shutters

In Palestinian contemporary architecture shutters were used mainly in residential buildings, they add up cost and need different details in construction process. Shutters when closed, keep sunlight out, reducing heat gain in summer time, and help insulate windows when it is cold outside. Besides that, they can provide privacy and security. Aluminum rolling shutters in the most famous technique in West Bank and Gaza Strip, they have a series of horizontal slats that run down along a track, and can be controlled from inside manually or mechanically. One disadvantage of this element is that when they are close in summer time to keep the sunlight out, room are dark and windows are not functioning for ventilation.

External shading elements are found in formal and popular architecture, beside all mentioned above from balconies and massing, they can be part of the construction (as cantilever element) or a temporary elements installed later, these elements have the same function as the shutters with one major difference that they keep the direct sunlight out but let indirect light and windows are still functioning for ventilation.



Photo (53) Cantilever Shading Elements in School Building – Al-Jalazon Refugee Camp



Photo (52) Typical Window Shutters



Photo (54) Temporarily External Shutters

In commercial building in front of external shops, temporary elements were installed, some are fixed metals and used for commercial signs, and some can be folded (awnings) and use in summer time only, they completely block direct sunlight. Awnings are very effective because. They are usually made of fabric or metal and are attached above the window and extend down and out. A light-colored awning does double duty by also reflecting sunlight.



Photo (55) Commercial Shops Awnings-Gaza

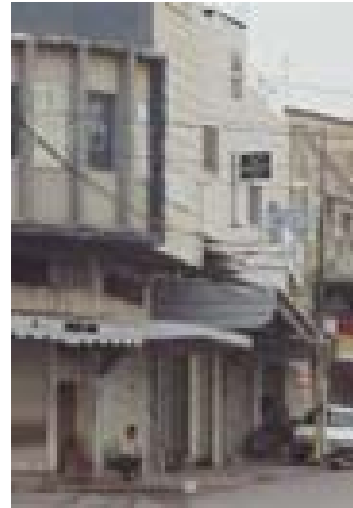


Photo (56) Commercial Shops Shading-Tolkarm

3.2.2. Interior Elements

Interior element in contemporary architecture is part of the interior design or furniture in most cases; they are not effective as exterior elements. Several ways are used to block the sun's heat from inside your house, and other to drop the temperature and have comfort indoor climate. Here is the most interior elements used in contemporary Palestinian architecture:

A. Drapes and Curtains

Are used in all residential building and some other building in West Bank and Gaza Strip. They made of tightly woven, light-colored, opaque fabrics reflect more of the sun's rays than they let through. The tighter the curtain is against the wall around the window, the better it will prevent heat gain. Two layers of draperies improve the effectiveness of the draperies insulation when it is either hot or cold outside.

B. Aluminum Roller

Other ways to block the sun's heat is Aluminum roller fixed on windows from inside, they have a series of horizontal thin aluminum slats that run down by cords, and can be controlled from inside manually to be closed fully or partially or angled to block sunlight but keep natural ventilation.

C. Vents and Lower Partitions

Some other architectural element found in northern cities and villages is vent above doors, this element is taken from traditional architecture, when doors are closed for privacy, vents can be open to give natural ventilation and air circulation between rooms. Lower partitions have the same effect and they are used and famous in office buildings.

D. Electro-Mechanical Fixtures

Electro-mechanical elements are now used widely across the Palestinian cities, villages and even in some refugee camps especially in Jordan valley area and Gaza strip. Electrical fans fixed on ceilings are used in houses and shops especially in northern cities and villages; they do not cool the room's temperature much, but make air circulation. Heating and cooling systems are found both as split units fixed on interior or exterior walls, and can be installed at any time, or as HVAC system for buildings which must be part of construction process in most of the cases. The split unites is the most electro-mechanical element used for its convenience and affordable prices.



Photo (57) Air-Conditioning Split Unit - Jericho

3.3. Factors Affecting Architectural Styles (Types)

Palestinian contemporary architecture have been affected by many factors, not only related to new building materials and techniques, but also to other factors affected and helped to change the architectural styles (type). These factors are:

3.3.1. Environment and Climate

A. Orientation of Buildings

Buildings should take in consideration the shaded indoor and outdoor living areas in design and orientation, and consider in hot and sunny days the indoor and outdoor areas, and the wind protection and breakers when the weather is cold.

It is not always possible to site the building to save energy, the Palestinian land is so limited for building purposes and shape and orientation of land is a predetermined element in design process well-designed buildings should be oriented, and the spaces arranged in such a way, that the majority of rooms

got enough natural light and ventilation. In this way the eastern and western sides are exposed to the low-angle summer sun in the morning and afternoon. The high angle of the sun in the sky in summer makes it easy to shade windows using only a generous roof overhang or horizontal shade. The longer north/south sides of the building benefits from the low angle sun in winter. The roof overhang or shading on the equator side should allow the Sun to shine into the building when its warmth is required in winter, and provide adequate protection from high-angle Sun in summer.

If the majority of windows are designed into the equator-facing wall, sun penetration into the building will be maximized. Living areas should be sited to gain maximum benefit from cooling breezes in hot weather and shelter from undesirable winds in winter. This does not mean that the orientation of the building should be varied from north towards prevailing breezes as it does not have to face directly into the breeze to achieve good cross-ventilation.

Within the internal planning, rooms such as dining and recreation area that require more heat during the winter months should be placed on the equator side. Rooms that are used for short periods of time during the day can be placed towards the rear, or more effectively, as buffer zones on the west side to protect living areas from the hot afternoon Sun (for example bathrooms, laundry, ensuite, entry corridors, stairs, bedrooms, bars).

B. Landscaping

Landscape is an important element to reduce cooling and heating cost if designed and planted well. Traditionally most of separate houses and buildings have spaces for domestic landscape, in which it is used as climatic element and as fruitful trees. Trees and other greening element were used as green screen for privacy and windbreakers in winter days beside shaded areas in sunny days.



Landscape is an important element and it is studied more carefully and in details in chapter 4.

3.3.2. Building Materials

The first use for steel was in roofs, using the solid concrete slab and steel (I Beam section) changed the roofing systems, which have been used and turned the roofs into flat roofs, with the possibility to have cantilevers, balconies and decorative elements. Besides the changing in the roofs' systems, by the second half of the 20th century steel started to be used as structural element for walls and different steel sections and bars were found as building materials. This changed the techniques of building from a bearing wall system (the traditional buildings) into a skeleton system (the columns).

