| 1 | The climate of hot-dry zones is in general characterized by high temperatures (40-50°C in summer), with sharp variations in both diurnal (day/night) and seasonal (summer/winter) temperatures; and precipitation (rainfall, snow) which is scarce, irregular and unreliable, but may nevertheless cause severe floods. Cold winds and dust/sandstorms prevail in winter. The solar radiation intensity is high and enhanced by the radiation reflected from the ground. The air humidity is low. |
| 2 | The main objective of climatic design is to provide comfortable living conditions with a minimum and meaningful input of artificial energy. This also reduces investment and running costs as well as ecological damage. |

### Design for hot-arid zones

- **Objectives**: Provide comfortable living conditions with minimal artificial energy input. Minimize heat gain and control air circulation.
- **Materials**: Light, reflective materials for walls and roofs, and permeable surfaces for footpaths and gardens.
- **Design Features**: Roof overhangs, shaded areas, and natural ventilation to reduce heat gain. Use of local materials for construction.

### Design for warm-humid zones

- **Objectives**: Design for moderate temperatures and high humidity. Use natural ventilation and shading to control heat gain.
- **Materials**: Light, permeable materials that can absorb and release heat slowly. Use of plants for shading and cooling.
- **Design Features**: Use of ventilation to reduce indoor humidity. Green roofs and walls to improve insulation and cooling.

### Design for temperate and upland zones

- **Objectives**: Design for moderate temperatures and varying humidity. Use of passive strategies for energy efficiency.
- **Materials**: Light, durable materials that can withstand varying weather conditions. Use of local materials for construction.
- **Design Features**: Use of passive solar design, natural ventilation, and shading to control heat gain and loss. Use of green roofs and walls to improve insulation and cooling.
| التحديات | - غيرت الوسائل التكنولوجية سبل معيشتنا وجعلت استخدام مكيفات الهواء وأنظمة الإضاءة أسهل من الحلول التقليدية.  
| | - يحدث تغيير في نمط الحياة وسائل المعيشة بما تزامن مع تغير في رنود الفعل تجاه الحلول التقليدية وتقبلها.  
| | - The technological means altered our ways of living and made the usage of air-conditioning or lighting systems easier than traditional solution.  
| | - a change in lifestyles and means of livelihood has occurred and a change in the responsiveness and acceptability to the traditional solutions happened with it.  
| ملاحظات عامة | - بالنسبة للوسائل المستخدمة للمعدات التقنية، تعتبر الوسائل المناخية الطبيعية حلولاً اقتصادية جداً في العادة من حيث التكاليف الإنشائية والتشغيلية. إلا أن استخدام الوسائل التكنولوجية الحديثة لا يمكن تجنبه في بعض الظروف نظراً لمتطلبات الراحة الملائمة الحالية.  
| | - من الضروري تطوير مبادئ بناء جديدة بما يشتمل على اعتبارات أساسية تتعلق بالطاقة والمناخ، إلا أن هذه المبادئ ترتبط بمتطلبات المجتمع المعاصر الوظيفية والاجتماعية.  
| | - Compared to solutions employing technical equipment, such natural means of climatization are usually very economical solutions, both in terms of construction and running costs. Nevertheless, the use of modern technical means is under certain circumstances unavoidable in trying to meet today's requirements for adequate comfort.  
| | - It is necessary to develop new building concepts which include essential energy and climate considerations, but are also linked to the functional, physiological and socio-psychological requirements of today's society.  
| الهدف العام لتصميم مباني متجاوبة مع المناخ | - تقليل اكتساب الحرارة نهاراً وزيادة خسرانها ليلاً في المواسم الحارة. وينعكس ذلك في المواسم الباردة.  
| | - تقليل الاكتساب الحراري الداخلي في المواسم الحارة.  
| | - اختيار الموقع بناء على عوامل المناخ الجزيئي.  
| | - زيادة كفاءة هيكل المبنى (وخصوصاً بالنسبة للمخزون الحراري والتآخير الزمني).  
| | - التحكم بالأشعة الشمسية.  
| | - تنظيم دوران الهواء.  
| | - · Minimize heat gain during daytime and maximize heat loss at night in hot seasons, and reverse in cold seasons.  
| | - · Minimize internal heat gain in the hot season.  
| | - · Select the site according to microclimatic criteria  
| | - · Optimize the building structure (especially regarding thermal storage and time lag).  
| | - · Control solar radiation.  
| | - · Regulate air circulation.  
| استراتيجيات التصميم | - تخطيط الموقع.  
| | - تصميم المبنى.  
| | - مكونات المبنى.  
| | - Settlement planning  
| | - Building Design  
| | - Building components  
| تخطيط المواقع | - يجب أخذ عوامل معينة بالاعتبار عند تخطيط المواقع، وتعد وسائل النقل والطرق ووصول الماء ومصادره والمواد والوسائط التقنية المتوفرة والبيئة التحتية والهيكل الاجتماعي واياديات الدفاع بعضها ودماً.  
| | - ويظهر للهدف العام الخاص بالحماية من المناخ الصعب بالإضافة إلى المخاطر، فإن المعايير الرئيسية التالية يجب اعتبارها: (أ) matériel المواقع والالتزامات في التلال والوديان (الارتفاع فوق سطح البحر).  
| | - (ب) شكل الأرض واتجاه الشمس.  
| | - (ت) شكل الأرض واتجاه الرياح.  
| | - (ث) الهماكل المفتوحة من قبل الإنسان (النطاق العمراني وشبكات الطرق).  
| | - Settlement planning (similar to the microclimate points)  
| | - · طبقة الرياح.  
| | - · طبقة الرياح.  
| | - · طبقة الرياح.  
| | - · طبقة الرياح.
Different factors have to be considered when planning settlements. Transportation means and ways, water access, water supply, available materials and technical means, infrastructure, social structure and defense considerations are but a few of them.

In view of the general goal of protection from the harsh climate as well as risks, the following main criteria have to be considered:

- Locations on slopes, hills and in valleys (elevation above sea level)
- Form of land and sun-orientation
- Form of land and Wind-orientation
- Manmade structures (urban pattern and street networks)
- Soil types and surface finishing
- Vegetation and green areas
- Hazards (additional point not in microclimate section)

7. a. المواقع على المنحدرات والتل والوديان (الارتفاع فوق سطح البحر)

Locations on slopes, hills and in valleys (elevation above sea level)

Attention has to be paid to the topographical altitude (The mean temperature decreases by 1°C with 100-m altitude difference), the geomorphology, and the most suitable orientation regarding sun exposure and prevailing winds. Differentiation must be made between locations on top of hills, on slopes, in valleys, on flatlands and near water.