The cement displaced the lime, and with steel it started to be not only the binding material, but also a structural element especially with steel. Different kinds of cement were used and two main colores are found the white cement and the black. With cement and steel the techniques of building walls had been changed and the stone was not any more structural element as in the traditional architecture. Even though stone is still used in most of the buildings in the West Bank Areas and some of the building in Gaza Strip area, it is only a cover material for the facades. Hollow blocks made from cement and other aggregates were used specially in refugee camps (for economical reasons), and plastered from both sides in West Bank and Gaza Strip Areas.

The main building materials used in West Bank and Gaza Strip are:

- **Natural Stone**
- **Concrete**
- **Hollow blocks**
- **Insulation**

Essentially, insulation is the use of a material with a low overall conductance to reduce the energy flow across another material. The insulation acts to retard and/or reduce the flow of heat, thus it must have a high resistance (resistance being the inverse of conductance).

In general, apart from vacuum, the worst conductors of heat are gases, and these insulate best when convection within the gas can be suppressed. Fibrous blankets in which the gas is trapped in a mat made from a low conductivity solid - such as glass or organic fiber (wool or polyester) - are good insulators, and closed-cell foams in which the gas is trapped in bubbles in a poor conductor such as polystyrene or polyurethane are even better.

3.3.3. Building laws in West Bank and Gaza Strip

After Oslo agreement Palestinian National Authority has modified building laws and by-laws, the previous laws that were acting is the Jordanian in the West bank and the Egyptian in Gaza Strip, and not to forget the Israeli laws and by laws that were affecting whole planning process for and community and urban developments. The modification made after Oslo agreement were to organize the building process and were not dramatic changes especially in the building codes issues. These are temporary laws and by-laws.

Laws and bylaws are a key word in studying the modern architecture after the second half of the 20th century. Classifications of buildings according to the function, the building materials, the set back line, height of the building, number of floors and built up area were determined in the laws according to the classifications of the land. In West Bank areas the outside shape of buildings must be from stone with its natural color and not more than 20% of the facades can be from different materials (concrete). Some exceptions can be made after having special approval from local or regional Authorities, (according to article 9). This has affected the building materials and details in most of the rural and urban developments except in the refugee camps. In Gaza Strip areas concrete replaced the stones since it is not a local materials, plaster and paintings are the finishing materials if not stone.

According to land classifications and zonings height, built up area, and number of floors in buildings varies as in this table:

Classifications	Built Up Area %	No. Of Floors	Height Of Building (m)
High residential area	36%	8	28
Residential A (high)	40%	6	22
Residential A	36%	4	15
Residential B	42%	4	15
Residential C	48%	4	15
Residential D	52%	3	12
Popular Residential Continuous	60%	3	12
Office buildings	Variable	5	18
Public buildings	36%	6	22
Touristic buildings	30%	6	22
Rural residential	10% (max. 300m2)	2	8

* The old cities and villages have different laws according to a special committee, and this was done to protect the Palestinian cultural heritage. Agricultural properties have different rules according to their areas.

3.3.4 Socio-Economic factor

West Bank and Gaza Strip were instable and passes through many political situations, in which affected building process as one side of Palestinian's lives. The instability of the political situation affected the social and economical life; this did not prevent people from building for a natural growth purposes, but affected the investment in building sector and the quality of building and quality of life, and made the priority for a place to live no matter the quality of the house. Local communities developed according to the daily life needs, with minor effects of planning procedures; the land use according to laws restricted the buildings in some areas but didn't manage to solve the chaos in crowded areas.

Last ten years as a result of Oslo agreements and according to its accords, social and economical life were more stable and more developed (until the beginning of the Intifada), this made the building sector one of the investments in Palestinian territories, the investment in building affected the building style (type)s and quality spaces, functions, building materials, insulation materials and techniques. During this period the urban fabric of many Palestinian cities and villages have been changed, and cities were more crowded and denser than ever.

Palestinian society is known as conservative society, privacy in functions is a goal for most of clients, this made a living space is different than guest room (Saloon), and the need to separate the two functions is a must, this fact made the concept of open space house is rare. Number of children at home can determine number of rooms; in some villages boys and girls have different areas and spaces in rooms, the kitchen and baths in house are not as the traditional way. For economical reasons houses and apartments may have variable areas for the same number of inhabitants, started from 80-200 sqm.

For economical reasons the stone was replaced by concrete hollow blocks in some villages and in refugee camps in West bank, although the all buildings have to be from stone according to laws. This is not the case in Gaza Strip since the stone is not a local material; low prices building materials were used in most of Palestinian villages and refugee camps, and some cities. This affected the durability of the building and the maintenance time for buildings, beside the quality of living and spaces. Some new house are not healthy and were not ventilated well or lightened naturally this is because some people do pay less time and money for design and orientation of buildings.

3.4. Existing Case Study

Design or construction according to the climate or energy saving is not a requirement to get a building license, it is not mentioned in building law or recommended by the Palestinian engineering association. Owners and the local community are not aware of the value of such an approach, few architects conducted academic researches and studies, and one case study (at least) was found. Hani Hassan did this case study, a Palestinian architect who did his master degree in Madrid in high technology in architecture and construction.

The architect used a special software program for thermal calculations, the efficiency of walls, roofs and windows as the main thermal conductive elements. It wasn't easy to get more information about this software or type of calculation he did, or methods of design or any special requirements for the project. This project was never tested for its efficiency and was not experimented for saving energy because it is still in interior finish process, and the landscape elements are still under planting.



Photo (58) Mubarak Villa South West Elevation
Betin

The building is a villa style located 5 km north of Ramallah city in Betin village; 820m ASL. It was under construction (foundation process) when he decided with the owner to take the climate in consideration. He did not change the orientation of the building (for technical reasons), but the functions were well oriented from the beginning. He managed to use the landscape as wind block and sun breakers, to solve any unconvinced orientation and to have outdoor comfort climate.



Photo (59) Site Plan

Building materials were the same local building materials and the same typical techniques, multi-layers walls; stone (5-7 cm) concrete fill (20 cm) polyester layer insulation (2 cm) and hollow blocks (7-10 cm) with typical plaster layer from exterior and pointing from exterior. The building materials were not the main issue to change the building behavior towards climate, it was the design itself.

In order to get better result and thermal comfort he worked hard in windows sizes and doors; minimizing windows in some elevation namely the southwest elevation and open large elevation in east elevation, beside open small opening (20*20cm) in some elevation on a high level to get light and better ventilation. Using insulation materials for roofs under the red tile he managed to get better result (from his calculations), and to get more shading on elevation that break the sun lights.



Photo (60) General View

Wind Catchers "Malqaf" was used in his design as one of the important element to have better indoor climate in summer time, an openings from the basement was made to let (cold) wind inter the house and penetrate different floors by special opening or traps and get out from a high place. This wind catcher helped in having natural air circulation in summer time and could be closed in winter.



Photo (61) Elevation and Opening Treatments

3.5. Most Common Prototypes

Following this survey, it was hard to get an accurate percentage of the most residential prototypes or styles built in West bank and Gaza Strip. Building classifications may be indistinct unless indoor visit took place; this is especially for separate houses, however in most cases apartment buildings and villas are distinct from exterior and identified as residential buildings, but the functions and interior spaces are still unknown. Palestinian cities have different prototypes than villages and refugee camps; cities are popular in apartment buildings in the first stage, then separate houses (single houses and villas), while Palestinian villages have more single houses than villas and apartments. In refugee camps single houses are the most common prototypes with a very tiny spaces and could be detached or attached.

Apartments



Photo (62) Ramallah



Photo (63) Gaza



Photo (64) Nablus

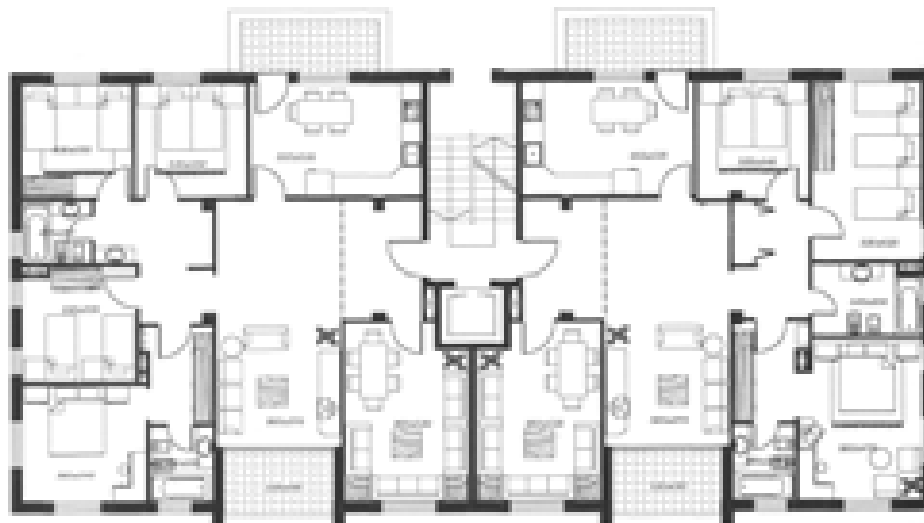


Fig. 3.5. Typical Apartment Plan
Left : four bedrooms, Right : Three Bedrooms, with the same area

Single House



Photo (65) Jenin



Photo (66) Arabeh Village



Photo (67) Al-Jalazon Refugee Camp



Photo (68) Tulkarem

Villas

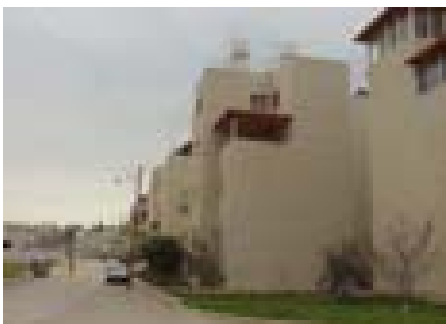


Photo (69) Simple Villas - Jenin



Photo (70) Tulkarem



Photo (71) Villas - Ramallah



Photo (72) Nablus

4. Landscaping for Energy Savings

It is possible to achieve as much as a 30% reduction in cooling and heating costs through careful landscape planning. Landscaping can reduce direct sun from striking and heating up building surfaces. It can prevent reflected light carrying heat into a house from the ground or other surfaces. By reducing wind velocity, an energy conserving landscape slows air leakage in a house. Additionally, the shade created by trees and the effect of grass and shrubs will reduce air temperatures adjoining the house and provide evaporative cooling.

The use of dense tree and shrub plantings on the west and northwest sides of a home will block the summer setting sun. This is the most effective landscape planting strategy. Additional considerations include the use of deciduous trees on the south side of the house that will admit summer sun; evergreen plantings on the north side will slow cold winter winds; constructing a natural planted channel to funnel summer cooling breezes into the house.

In traditional architecture landscape was part of the building process and was very effective process, traditional houses were not more than three story buildings so trees and other landscape elements can affect the outdoor climate and the indoor climate. Out door functions was part of the house (cooking and cleaning), so shaded areas were needed. While in modern architecture landscape elements are less effective especially for those high buildings and for the absence of outdoor functions in apartment buildings and office building. This does not lead that the landscape is not an important element but lead to the fact that the use of landscape elements must be used in a new concepts for large scale buildings.

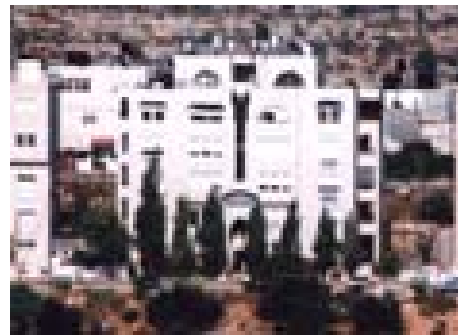


Photo (73) High Trees in front of Apartment Building - Ramallah

Carefully evaluate existing plants at a building site to identify those that can play a role in an energy conserving landscape. The established plants will require less effort to maintain and will generally be of a larger size and better established than new plantings.

4.1. Shading

Trees are primary in an energy conserving landscape. Trees can have a canopy large enough to shade roofs, reducing cooling costs and increasing comfort.

The best locations for deciduous trees are on the south and east sides of a house. When these trees drop their leaves in the winter, sunlight can reach the house to help in heating the home. Note: Even without leaves, trees can block as much as 60% of the sun, making placement of trees critical to effectiveness.

Evergreen trees on the north and west sides afford the best protection from the setting summer sun and cold winter winds.

If large trees need to be planted, it is best to select trees that have a moderate growth rate rather than fast growing varieties. Moderate growing varieties are sturdier against storm damage and generally more resistant to insects and disease.

A tree that will reach a medium to large size should be located 15 to 20 feet from the side of a house and 12 to 15 feet from the corner. Smaller trees can be planted closer to a house and shade walls and windows.