7. b. تشكيل الأرض واتجاه الشمس

Form of land and sun-orientation

Settlements are preferably placed on northern slopes to avoid excessive sun exposure, using natural shade. West slopes should be avoided (The general preference for the orientation of slopes referring to sun exposure (on the northern hemisphere) is: 1st: north; 2nd: east; 3rd: south; 4th: west, This can vary in relation to the local conditions, topography, vegetation, sun angle and exposure time.). At higher altitude south exposure might be adequate for reasons of passive heating.

Valley bottoms are additionally heated by reflection of sun radiation from the surrounding slopes.
<table>
<thead>
<tr>
<th>7.</th>
<th>c</th>
<th>تحويل الأرض واتجاه الرياح</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form of land and Wind-orientation</strong></td>
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</tr>
</tbody>
</table>
| تكون حركة الهواء في العادة أكثر برودة وتكرارا على المنحدرات والمناطق العالية باتجاه الرياح السائدة. وتكون المواقع في قاع الوادي مقيدة في الأغلب. تسود سرعة الرياح الخفيفة في الوادي، مما يتسبب بتقليل تأثير الرياح (يمكن أن تنتج الرياح بسبب اتجاهات وظروف خاصة في الوادي). الهبوب فوق سطح مائي يمكن أن ينتج بالخفاش محدود في درجة حرارة الرياح.  
Air movement is usually frequent and cooler at slopes and high locations and towards the prevailing wind. Locations situated at the bottom of valleys are often handicapped. Valleys tend to have low wind velocity and hence the cooling effect by wind is reduced (Wind can also be caused by specific direction and conditions in a valley). Blowing over a water-body can result in a drop of a few degrees in the temperature of a wind.  |
| توجه شمال-غرب قطري للانسجام مع الشمس (عدم استقبال إشعاع مباشر طوال اليوم) والرياح (استقبال النسيم).  
Diagonal north-western orientation to align with sun (not receive direct radiation all day) and wind (receive the breeze)  
Above slopes is better than valleys. In case of flat areas, similar effects of shading and wind channeling can be achieved through vegetation  |
| التوجه الجنوبي (باحتمال التوجه جنوب-غرب) للإستفادة المثلية من الإشعاع الشمسي والانسجام مع الرياح الصيفية مع محاولة تجنب الرياح الشتوية. يمكن تشكيل سواتر الرياح عبر التشجير الحالي أو الذي تم زراعته أو عبر الهياكل أو الطبوغرافية (الجبال أو الوادي).  
Southern orientation (perhaps south-west) to best benefit from sun radiation and align with summer wind while trying to avoid winter wind. Shield from wind can be formed by existing or newly planted  |
| تكون المنحدرات العالية شديدة البرودة في الشتاء في حين تتمكن الوادي من احتزاز البرودة. تكون المنحدرات المتوسط الأقل ضررا من حيث درجات الحرارة والانسجام. وتوفير حاجز من الجبال حول المنطقة المختارة الحماية من الرياح.  
The temperatures on the slopes are very cold in winter in contrast to the valley which can retain cold. The slopes are less affected in terms of temperature and harmony. A barrier from the mountains around the selected area can protect from wind.  |
vegetation, by other structures or by topography (mountains or valleys).

Above slopes will be very cold in winter while valleys can trap coolth. Middle slopes is the least harmful in terms of temperature and radiation. Fence of mountains around the selected area provide a protection from wind.

Large bodies of water have a significant moderating effect on temperature, they generate the daily alternating land and sea breezes, and they increase the humidity.

Proximity with water should be carefully considered as it contributes to more humidity and coolth in winter.

Settlements for hot, dry climates are characterized by optimal protection against solar radiation by mutual shading, which leads to compact settlements, narrow streets and small squares which are shaded by tall vegetation.

Settlements for warm humid areas are laid out to make maximum use of the prevailing breeze. Buildings are scattered, vegetation is arranged to provide maximum shade without hindering natural ventilation.

The urban form cannot change the regional climate, but can moderate the city's microclimate and improve the conditions for the buildings and their inhabitants.

Urban forms are not only a result of physical and functional, but also of social and cultural factors and traditions in a region.

Aspects of proper sun orientation and wind protection should already be considered while working out the basic pattern of a settlement. This pattern should be of a semi-compact type.
حول الشمس

- الحد الأدنى من التعرض للشمس في الصيف، مما يتطلب التراص والتظليل. ومن العوامل المشابهة بالإضاءة والتهوية الطبيعية.
- تتوفر شبكة تظليل مكونة من شوارع ضيقة ومساحات صغيرة في المساكن المشابهة للشرفات.

(points about sun)

- Minimal sun-exposure in summer and therefore compactness and shade are the main principals. Of equal importance is natural lighting and ventilation.
- A shaded network of narrow streets and small spaces in between as patio-like areas.

- يتعد الأقواس والأعمدة والمباني ذات البروزات أو مكونات المباني والغشاء والأحواض الصغيرة والملونة رودود تقليدية للمناخ. كما يجب إشادة المساحات الكبيرة أيضاً بحيث نظل للداخل في معظم مراحل اليوم.

(points about sun)

- The plot dimensions should allow the positioning of a building with its wider side facing south. Provision for row buildings along the east-west axis may also be favoured.
- The walking distance to public spaces should be minimal and the footpaths shaded.
- Groups of buildings should not be built in too compact a manner.
<table>
<thead>
<tr>
<th>Points about wind</th>
</tr>
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<tbody>
<tr>
<td>- Air circulation can be improved through wind channelling in shaded narrow streets in the direction of the main wind.</td>
</tr>
<tr>
<td>- Buildings should be scattered and have a low population density.</td>
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<td>- Buildings should be separated with large, free spaces between them. This allows airflow which provides ventilation.</td>
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</tr>
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<td>- Shelter against the winter wind is required all the year round (winter wind to be disallowed and summer wind to be allowed). Excessive wind effects as well as cool air pools should be avoided.</td>
</tr>
<tr>
<td>- Houses should be located behind a wind shield, but be assured of exposure to the sun. This shield can be formed by existing or newly planted vegetation, by other structures or by topography (mountains or valleys).</td>
</tr>
</tbody>
</table>

حوَل الرياح:

- يمكن تحسين دوران الهواء من خلال توجيه الرياح في الشوارع الضيقة المظلمة وذلك باتجاه الرياح الرئيسي.
- يجب أن تسمح تجمعات المباني والأزقة والمسارات بتغوية مناسبة أو زيادة في سريان الهواء.
- يعتبر قرب الموقع من سطح مائي واعتبار المساحات الخضراء شديد الأهمية.