Shrubs or small trees can be used to shade split air conditioning or heat pump equipment that sits outside. This will improve the performance of the equipment. For good airflow and access, plants should not be closer than 3 feet to the compressor.

Evergreen shrubs and small trees can be planted as a solid wall at least four to five feet away from the north side and provide a windbreak. However, it is better to have dense plantings further away so air movement can occur during the summer.

4.2. Windbreaks

The effective zone of protection for a windbreak can be 30 times the height of the trees. However, the maximum protection occurs within 5 - 7 times the tree height. For example, if the windbreak will be 25 feet tall, it should be placed from 125 to 175 feet from the house.

Characteristics of an effective windbreak

- *The windbreak extends to the ground.*
- *Foliage density on the windward side is optimally 60%.*
- *Two to three rows of evergreen trees in staggered order should be used. If using deciduous trees, there should be five to six rows.*
- *The length of a windbreak should be 11.5 times the mature width of the stand of trees.*
- *The tree heights within the windbreak should be varied.*

4.3. Vines for Shading

When trees are young and not providing much shade, vines can be used to provide shading on walls and windows.

Some vines such as English Ivy will cling to any wall surface. This can harm wood surfaces.

Trellises placed close to the walls can be used to support vine growth without touching the walls.

Using vines, which lose foliage in the winter, can be used for summer shading as long as vine stems do not significantly block winter sun.

Evergreen vines will shade walls in the summer and reduce the effects of cold winds in the winter.

4.4. Arbors

Arbors along the sides of the house, attached or detached, will similarly reduce temperatures as the air movement can pass through the arbor and be cooled by evaporation at the plant's leaves. The shade created by the arbor is also beneficial. The arbor is a traditional cooling method used worldwide.

4.5. Absorbent and Reflective Materials

Groundcover and/or turf also have a cooling effect from evapotranspiration (the loss of water from the soil by evaporation and by the transpiration of the plants growing therein).

The temperature above a groundcover will be 10 to 15 degrees cooler than above a heat absorbent material such as asphalt or a reflective material such as light colored gravel or rock.

A heat absorbent material like asphalt will also continue to radiate heat after the sun has set. It is best to either minimize the use of heat absorbent and reflective materials near a house and/or shade them from any direct sun.

Analysis and Conclusions

In the last fifty years, and as a result of development in communities' technology, the impact of western civilization has been very powerful on the third world countries. It influenced all aspects of life including architecture. Consequently new building styles start to arise which are not suitable to the local social, economic, cultural, and climatic conditions, it's noticed that new houses have no courtyards and unshaded external walls, with large, western style windows and thin concrete or metal roofs. That says, "Without full air-conditioning, these houses are far less comfortable".

Following this survey, reading and analyzing data and information lead to the fact that no special contemporary architectural elements were used in West Bank and Gaza Strip for energy saving or to reduce thermal loss. Having said that does not mean that there is no element that helped in reducing thermal loss, some element were helping elements and were done spontaneously or as tradition, but not meant to be done for energy saving. These helping elements were not selected after thermal calculations, such as Balconies, colors, shading elements, opening, etc.

Building materials and techniques were not used as an important element in thermal isolation, and building is still treated as a structure and not as a living object that needs special techniques to breath, and to keep air temperature in comfortable level in summer and winter times. Insulation materials were mainly used as typical detail and not according to thermal calculations; different areas and spaces with different opening and orientation were treated and isolated with the same technique, building materials, and the same wall section and sicknesses.

Building technology in Palestine pays a little attention to climate and most people build their house without referring to any engineering consultancy, in addition to that most designers do not consider climate as one of the main design criteria in their buildings. Many buildings do not provide the occupants with the comfortable environment they wish. This comfortable environment can be achieved by using energy. But when as the case in Palestine, energy is valuable, and out of reach of many people, this becomes unreasonable. The alternative is a careful design of buildings respect to the climatic condition in the area.

On the other hand, traditional architecture provides the architect with the experience learned through generations of trial and error and, obviously, has gone a long way in satisfying the climate among other requirements. Thus many architects have looked to vernacular construction and traditional buildings as an inspiration. However, this has led to some mistakes and it worth to mentioning here that, although traditional buildings and traditional building methods have always paid some respect to the climate and include some ingenious solutions, it is strongly believed that these buildings and solutions should be studied, evaluated and developed but not copied. It is known that some of the traditional examples could not be repeated now a days because it needs larger piece of land (for courtyard houses) or for the differences in the contemporary functions we need.

RECOMMENDATIONS

Following this survey in traditional and contemporary architecture in West Bank and Gaza Strip, these findings and recommendations resulted from analysis of the research and observations made during fieldwork and interviews:

- 1. In design and construction process we should be more aware to the importance of orientation, finding the best orientation for the building can reduce heat loss in winter time and heat gain in summer time. And by well orientation architects can achieve better natural lighting and ventilation and air circulation in summer time.*
- 2. Some architectural elements should be taken in consideration, we should be aware to the opening and its treatments; opening sizes in different elevations are important valuable element, especially in southwest and east elevations. Glazing is not less effecting factor single, double, and triple glazing as well as reflected glass can give totally different thermal loss in summer and winter.*
- 3. Building materials must be studied more, in order to use new building materials and techniques for isolation. This can be achieved by organizing building materials' exhibitions and public lectures in different places in West Bank and Gaza Strip. Experience, proven and appropriate Computer softwares for local climate may help architect and engineers to calculate thermal loss.*
- 4. Architects and engineers should be more aware to the value of traditional architectural elements, studying traditional architecture and its effect on saving energy. Beside these elements massing and shading on elevations should be considered as well as landscape elements.*

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ANNEX I

ANNEX I

Passive Solar Design

Passive solar design is a broad term used to encompass a wide range of strategies and options resulting in energy-efficient building design and increased occupant comfort. The concept emphasizes architectural design approaches that minimize building energy consumption by integrating conventional energy-efficient devices, such as mechanical and electrical pumps, fans, lighting fixtures, and other equipment, with passive design elements, such as building siting, an efficient envelope, appropriate amounts of fenestration, increased daylighting design, and thermal mass. Many passive buildings are compatible with active components such as solar hot water systems. In short, “passive solar design balances all aspects of the energy use in a building: lighting, cooling, heating, and ventilation. It achieves this by combining, in a single concept, the use of renewable resources and conventional, energy-efficient strategies.”

The basic idea of passive solar design is to allow daylight, heat, and airflow into a building only when beneficial. The objectives are to control the entrance of sunlight and air flows into the building at appropriate times and to store and distribute the heat and cool air so it is available when needed. Many passive solar design options can be achieved at little or no additional cost.

1. Passive Solar Design Strategies

A solar energy system should seek to provide the optimal combination of efficient performance, low initial and running costs, robustness and durability. Successfully integrating passive solar design strategies requires a systematic approach that begins in the pre-design phase and carries throughout the entire design process. It is critical that the building owners and the design team agree to integrate passive solar design considerations during the appropriate project phases. The following passive solar design strategies should be included during the building-design process.

- **Site Selection:** Evaluate building site options/positions for solar access and use of landscaping elements.
- **Programming :** Establish energy-use patterns and set priorities for energy strategies (e.g., daylighting versus efficient lighting); determine base-case conditions and conduct life-cycle cost analysis; establish an energy budget.
- **Schematic Design:** Maximize site potential by considering orientation, building shape, and landscaping options; conduct a preliminary analysis of representative building spaces as they relate to insulation, thermal mass, and window type and location; determine the available daylighting; decide on the need for passive

- heating or cooling load avoidance, lighting, and HVAC systems. Determine the preliminary cost-effectiveness of options and compare the budgets.
- **Design Development:** Finalize the analysis of all individual building zones, including analysis of design element options and life-cycle costs.
 - **Construction Documents:** Simulate total building projections and develop specifications that meet the intent of energy-efficient design.
 - **Bidding:** Use life-cycle cost analysis to evaluate alternates or “equals.”
 - **Construction:** Communicate to the contractor the importance of adhering to design elements and ensure compliance.
 - **Occupancy:** Educate occupants on the intent of the energy design and provide an operations manual for maintenance staff.
 - **Post-Occupancy:** Evaluate performance and occupancy behavior for comparison with goals.

2. Passive Solar Characteristics

Passive solar buildings generally have the following distinctive design features:

- In the southern hemisphere most of the windows face north (in the northern hemisphere windows face south). This can be generalized by referring to equator-facing glazing.
- Ideally, the internal surfaces that the light strikes are high density materials, such as concrete, brick, stone, or adobe. These materials, because of the 'thermal lag' effect (the ability to absorb heat energy and re-radiate it over time), can store the energy for constant slow re-radiation, resulting in very smooth temperature swings for the building, reducing the possibility of daytime overheating. In this way a large portion of the building's heating requirements can be supplied solely by the sun.
- In early passive solar buildings, architects and builders were advised to reduce window areas on the east, west, and south sides of the building. This is still the general rule; however the more recent introduction of super-insulated windows and radiation-modifying films enables designers and builders to relax this rule. This is important for sites with attractive views other than towards the equator. West-facing windows are always a source of high heat gain during summer and must be shaded.
- Generally, the building plan with a long east-west axis and optimized equator-facing wall will provide the best passive solar performance.
- Passive solar buildings tend to be well insulated and have reduced air leakage rates, to keep the solar heat within the building envelope.
- Since auxiliary heat requirements are greatly reduced in a passive solar building compared to a conventional building, smaller, direct-vented or radiant units for extended cloudy periods are all that may be required in very cold climates.

- Passive solar buildings often have 'open floor plans' to facilitate the 'thermosiphoning' movement of solar heat from the equator side through the rest of the spaces. Sometimes small fans can be used to aid warm air distribution in buildings with closed floor plans.
- **Summer Heat Gain:** Passive systems that provide heat in the winter will go on providing heat in the summer unless measures are taken to block the summer sun. The most effective measure is a combination of roof overhangs, external shutters or shades, and foliage to keep the summer sun from entering the home. Unless these measures are employed, the system will continue to heat the home in summer, increasing air conditioning loads and canceling the net energy benefit of the passive system

3. Passive Solar Major Principles:

Good passive design for thermal comfort is based on the following six major principles:

- Orientation of frequently used areas towards the equator (north in the southern hemisphere, south in the northern hemisphere), to allow maximum sunshine when it is needed for warmth, and to more easily exclude the sun's heat when it is not.
- Glazing used to trap the sun's warmth inside a space when it is needed, with adequate shading and protection of the building from unwanted heat gain or heat loss.
- Thermal mass to store the heat from the sun when required, and provide a heat sink when the need is for cooling.
- Insulation to reduce unwanted heat losses or heat gains through the roof, walls, doors, windows and floors.
- Ventilation to provide fresh air and capture cooling breezes.
- Zoning of internal spaces to allow different thermal requirements to be compartmentalized when required.

A - Orientation

Buildings should be planned in such a way that benefit is obtained from shaded indoor and outdoor living areas when the weather is hot and sunny indoor and outdoor areas with wind protection when the weather is cold.

Well designed buildings should be oriented, and the spaces arranged in such a way, that the majority of rooms face towards the equator. In this way the eastern and western sides are exposed to the low-angle summer sun in the morning and afternoon. The high angle of the sun in the sky in summer makes it easy to shade windows using only a generous roof overhang or horizontal shade. The longer north/south sides of the building benefits from the low angle sun in winter. The roof overhang or shading on the equator side

should allow the Sun to shine into the building when its warmth is required in winter, and provide adequate protection from high-angle Sun in summer.

If the majority of windows are designed into the equator-facing wall, sun penetration into the building will be maximized. Living areas should be sited to gain maximum benefit from cooling breezes in hot weather and shelter from undesirable winds in winter. This does not mean that the orientation of the building should be varied from north towards prevailing breezes as it does not have to face directly into the breeze to achieve good cross-ventilation.

Within the internal planning, rooms such as dining and recreation area that require more heat during the winter months should be placed on the equator side. Rooms that are used for short periods of time during the day can be placed towards the rear, or more effectively, as buffer zones on the west side to protect living areas from the hot afternoon Sun (for example bathrooms, laundry, ensuite, entry corridors, stairs, bedrooms, bars).

B - Glazing

Windows, glass doors, panels and skylights play a crucial role in admitting heat and light, and can have a significant impact on energy consumption. They are also the most difficult parts of the building envelope to adequately insulate. Care needs to be taken to ensure that windows are positioned, sized and protected so as to get the most benefit from winter sun while avoiding overheating in summer and heat loss in winter.