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<table>
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<tr>
<th>مهني ủng (من صنع البشر)</th>
<th>Manmade structures (street networks)</th>
</tr>
</thead>
</table>

1) **Grid diagonal**

This grid supports shading and the dynamic movement of air. More important, however, is the form of alleys and buildings.

2) **Narrow, zigzagging alleys**

Winding or zigzagging narrow alleys receive minimum radiation, reduce the effect of stormy winds. It also stays relatively warm during cold nights and in winter.

<table>
<thead>
<tr>
<th>اشجار (الرياح الصيفية)</th>
<th>Prevailing wind</th>
</tr>
</thead>
</table>

The settlement pattern should allow for a loose open street network.

External public spaces, streets, squares and footpaths should be protected from sun and rain.

Squares and passages should be covered, but cross-ventilation should not be impeded. Generous and well distributed areas of vegetation help to improve the microclimate.

Street spaces should be long and straight to facilitate air movement and lined by high, shade-providing trees.

<table>
<thead>
<tr>
<th>يتم التخطيط الأمثل للشوارع يكون بتوجيهها باتجاه الرياح الصيفية مع تجنب اتجاه الرياح الشتوية.</th>
<th>Streets are best planned in the direction of summer winds, avoiding the direction of winter winds.</th>
</tr>
</thead>
</table>

Wind can be allowed but openable gates might be used to allow winds at certain times and block it at others. Normally, summer wind to be welcomed and winter wind to be blocked.
3) Blocked streets and alleys

Storm effects can be reduced by blocking streets. Two-story buildings with closed patios open to the sky will maximize shade, minimize radiation, yet still retain ventilation and reduce the effects of stormy winds. Buildings should be attached (cluster) to reduce exposed surfaces.

Another option is diagonal orientation and hierarchal distribution of spaces and streets to allow wind to go through.

Vegetation and green areas

- It improves the microclimate both outdoors and indoors.
- It cleans and cools the air
- It blocks hot and dusty winds in arid regions and channels wind in humid areas.
- Through the transpiration of leaves temperatures are lowered.
- Its shade lowers daytime temperatures and heat emission at night is also reduced, thus resulting in more balanced temperatures.
- It balances the humidity. During precipitation much of the free water is absorbed and during dry periods water is evaporated.

Trees, hedges and plants in an urban context can have a dramatic effect on the microclimate and help to tie down sand and dust. As vegetation is generally sparse, an oasis-like concentration of plant and grass-covered areas is desirable. Nevertheless, landscaping should not always imply the inclusion of very high water consuming lawns and grassed areas. Local desert plants as well as rock and stone garden as well as gravel coverage should also be considered as adequate design elements.

Trees, hedges and plants in an urban context can have a dramatic effect on the microclimate and help to tie down sand and dust. As vegetation is generally sparse, an oasis-like concentration of plant and grass-covered areas is desirable. Nevertheless, landscaping should not always imply the inclusion of very high water consuming lawns and grassed areas. Local desert plants as well as rock and stone garden as well as gravel coverage should also be considered as adequate design elements.

High trees with wide, shading crowns provide significant protection from solar radiation and should be incorporated as much as possible into any landscape planning.

Certain species of trees (e.g. rain trees) form an extraordinary outdoor space by creating a canopy effect. They should not be planted too far from each other, so that the crowns form a wide hall-like space, creating a comfortable microclimate.
The vegetation in and around the city promotes and controls air movement. Apart from water areas, evaporation and cooling takes place only in green areas. Green areas located near and in a city will therefore improve the urban climate. The difference in temperature between green areas and built-up land causes minute air cycles and a horizontal exchange takes place. An arrangement of small parks and lanes could facilitate the ventilation of the town. The wind from the countryside is encouraged to penetrate as far as possible into the built-up area.

7. Soil types and surface finishing

The material, color, texture, and the thermal mass have their effect in absorbing or reflecting the temperature.

An unshaded pavement exposed to the sun heats up and can reach very high temperatures. A vegetal cover of the ground vegetation and the high crowns of the trees should remain open, providing free access for the wind at the level of the living spaces.

The vegetation in and around the city promotes and controls air movement. Apart from water areas, evaporation and cooling takes place only in green areas. Green areas located near and in a city will therefore improve the urban climate. The difference in temperature between green areas and built-up land causes minute air cycles and a horizontal exchange takes place. An arrangement of small parks and lanes could facilitate the ventilation of the town. The wind from the countryside is encouraged to penetrate as far as possible into the built-up area.

High bushes, however, should be avoided near buildings because the space between the ground vegetation and the high crowns of the trees should remain open, providing free access for the wind at the level of the living spaces.
The town structure and the public spaces should thus counteract heat with a shaded and dense layout. There should be a close connection between public spaces and residential areas to limit exposed spaces. Dwelling units or groups should create patio-like areas. Paved open spaces within a flat cityscape should be avoided or kept to a minimum size.

Most important is the design of the whole urban configuration, because the ratio of shaded space to space open to solar radiation affects air temperature significantly. The temperature in and around buildings can either be tempered or aggravated by the nature of the surrounding surface.

An unshaded pavements should be avoided as far as possible and air should not be allowed to pass over such hot surfaces before reaching buildings.

In dense settlements it is difficult to provide privacy as well as allowing the free flow of air. Various systems of paling fences and screen walls have been devised consisting of louvred or overlapping timber boards or planks. They do not permit a direct view and allow breezes to penetrate, but reduce the air velocity quite substantially. A suitably spaced, scattered settlement pattern helps to avoid fences, yet provides privacy.
المخاطر: وتعد هذه خطيرة للمبنى في الوديان. ورغم قلة احتماليتها في المناطق القاحلة، إلا أن الأمطار الغزيرة تحدث مسببة اندفاعا للماء مصحبا للكتل من الطين والصخور.