C - Thermal Mass

Thermal mass is basically the ability of a material to store heat. It can be easily incorporated into a building as part of the walls and floor. Thermal mass affects the temperature within a building by:

- Stabilizing internal temperatures by providing heat source and heat sink surfaces for radiative, conductive and convective heat exchange processes.
- Providing a time-lag in the equalization of external and internal temperatures.
- Providing a reduction in extreme temperature swings between outside and inside

Material selection to capitalize on thermal mass is an important design consideration. For instance, heavyweight internal construction (high thermal mass) such as brick, solid concrete, stone, or earth can store the Sun's heat during winter days, releasing the warmth to the rooms in the night after it conducts through. Lightweight materials such as plasterboard and wood paneling are relatively low mass materials and will act as insulators to the thermal mass, reducing its effectiveness. Lightweight construction responds to temperature changes more rapidly. It is therefore suitable for rooms that need to heat or cool very quickly.

For maximum energy efficiency, thermal mass should be maximized in the equator-facing sides of a building. Any heat gained through the day can be lost through ventilation at night. In using this technique, the thermal mass is often referred to as a 'heat bank' and acts as a heat distributor, delaying the flow of heat out of the building by as much as 10-12 hours.

Thermal mass design considerations include:

- Where mass is used for warmth, it should be exposed to incident solar radiation.
- Where mass is required for cooling, it is better placed in a shaded zone.
- Buildings may be preheated using electric or hot water tubing embedded in the mass (mostly concrete floors).
- Buildings may be pre-cooled using night-purge ventilation (opening the building up to cool breezes throughout the night), although this requires significant amounts of exposed mass, and may be necessary only at certain times of the year.
- Thermal mass is particularly beneficial where there is a big difference between day and night outdoor temperatures.

D - Insulation

Insulation specifications are another important design feature. The building envelope provides a barrier against the extremes of the outdoor environment, allowing the thermal comfort levels indoors to be adjusted to suit the occupants. This might require heating or cooling depending on the season and location of the building. The energy required for heating or cooling will be greatly reduced if the building envelope is well insulated to reduce incidental losses. This means insulating the ceiling, walls and floor of the building, an easy task during construction, but often more difficult for existing buildings.

Insulation reduces the rate at which heat flows through the building fabric, either outwards in winter or inwards in summer. In temperature controlled buildings, this will result in significant energy savings and increased thermal comfort. In passive buildings, it means that any low-grade energy available will be more effective at its job of heating or cooling.

Insulation has an additional benefit in that it also reduces noise transfer through the fabric; however its resistance to both fire and insects should also be major considerations. Proper installation is also essential to maximize performance, and there often local and international standards to cover the fire safety and health aspects of installation.

E - Ventilation

Ventilation of a building is critical during summer as the building must provide sufficient ventilation and breeze paths to assist with cooling. For warmer climates doors and

windows should be positioned to facilitate prevailing cooling breezes. An analysis of local wind directions at different times of the year may be necessary in order to best locate windows and design systems to 'catch' or funnel the breezes through them.

To maintain indoor air quality, the opportunity to provide clear breeze paths through a building should be maximized to encourage air flow for night time cooling in summer and 'flushing out' the accommodation, by removing stale air that contains CO₂, water vapor, and mould.

4. Passive Solar Systems

Solar energy is a radiant heat source that causes natural processes upon which all life depends. Some of the natural processes can be managed through building design in a manner that helps heat and cool the building. The basic natural processes that are used in passive solar energy are the thermal energy flows associated with radiation, conduction, and natural convection. When sunlight strikes a building, the building materials can reflect, transmit, or absorb the solar radiation. Additionally, the heat produced by the sun causes air movement that can be predictable in designed spaces. These basic responses to solar heat lead to design elements, material choices and placements that can provide heating and cooling effects in a home.

The list of passive design techniques given here is by no means meant to be exhaustive. However, for the purposes of categorization, the following two topics cover passive heating and passive cooling systems.

A - Passive Solar Heating Systems

- **Two primary elements of passive solar heating are required:**
 - South facing glass
 - Thermal mass to absorb, store, and distribute heat

There are three approaches to passive systems - direct gain, indirect gain, and isolated gain. The goal of all passive solar heating systems is to capture the sun's heat within the building's elements and release that heat during periods when the sun is not shining. At the same time that the building's elements (or materials) is absorbing heat for later use, solar heat is available for keeping the space comfortable (not overheated).

- **A.1 Direct Gain**

In this system, the actual living space is a solar collector, heat absorber and distribution system. South facing glass admits solar energy into the house where it strikes directly and indirectly thermal mass materials in the house such as masonry floors and walls. The direct gain system will utilize 60 - 75% of the sun's energy striking the windows

Thermal mass in the interior absorbs the sunlight and radiates the heat at night

In a direct gain system, the thermal mass floors and walls are functional parts of the house. It is also possible to use water containers inside the house to store heat. However, it is more difficult to integrate water storage containers in the design of the house.

The thermal mass will temper the intensity of the heat during the day by absorbing the heat. At night, the thermal mass radiates heat into the living space.

- **A.1.1 Direct gain system rules of thumb:**

- A heat load analysis of the house should be conducted.
- Do not exceed 6 inches of thickness in thermal mass materials.
- Do not cover thermal mass floors with wall to wall carpeting; keep as bare as functionally and aesthetically possible.
- Use a medium dark color for masonry floors; use light colors for other lightweight walls; thermal mass walls can be any color.
- Fill the cavities of any concrete block used as thermal storage with concrete.
- Use thermal mass at less thickness throughout the living space rather than a concentrated area of thicker mass.
- The surface area of mass exposed to direct sunlight should be 9 times the area of the glazing.
- Sun tempering is the use of direct gain without added thermal mass. For most homes, multiply the house square footage by 0.08 to determine the amount of south facing glass for sun tempering.

- **A.2 Indirect Gain**

In an indirect gain system, thermal mass is located between the sun and the living space. The thermal mass absorbs the sunlight that strikes it and transfers it to the living space by conduction. The indirect gain system will utilize 30 - 45% of the sun's energy striking the glass adjoining the thermal mass.

There are two types of indirect gain systems:

- Thermal storage wall systems (Trombe Walls)
- Roof pond systems

- **A.2.1 Thermal storage wall systems:**

The thermal mass is located immediately behind south facing glass in this system.

Operable vents at the top and bottom of a thermal storage wall permit heat to convect from between the wall and the glass into the living space. When the vents are closed at night radiant heat from the wall heats the living space.

Thermal Mass Wall or Trombe Wall Day and Night Operation

- **A.2.2 Roof pond systems**

Six to twelve inches of water are contained on a flat roof.

This system is best for cooling in low humidity climates but can be modified to work in high humidity climates.

Water is usually stored in large plastic or fiberglass containers covered by glazing and the space below is warmed by radiant heat from the warm water above.