1) الفيضانات والانجرافات: A threat to building in valleys may be the danger of floods and landslides. Although seldom, even in arid regions heavy rain can occur, causing torrent streams combined with masses of mud, rocks and boulders.

2) الرياح: In almost all areas, heavy winds occur and a firm structure is required. Special care, however, has to be taken in areas that are threatened by hurricanes and sandstorms.

3) الزلازل: Despite the fact that earthquakes are not a topic of climatic design, the location of settlements has to be checked for possible earthquake risks and safe constructions have to be made. They may be in contradiction to traditional design or climatic construction requirements.

يمكن تخفيف تأثير العواصف الرملية عبر المواقع في أمناء مرتفعة وتخطيط توزيع غير منتظم لتكسير العاصفة. ويمكن أن تسبب الأمطار الغزيرة بالانجرافات في الوديان والمناطق الجبلية. كما يمكن أن تسبب بالفيضانات في حال التصرف السيء، وتعد الزلازل خطرا آخر وخاصة في المناطق الجبلية المكونة من الطين والطوب والتي قد لا تكون مقاومة.

The reduction of the effects of sand storms can be achieved through the location of settlements at higher elevations and planning irregular patterns to break the storm.

Heavy precipitations can cause landslides both at the bottom of valleys and on slopes. It also can cause floods if drainage was bad.

Earthquakes is another hazard especially with the traditional construction of mud and brick that might be not resistant.
8. Orientation of buildings

To define the optimal orientation of a building, three factors have to be considered:

- Solar radiation
- Prevailing wind
- Topography

Optimal sun-orientation reduces radiation to a minimum in the hot periods, while allowing adequate radiation during the cool months.

In regard to wind orientation, usually cooling by ventilation is desired. Buildings should therefore be oriented across the prevailing breeze.
In regards to **topography-orientation** and depending on the surface's angle relative to the solar radiation and on the type of surface, more sun radiation could be blocked and breeze can be altered.

**Sun orientation**

Shading of the east and west elevations is difficult because of the low sun, and may require special devices; whereas the south and north sides can easily be protected by an overhanging roof. Thus the best orientation for protection from the sun is along the east-west axis.

Attention should be paid to solar radiant heat reflected from the surroundings (topography, slopes, rocks) to the building.
|ной стороны солнца, температура воздуха достигает максимальной.
|чтобы получить правильное проникновение солнечного света, необходимо учитывать солнечный обогрев и гигиену, глубина интерьера не должна быть избыточной.

|بالنسبة لاتجاه الرياح، فإن الجدران والنوافذ الرئيسية يجب أن تواجه اتجاه الرياح السائد والباردة للسماح بالتهوية المتبادلة للغرف.
|In regard to wind orientation, main walls and windows should face the prevailing (cool) wind direction in order to allow maximum cross-ventilation of the rooms.

|妥协
| Often the above two parameters are contradictory. In this case, a reasonable compromise should be made based on a detailed analysis of the specific situation, considering the possibilities for diverting the wind direction by means of vegetation and structural arrangements, such as parapet walls within the external adjoining space.

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| Often the above two parameters are contradictory. In this case, a reasonable compromise should be made based on a detailed analysis of the specific situation, considering the possibilities for diverting the wind direction by means of vegetation and structural arrangements, such as parapet walls within the external adjoining space.

|Wind orientation
|Where a predominant wind direction can clearly be identified, long-shaped buildings should be arranged across this direction.

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|Wind orientation
|Buildings should be arranged so that they benefit from summer winds because this season is usually humid and a proper cross-ventilation is required for cooling and hygienic reasons (prevention of mould growth). Shelter should be provided from the winter winds.

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|Buildings should be arranged so that they benefit from summer winds because this season is usually humid and a proper cross-ventilation is required for cooling and hygienic reasons (prevention of mould growth). Shelter should be provided from the winter winds.
As a general rule, with low rise buildings, where the walls would not receive much radiation, orientation according to the wind direction is more advisable. With high-rise buildings the opposite holds true and protection from sun radiation should be the decisive factor.

In regards to topography-orientation and depending on the surface’s angle relative to the solar radiation and on the type of surface characteristics (topography, slopes, rocks), it is possible to block the excessive solar radiation and adjust the wind flow.

In general, for low-rise buildings that are not exposed to much radiation, the orientation according to the wind direction is preferable. Conversely, for high-rise buildings, protection from solar radiation should be the deciding factor.

With regards to the direction and orientation of the building, depending on the angle of the surface relative to the solar radiation and the type of surface, it is possible to block excessive solar radiation and adjust the wind flow.

By orientation and depending on the topography and surface characteristics (topography, slopes, rocks), it is possible to block excessive solar radiation and adjust the wind flow.
In regards to **topography-orientation** and depending on the surface's angle relative to the solar radiation and on the type of surface, more sun radiation could be blocked and breeze can be altered. Attention should be paid to solar radiant heat reflected from the surroundings (topography, slopes, rocks) to the building.

### 8. **Shape and volume**

The shape and volume of buildings should be compact, yet somewhat elongated along the east-west axis; (e.g. the optimum shape is 1:1.3), because large, compact building volumes gain less heat.

The heat exchange between the building and the environment depends greatly on the exposed surfaces. A compact building gains less heat during the daytime and loses less heat at night. Therefore, the ratio of surface to volume is an important factor.

A similar phenomenon can be observed when comparing large buildings with small buildings of the same shape.

**Notes:**

- The shape and volume of buildings should be compact, yet somewhat elongated along the east-west axis; (e.g. the optimum shape is 1:1.3), because large, compact building volumes gain less heat.

- The heat exchange between the building and the environment depends greatly on the exposed surfaces. A compact building gains less heat during the daytime and loses less heat at night. Therefore, the ratio of surface to volume is an important factor.

- A similar phenomenon can be observed when comparing large buildings with small buildings of the same shape.
وعند الرغبة بالتبادل الحراري للحصول على ليالي باردة في المناطق الدافئة والرطبة على سبيل المثال، فإن عامل السطح للحجم يجب أن يكون أكبر. ويساعد ذلك أيضا على معدل تهوية أكبر.

In general, where little heat exchange between the interior and the environment is desired, the surface to volume factor should be small. The indoor temperature will be near to the average outdoor temperature.

Where heat exchange is desired, for instance to gain from cool nights in warm-humid areas, the surface to volume factor should be bigger. This also favours a higher ventilation rate.

The shape and volume of buildings should be compact, yet somewhat elongated along the east-west axis; (e.g. the optimum shape is 1:1.3), because large, compact building volumes gain less heat.

In general, the optimum shape is that which has a minimum heat gain in summer and the maximum heat gain in winter. Under winter conditions an elongated form is ideal; under summer conditions a square shape is better.

A compact "patio" house type is therefore preferable.

Forms with large surface areas are preferred to compact buildings. This favours ventilation and heat emission at nighttime.

Buildings are preferably rather compact. However, because of the conflicting climatic conditions, several solutions are possible, depending on local topographical conditions and functional requirements.

Buildings may be large and grouped close together. Row houses or adjoining buildings have the advantage of reduced heat loss.

Courtyard buildings with proper wind protection are a suitable solution.
### The suitable type and form of building differs very much between the different climatic zones

<table>
<thead>
<tr>
<th>8. Type and form of buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>المنزل الضيق داخلي التوجه في المنطقة الحارة الفاحلة</strong></td>
</tr>
<tr>
<td>▪ تفضل الهياكل كبيرة الوزن ويمنع الحرارة والقهوة الساخن</td>
</tr>
</tbody>
</table>
| ▪ تعديل هياكل البناء (السطح الضخم المناخ الداخلي)
  
• في ظروف البارد والبارد والبارد.
  
• يتم الانزلاق على سطح الأدائي مكافئ بالحجم بحيث يتم تقليل تبادل الحرارة والبرودة للحد الأدنى. |
| ▪ بشكل عام، يجب أن تكون المساحات المعيشية الداخلية والخارجية مماثلة.
  
• ويجب التحكم بالتهوية عبر تقليلها خلال الحرارة العالية وتقليلها في الفترات التي تكون فيها درجات الحرارة الخارجية على مستوى الراحة. |
| ▪ ويعود هذا النوع مناسبًا في المناطق ذات درجات الحرارة النهارية والليلية المتوازنة. |
| **The compact, inward oriented house of the hot-arid zone.** |

| **Light weight structures are preferred to allow ventilation** |
| ▪ The surface is large compared to the volume and therefore the exchange of heat energy high. As a consequence the indoor temperature approaches the outdoor temperature. The walls are light and maximum ventilation can easily be achieved. Large overhanging roofs are the main important element. |
| ▪ This type is appropriate in zones with even day and nighttime temperatures. |

| **المنزل المفتوح خارجي التوجه والمضيق والمنائي في المنطقة الدافئة الرطبة** |
| ▪ تفضل الهياكل منخفضة الوزن للسماح بالتهوية |
| ▪ السطح كبير مقارنة بالحجم وبالتالي يكون التبادل الحراري عاليًا. ونتيجةً لتأثير درجة الحرارة الداخلية ذاتها الخارجية. وتكون جدرانها خفيفة مع إمكانية تحقيق أقصى مستويات التهوية. ويتم تنظيم الأسطح على شكل في الفترات التي تكون فيها درجات الحرارة الداخلية بسهولة |
| ▪ ويكون هذا النوع مناسبًا في المناطق ذات درجات الحرارة النهارية والليلية المتوازنة. |
| **The open, outward oriented, detached, built on stilts house of the warm-humid zone.** |

| **The windows are of medium size, providing good ventilation and moderate solar heat gain.**
| ▪ **The suitable type and form of building differs very much between the different climatic zones.**

| **انحفاظ من أسطح مطلة بالإضافة لحدار حامية التي تكون أقل ضخامة من مثيلاتها في (أ) أعلاه. وتكون النوافة متوسطة الحجم مما يوفر تهوية جيدة واكتساب حراري محسوس معتدل.**

| **A compromise between the two extremes is the house of the temperate zone.**
| ▪ It is composed of shading roofs as well as protective walls which are less massive than in a) above. |
during the heat and increased during periods when the outdoor temperature is at comfort level.

Such types are generally appropriate in areas with large temperature differences between day and night.

The main goal is the reduction of direct heat gain by radiation through openings and of the internal surface temperature. The building should therefore be designed not only with protected openings, but also with protected walls. This task will be much easier if the building is kept low. In addition, the roof should extend far beyond the line of walls, with broad overhanging eaves and other means of shading.
provides a cool area within the building. It also meets other requirements such as safety, defense, privacy, lifestyle etc.

وفي بيت الحوش الشرقي الاعتيادي، تمكن الشرفات المغطاة (والتي تكون على جانبي أو ثلاثة جوانب من الحوش) والمصلى المتطابقة والمغطاة في الطابق الأول في تقليل اكتساب الحرارة خلال النهار وتوفير مساحات مظللة. كما يجب أن تسهم النسبة الصحيحة بين ارتفاع وعرض الحوش دوما بالتنظيم المثالي حتى وقت يكون شمس الصيف تقريبا عامودية. وعندما يتم تزويد الحوش بالماء والنباتات فإنه يمثل مصدر للتبريد ويغير المناخ الجزئي كنتيجة لذلك.

In the typical oriental courtyard house, the covered terraces, which are usually on two or three sides of the courtyard, and the identical covered gallery on the first floor help to reduce the heat gained during the day and provide shaded areas. The correct ratio between the height and width of the courtyard should always allow for adequate shading, even when the summer sun is almost directly overhead. When the courtyard is provided with water and plants, it acts as a cooling source and modifies the microclimate accordingly.

وفي المناطق ذات الليالي الباردة أو الشتاء، يجب أن يسمح الحوش بتعرض جنوبي ملائم لاكتساب الحرارة السلبي ويجب تزويده بأجهزة تظليل متحركة للمنطقة الحارة.

The height of the buildings should, in general, not exceed 3-stories. Higher buildings receive too much radiant heat and give wind obstruction to neighbouring buildings.

ويتطلب هذا الإشعاع الشمسي المتغلغل مباني بمسطح كبيرة بارزة وشرفات عريضة مظللة.

وتتوفر صفوف المنازل ذات الاستطالة بموازاة محور شرق-غرب التظليل الأمثل للجدران الشرقية والغربية الهامة.

وتم حماية هذه الجدران الهامة الشرقية والغربية بشكل أملس في حال كان المنزل مغطى بسطح مكسير.

The intense diffuse solar radiation calls for buildings that have large overhanging roofs and wide shaded verandahs.
Row houses elongated along the east-west axis provide the best shading of the critical east and west walls.