These require somewhat elaborate drainage systems, movable insulation to cover and uncover the water at appropriate times, and a structural system to support up to 65 lbs/sq ft dead load.

- **A.2.3 Indirect gain system rules of thumb for thermal storage walls**

- The exterior of the mass wall (toward the sun) should be a dark color.
- Use a minimum space of 4 inches between the thermal mass wall and the glass.
- Vents used in a thermal mass wall must be closed at night.
- If movable night insulation will be used in the thermal wall system, reduce the thermal mass wall area by 15%.

- **A.3 Isolated Gain**

An isolated gain system has its integral parts separate from the main living area of a house. Examples are a sunroom and a convective loop through an air collector to a storage system in the house. The ability to isolate the system from the primary living areas is the point of distinction for this type of system.

The isolated gain system will utilize 15 - 30% of the sunlight striking the glazing toward heating the adjoining living areas. Solar energy is also retained in the sunroom itself.

Sunrooms (or solar greenhouses) employ a combination of direct gain and indirect gain system features. Sunlight entering the sunroom is retained in the thermal mass and air of the room. Sunlight is brought into the house by means of conduction through a shared mass wall in the rear of the sunroom, or by vents that permit the air between the sunroom and living space to be exchanged by convection.

The use of a south facing air collector to naturally convect air into a storage area is a variation on the active solar system air collector. These are passive collectors. Convective air collectors are located lower than the storage area so that the heated air generated in the collector naturally rises into the storage area and is replaced by return air from the lower cooler section of the storage area. Heat can be released from the storage area either by opening vents that access the storage by mechanical means (fans), or by conduction if the storage is built into the house.

Day and Night Operation of a Sunroom Isolated Gain System

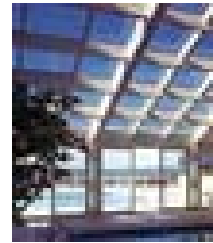
Both the warmed air and the direct solar radiation act to heat up the thermal storage wall between the internal space and the sunspace. After sundown, the vents that allow air movement are closed to prevent a reverse cooling convection current from occurring. As the internal space begins to cool, the heat slowly passing through the thick mass wall begins to reach the inside surface, radiating its heat energy for several hours thereafter.

The sunroom has some advantages as an isolated gain approach in that it can provide additional usable space to the house and plants can be grown in it quite effectively.

The convective air collector by comparison becomes more complex in trying to achieve additional functions from the system. This is a drawback in this area where space heating is less of a concern than in colder regions where the system would be used longer. It is best to use a system that provides more than one function if the system is not an integral part of the building. The sunroom approach will be emphasized in this information since it can provide multiple functions.

- **A.3.1 Sunrooms**

Sunrooms can feature sloped and/or overhead glass, but is not recommended for the hot areas. A sunroom will function adequately without overhead or sloped glazing. Due to long hot summers in these areas, it is important to use adequate ventilation to let the heat out. Sloped or overhead glazing is also a maintenance concern. Due to the intensity of weather conditions for glazing facing the full .i.ventilation: passive design and brunt of the sun and rain, seals between the gazing panels need to be of extremely high material and installation quality.



A thermal wall on the back of the sunroom against the living space will function like the indirect gain thermal mass wall. With a thermal wall in the sunroom, the extra heat during the day can be brought into the living space via high and low vents like in the indirect gain thermal wall.

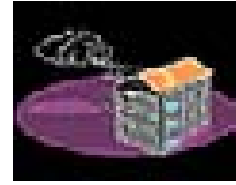
- **A.3.2 Isolated Gain rules of thumb for sunrooms:**

- Use a dark color for the thermal wall in a sunspace.
- Withdraw excess heat in the sunroom (if not used for warm weather plants) until the room reaches 45 degrees and put the excess heat into thermal mass materials in other parts of the house.
- Have a ventilation system for summer months.
- If overhead glass is used in a sunroom, use heat reflecting glass and or shading systems in the overhead areas.

B - Passive Solar Cooling

- **B.1 Ventilation & Operable Windows**

A primary strategy for cooling buildings without mechanical assistance (passive cooling) in hot humid climates is to employ natural ventilation. (The Fan and Landscape sections also address ventilation strategies.) In this area, prevailing summer breezes are from the south and southeast. This matches nicely with the increased glazing on the south side needed for passive heating, making it possible to achieve helpful solar gain and ventilation with the following strategies:



- Place operable windows on the south exposure.
 - Casement windows offer the best airflow. Awning (or hopper) windows should be fully opened or air will be directed to ceiling. Awning windows offer the best rain protection and perform better than double hung windows.
 - If a room can have windows on only one side, use two widely spaced windows instead of one window.
- **B.1.1 Wing Walls**

Wing walls are vertical solid panels placed alongside of windows perpendicular to the wall on the windward side of the house.

Wing walls will accelerate the natural wind speed due to pressure differences created by the wing wall

Top View of Wing Walls Airflow Pattern

- **B.1.2 Thermal Chimney**

A thermal chimney employs convective currents to draw air out of a building. By creating a warm or hot zone with an exterior exhaust outlet, air can be drawn into the house ventilating the structure.

Sunrooms can be designed to perform this function. The excessive heat generated in a south facing sunroom during the summer can be vented at the top. With the connecting lower vents to the living space open along with windows on the north side, air is drawn through the living space to be exhausted through the sunroom upper vents. (The upper vents from the sunroom to the living space and any side operable windows must be closed and the thermal mass wall in the sunroom must be shaded.)

Summer Venting Sunroom

Summer Venting Thermal Mass Wall

Thermal mass indirect gain walls can be made to function similarly except that the mass wall should be insulated on the inside when performing this function.

Thermal Chimney

Thermal chimneys can be constructed in a narrow configuration (like a chimney) with an easily heated black metal absorber on the inside behind a glazed front that can reach high temperatures and be insulated from the house. The chimney must terminate above the roof level. A rotating metal scoop at the top which opens opposite the wind will allow heated air to exhaust without being overcome by the prevailing wind.



Thermal chimney effects can be integrated into the house with open stairwells and atria. (This approach can be an aesthetic plus to the home as well.)

- **B.1.3 Other Ventilation Strategies**

- Make the outlet openings slightly larger than the inlet openings.
- Place the inlets at low to medium heights to provide airflow at occupant levels in the room.

Thermal Chimney Effect Built into Home

Inlets close to a wall result in air "washing" along the wall. Be certain to have centrally located inlets for air movement in the center areas of the room.

Window insect screens decrease the velocity of slow breezes more than stronger breezes (60% decreases at 1.5 mph, 28% decrease at 6 mph). Screening a porch will not reduce air speeds as much as screening the windows.