These critical east and west walls are best protected if the house is covered with a hipped roof.

In areas with cold nights or winters the courtyard has to allow for adequate south exposure for passive heat gain and should be equipped with movable shading devices for the hot period.

However, the one or two storied courtyard building type cannot always fulfill today’s functional and urban planning requirements, where high population density, economic land use, adequate car traffic, accessibility and suitable public transportation, etc. are required.

2) cluster settlements of high buildings to create suitable patterns.

In certain regions, such as mountainous and coastal areas, (North Africa, Arabian Peninsula, etc.) high, compact buildings are the traditional solution, having also had an important defense purpose in the past. Cooler air from the lower floors is channeled through the building. High walls with integrated ventilation shafts are built at the back on the shady side. Large openings or bay windows for cross-ventilation are...
protected with wooden screens such as "Rowshans" or "Mashrabiyyas".

3) Particular solutions may utilize underground (subterranean) buildings or caves. Some heat gain and storage in the winter season is desirable. At a depth of about 2.5 m, the temperature of the earth is practically constant and remains close to the average yearly temperature. The indoor climate of structures built underground or covered with a thick layer of soil benefits from the huge thermal mass of the adjacent ground and is thus not affected by hot days and chilly nights. Structures can be carved into
suitable rock formations or may consist of a structural shell (even several floors underground), which is mainly concrete and covered by soil. (The provision of natural lighting might cause difficulties.)

8. **Room arrangement**

> Important rooms should be located at places with climatic advantages. For instance, in hot climates a bedroom is preferably located on the east side where it is relatively cool in the evening, whereas the living room is placed on the northern side. Auxiliary spaces should be located on the disadvantaged sides, mainly west.

> Rooms with high internal heat load, such as kitchens, should be detached from the main rooms.

Separate day and night zones may be provided in the house. The day zone would be a heavy structure retaining the coolness of the night and oriented towards west. The night zone would be a light structure which cools down quickly after sunset and is oriented towards east.
Similarly, variation in living spaces used in summer time or in winter time could be provided - a concept which is feasible mainly in temperate zones.

Important rooms should be located at places with climatic advantages. For instance, in hot climates a bedroom is preferably located on the east side where it is relatively cool in the evening, and outdoor or roof sleeping possibilities should be considered. The living room is placed on the northern or southern side. Auxiliary or non-used spaces should be located on the disadvantaged sides, mainly west. Rooms with high internal heat load, such as kitchens, should be detached from the main rooms. The depth of interior spaces should allow for proper natural lighting. Also, insider and outsider views to be considered.

The arrangement of rooms depends on their function. Since the thermal load is related to the orientation, rooms on the east side are warm in the morning and if not built with much thermal mass, cool down in the afternoon. Rooms on the west side are cooler in the morning and heat up in the afternoon. Rooms facing north and south remain relatively cool if provided with adequate shading. Thus, the rooms can be arranged according to their functions and according to the time of the day they are in use.

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A moderately compact internal room arrangement is of benefit for most of the year. Courtyard buildings are suitable, terraced buildings facing south may also be appropriate. In cooler areas, exposure of the main rooms to the winter sun is essential, whereas in warmer areas these rooms can also be placed north facing.

Heat losses can be efficiently reduced by dividing the house into zones with higher and lower heat demands, according to their
مناطق منفصلة للنهار والليل، وللصيف والشتاء

يمكن وضع مناطق منفصلة للنهار والليل في المنزل. وتكون المناطق النهارية ذات هيكل ثقيل للحفاظ على البرودة ليلة المدينة، وتكون المنطقة الليلية ذات هيكل خفيف مما يتسبب بالتبريد السريع بعد غروب الشمس وتوجيهها للشرق.

بالشكل المشابه، يمكن إعداد تغييرات في المساحات المعينة في وقته الصيفي والشتاء. وهو مبدأ يمكن تحقيقه في المناطق المعتدلة.

غرف النوم: يجب أن يتم وضعها بشكل ملائم على الجانب الشرقي حيث تكون أبرد في المساء. وتكون الواجهة الوعائية ذات هيكل خفيف مما يساهم في تبريدها بعد غروب الشمس.

المطبخ: يمكن وضع المطبخ على الجانب الغربي لكي يتم استخدامه خلال ساعات الصباح. وفي المناطق الأكثر دفئاً، يمكن للرطوبة أن تسبب مشاكل خلال موسم مونسون، وبالتالي يجب إقامة إجراءات للتهوية المتبادلة للحماية من الرطوبة من ناحية المطبخ والمضافات.

وبالنظر للمناخ في مختلف الفصول، فإنه من المعقول إبقاء جزء من المبنى متصل للبرد والحاء. ويمكن أن يكون أحد الحلول هو بناء بناية نادرة في المناطق الحارة.

ويتألف من طابق أرضي بجدران هائلة وطابق أعلى بهيكل خفيف. ويتم استخدام الطابق الأعلى في النهار.

وفي المناطق الأكثر دفئاً، يمكن للطية أن تسبب مشاكل خلال موسم مونسون، وبالتالي يجب إقامة إجراءات للتهوية المتبادلة في المطبخ والمضافات.

functions. The zone with the higher heat demand, such as living rooms, is placed facing towards the sun (south). The zones with less heat requirements, e.g. sleeping areas, kitchen, stores, entrance etc., are arranged around the warm zone on the north, west and east side, providing protection against heat loss and wind. This zone functions as a thermal buffer. An external belt of vegetation or other adjoining buildings and parapet walls may provide additional protection.

This concept applies in the colder areas only.
The floor is preferably elevated above the ground to allow for a better ventilation.

Wet rooms: Special attention should be given to the arrangement of rooms with a high humidity (bathrooms). Here a proper cross-ventilation is especially important to avoid mould growth.

Free passage of air for cross-ventilation through the interior is important to achieve high ventilation on the floor plan. This can be achieved by large openings, not only in the outer walls but also in the internal partitions. An even more efficient solution is that of single-banked rooms with access from open verandas or galleries.

For the climate of different seasons, it would seem reasonable to conceive one part of the building for the cold period and another one for the warm period.

One solution would be a building type which is also useful in hot and dry areas, consisting of a ground floor with massive walls and an upper floor of a light structure. The ground floor would be relatively cool in the daytime and relatively warm at night. The light structure on the upper floor would perform the opposite way. As a consequence, in the winter time the inhabitants would use the upper floor in the daytime and the ground floor at night. In the summer time the pattern would be reversed.

It would even be possible to use different sites in different climatic regions - a warm
Houses are best built on stilts or at least on raised platforms.

In reality, however, for both economical and organizational reasons, such day and night rooms or summer and winter houses are often not feasible, and a building or room has to be designed to serve all year round. The large range of thermal conditions requires the utilization of radiation and wind effects, as well as protection from them. Hence, the arrangements have to play a dual role.

Trees and other plants are important elements of immediate outdoor spaces. They are inexpensive elements which regulate and improve the climate. At the same time they add to the attractiveness of this space.

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The walls of houses and courtyards, cantilevered building parts and plants should be designed to provide shade and maximum ventilation. The same principles of maximum shading and maximum ventilation also apply to the design of the outdoor space. Tall shading trees and other plants provide shade, improve the climate, and enhance the attractiveness of the space.
provide shade to outdoor living areas. Half and full shade protection by arcades or loggias, membranes and trees is desirable; exposed paved surfaces should be avoided; pools of water are beneficial for cooling. trees and reduced ground vegetation are important elements. The outdoor space should also be designed as a compromise with ventilation and shade in summer, and wind protection and solar radiation gain in winter. The vegetation should be planned accordingly, to provide partly sunny and partly shaded spaces. Deciduous trees are an excellent medium with which to achieve this goal.

<table>
<thead>
<tr>
<th>مكونات المبنى (مخزون الحرارة، المقاومة الحرارية، رد الفعل)</th>
<th>Building components (heat storage, thermal resistance, and reflexivity)</th>
</tr>
</thead>
</table>

9. a) Heat storage and time lag, which provide a balanced indoor climate and take advantage of outdoor temperature fluctuations. The capacity of building components to store heat and to release it later has an important regulating effect on the indoor climate. A high internal mass reduces the indoor temperature swing. During the daytime it is thus cooler and at night warmer than outdoors. Heavy structures have higher thermal mass than light structures.

ب) العزل الحراري، والذي يمنع الاكتساب الحراري غير المرغوب في حين لا يمنع انبعاث الحرارة الزائدة. في حالة اختلاف درجات الحرارة، تنقل الطاقة الحرارية من الأسطح للبرودة، حيث يقلل العزل الحراري هذا الانبعاث. ونتيجةً، يقلل هذا من الحرارة النهارية الزائدة التي تدخل للمبنى مع معاعيب المبنى من البرودة في الليل. وبشكل عام تجعل هذه الوظيفة المزدوجة العزل غير مرغوب في المباني ذات التحكم الطبيعي بالمناخ.

b) Thermal insulation, which prevent undesired heat gain, but do not impede emission of surplus heat. In the case of a temperature difference, heat energy always travels from hot to cold. Thermal insulation reduces such heat transfer. As a consequence, it reduces daytime surplus heat entering a building, but prevents the building from cooling down at night. In general, this dual function makes insulation unsuitable for naturally-climatized buildings.

c) Reflectivity, absorption and emissivity, which regulate the radiation from and to the sky and the surroundings.
Much of the heat received by a building is through radiation, (direct radiation from sun, indirect radiation from surrounding surfaces) 
The treatment of the outer surface is therefore important

Reflectivity: light colored smooth surfaces reflect radiation
Absorption: dark colored rough surfaces absorb radiation and emit it later
Emissivity: dark colored rough surfaces

---

**a)** Heat storage and time lag should be minimal.

Due to the relatively narrow diurnal temperature fluctuation it is not possible to achieve much cooling by utilization of the thermodynamic properties of building components. The main goal is, on the one hand to store as little heat as possible in the structure in order to obtain the maximum benefit of the cooler night temperatures.

Heat accumulated during the daytime should be stored by an adequate thermal capacity of the walls, ceilings and floors to balance the temperature. A properly dimensioned thermal mass means that rooms do not overheat during days with high temperature and high solar radiation gain, and do not cool out too much at night, or even during the following cooler day.

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يعتبر الطابوق المجفف بالشمس من أقل موصلات الحرارة، في حين يعتبر الطابوق الطيني وسيلة غير مثلى للاحتفاظ بالبرودة، حيث أنه يحتفظ بالحرارة لفترات طويلة. وبالتالي، يجب التخطيط وحساب التأخر الزمني المناسب. يمكن لكتلة حرارية كبيرة أن تحافظ على البرودة خلال النهار مع عدم كونها باردة جدا خلال الليل.

ويتلخص المبدأ التقليدي لذلك بالاحتماء خلف الجدران الطينية السميكة نهارا، ونوم على السطح أسفل خيمة ليلا.

Sun-dried earth brick is one of the poorest conductors of heat, Yet thick mud bricks are not a perfect means of keeping cool; they retain heat for a long time. Therefore, it is important to calculate and plan the proper time lag. A big thermal mass can keep cool during the daytime and not be too cold at night. The traditional principle is to shelter behind very thick mud walls by day, and to sleep on the roof under a tent at night.

The retention of nighttime low temperatures is desirable in the hot-dry season. In the cold season the retention in the evening of heat gained during the daytime is desirable. Both can be achieved with a solid floor, wall and roof structure with a time lag of some 9 to 12 hours. This thermal capacity is preferably provided by internal walls, floors and roof, permitting the outer walls to be used more freely for large openings which will help to meet the requirements of the warm-humid period.

يجب تجنب الكتل الحرارية الزائدة، وفي الأخص في المناطق المرتفعة. يمكن أن تسبب الكتلة الحرارية الكبيرة في جعل الموقع غير قابل للتدفئة خلال ساعات السماء في الموسم البارد. ولا يجب أن يتجاوز التأخر الزمني 8 ساعات. ومن الأفضل أن يكون زمن التأخير الزمني لحائط خرسانة بسماكة 20 سم.

و عند استخدام العزل الحراري، يجب وضعه إلى خارج الجدران والسطح بحيث لا يتم تقليل التأثير المفيد لطاقة التخزين الحرارية.

A too excessive thermal mass should be avoided. This is especially important in upland areas. A large thermal mass would make the space almost unheatable during the evening hours of the cold season. The time lag should not exceed 8 hours, which is equivalent to the time lag of a concrete wall of 20 cm thickness.