Night ventilation of a home should be done at a ventilation rate of 30 air changes per hour or greater. Mechanical ventilation will be required to achieve this.

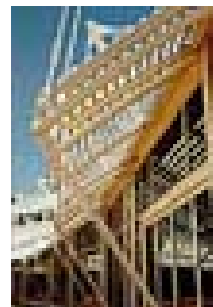
High mass houses can be cooled with night ventilation providing that fabric furnishings are minimized in the house.

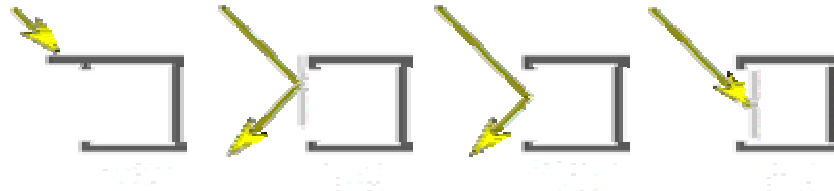
Keep a high mass house closed during the day and opened at night.

• **B.2 Shading**

The control or otherwise of solar radiation is an important part of building design. It represents one of the most significant sources of potential summer heat gains in a building. At the same time, it represents the most significant source of sustainable energy we have at our disposal as designers.

With some innovative design, solar radiation in summer can actually be used to induce cooling air movement within buildings. Even with some of the most recent lighting technologies, diffuse daylight is still the most efficient (and cheapest) way to light a building when you consider its heat load per lumen output. At the same time, however, uncontrolled direct sunlight is a very efficient heat source, equivalent to a 1000W electric bar radiator for every square meter exposed window area in summer.





Basic shading device strategies

The use of appropriate solar controls is very important, especially within air-conditioned buildings to greatly reduce what is essentially needless waste associated with large areas of unprotected glazing. The diagram above indicates the four basic shading strategies available. It is essential that the designer understand the benefits and disadvantages of each in order to apply them correctly.

B.2.1 External vs Internal Devices

Both exterior and interior shades control heat gain. Exterior shades are more effective than interior shades because they block sunlight before it enters the window (and therefore the space). The table below compares the Shading Coefficient (SC) of various shading devices. The SC is simply the fraction of solar radiation transmitted by the specified device, compared to that transmitted by an unprotected sheet of 3mm clear float. The higher the SC the more solar heat passes through.



When deciding which devices to use and where to use them, the designer must consider a whole range of issues, whether they will be opened and closed daily as needed or just put up for the hottest season, whether they will adversely affect natural lighting level or even produce more glare, and how they might affect any natural ventilation strategy.

1.0	3mm Clear Float Glass
0.8	Standard Double Glazing
0.5-0.9	Internal Venetian Blinds - Drawn
0.4-0.8	Internal Curtains - Drawn
0.4-0.8	Internal Roller Blinds - Drawn
0.7	Heat Absorbing Glass
0.6	Trees Providing Light Shade
0.5	Internal Blind - Reflective Backing
0.4	Solar Control Glass
0.3	1m Eaves Over North Wall
0.2	2m Pergola Over North Wall
0.2	External Blinds - Drawn
0.2	External Shutters - Closed

***Comparison of shading coefficients for
a range of shading devices***

*"Energy conserving landscapes"
reduce energy costs in a home
during summer and winter. Ideally,
the energy conserving landscape is
also a water conserving landscape.*

References

ANNEX II

ANNEX II

Photo Archive

The southern mountains area





The Central mountains area

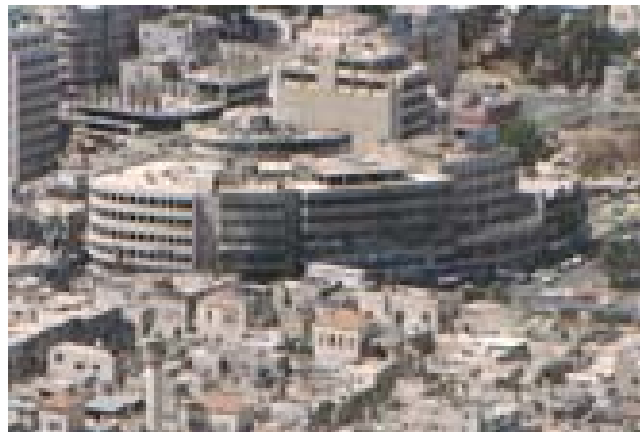




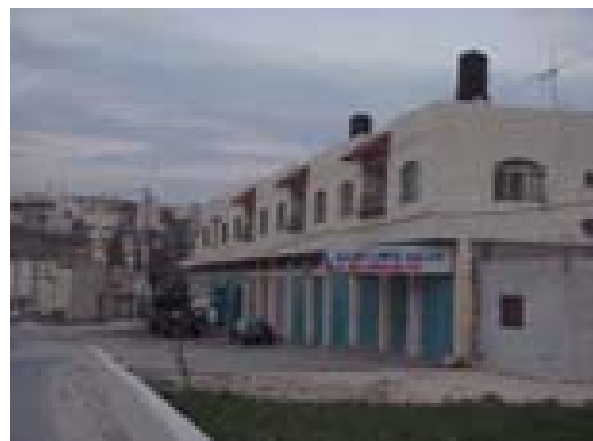
The Jordan Valley area

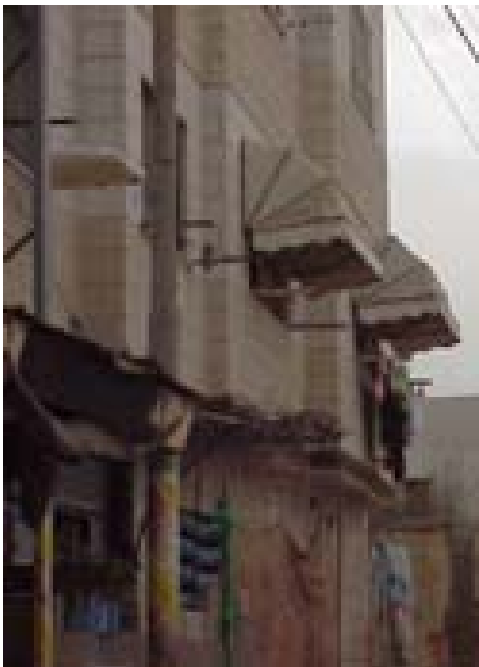


The Nablus mountains area



The semi coastal area





The Coastal plain