If thermal insulation is used, it should be placed on the outside of walls and roof, so
that the beneficial effect of the thermal storage capacity is not reduced.

b) Thermal insulation is not effective except on surfaces exposed to direct radiation. Also, materials should be permeable to air.

Thermal insulation is important to suppress surface temperature variations, but is only applicable in connection with adequate inner ventilation and cooling means or in combination with light structures (Insulation can also reduce necessary heat loss at night). Roof insulation is especially important in decreasing summer temperatures. The outside application of insulation is preferable because the structure and the construction materials are less exposed to thermal stress, and the storage capacity of a heavy structure material helps to balance the inner temperature. The additional needed skin for the building or roof must protect the insulation against damage by physical, mechanical forces, and should be of a hard material. The required insulation value depends on the sun exposure.

In upland areas, conductive and radiant heat losses should be minimized. As a consequence, the use of thermal insulation material may be appropriate.

At least as important is, however, an airtight construction. Thermal insulation is only effective in a building with no or very little air leakage.
c) Reflectivity, absorption and emissivity, which regulate the radiation from and to the sky and the surroundings.

- Shading devices, such as a heavily ventilated double roof, and radiation reflection by a white surface are necessary to decrease heat gain from solar radiation - mainly through the roof - during the hot period.

- External colors are required as a combination of high reflectivity of solar radiation and high emissivity of infrared radiation to the cool sky at night. White paint has a high reflection ratio on sun exposed surfaces. Dark absorptive colors are usable where reflection towards the interior should be avoided (such as under eaves).

- Internal colors, such as "cool" and bright colors can be used to distribute natural light for deep room arrangements.

High reflectivity and high emissivity are required properties for keeping the indoor temperature and the inner surface temperature low.

- External colors are required as a combination of high reflectivity of solar radiation and high emissivity of infrared radiation to the cool sky at night. White paint has a high reflection ratio on sun exposed surfaces. Dark absorptive colors are usable where reflection towards the interior should be avoided (such as under eaves).

- Internal colors, such as "cool" and bright colors can be used to distribute natural light for deep room arrangements.
9. **Building components (foundations, walls, openings, and roofs)**

   **a) Foundations, basements and floors**

   - They generally have a large thermal storage capacity. It depends on whether these properties are an advantage or whether the rooms have to be insulated against it.
   - They act as structural elements and serve as means of space definition and partition.
   - They provide protection from heat, precipitation, wind, dust and light and serve as a means of space definition and partition.
   - They store, reflect, emit heat depending on material, color, thickness, texture.

   **b) Walls**

   - They act as structural elements and serve as means of space definition and partition.
   - They provide protection from heat, precipitation, wind, dust and light and serve as a means of space definition and partition.
   - They store, reflect, emit heat depending on material, color, thickness, texture.

   **c) Openings and windows**

   - In hot-arid zones, openings should be of minimal size or adjustable in size by shutters, and the view not directed towards the ground (glare) as far as considerations of natural lighting permits. The seasonal difference of the sun angle should be taken into account. Airtight closing should be possible.
   - In warm-humid zones, openings should be as large as possible, and the view directed to surrounding grass or trees, with the sky blocked by roof overhangs or sun breakers. Air circulation should not be blocked by vegetation. An airtight construction is not needed.
   - Outlet openings should be located at high levels, where hot air accumulates. Louvres are a suitable accessory to assist the channeling of airflow.

   **d) Roofs**

   - The thermal performance depends to a great extent on the shape and details of the roof and the construction of its skin, whereas the carrying structure has little influence.
   - The shape and details of the roof should be in accordance with precipitation, solar impact and utilisation pattern (pitched, flat, vaulted, etc.).
يجب أن تكون الطوابق الأرضية صلبة ومبنية مباشرة على الأرض أو داخلها باستخدام مواد ممتصة للحرارة (الحجر أو الطين أو الأجر المحروق أو المنتجات الاصطناعية). ولا يجب أن تكون الطوابق الأرضية معلقة أو مبنية على قوائم. يجب أن تكون الطابق الأرضية مكونة من مواد جيدة للحرارة. يجب تظليل الأرض القريبة من المبنى خلال النهار، في حين تكون مكشوفة تماماً للسماء ليلاً بحيث لا تتراكم الحرارة المضيئة.

The ground is a valuable means of heat absorption; therefore the building should have maximum contact with the ground.

Ground floors should be solid and built directly on to the ground or into the ground with heat absorbing materials (stone, adobe, earth, high density burnt clay or cement products) Ground floors should not be suspended and on no account be built on stilts. Flooring materials should be of high thermal conductance.

The ground near the building should be shaded during the day, but fully exposed to the night sky, so that the emission of radiant heat is not obstructed.

As a consequence, it is better to raise the floor and ventilate the space underneath.

The floor should be of low thermal capacity (e.g. timber floor with void). The advantages are better ventilation due to the elevated space and maximum benefit of the slightly lower night temperature.

جدار

Walls

في الفصل الحار، يجب أن يتم إنشاء جدران مناطق العيشة المدارية من مواد متخزنة للحرارة في حين يجب أن تكون جداراً هوائياً ذات سعة حرارية عالية. يفضل أن تكون الجدران الشرقية والغربية مقاومة للإشعاع والمرنة الحالية من الأماكن التي تستجيب التعريض سطحياً للإشعاع الشمسي والحراري الداخلي.

During the hot season, walls of daytime living areas should be made of heat-storing materials; walls of rooms for nighttime use.

الجدار

Walls

كلما كان المناخ بارداً، كلما ظهرت الحاجة لعزل حراري وهواء أفضل. وتكون سعة تخزين الحرارة في الحدود الداخلية والخارجية ملائمة لتجنب زيادة الحرارة في النهار والحفاظ على درجات الحرارة الليلية مرضية.

يجب أن تكون الألوان الأسطح متوازنة الألوان. وفي المناطق الأفغانية تكون الحاجة لأسطح أفتح بانعكاس أكبر، ويمكن أن تستخدم الأسطح الداكنة والممتصة في المناطق الرياحية والتي قد لا تصلها أشعة الشمس المناسبة للأشخاص حافي القدمين أو الجالسين على الأرض.

Direct contact with the ground does not necessarily provide cooling because the temperature of the shaded surface is about equal to the mean air temperature. A certain cooling may only be possible by conduction for barefooted persons or persons sitting on the floor.

And it results in this, it is better to raise the floor and ventilate the space underneath.

The floor should be of low thermal capacity (e.g. timber floor with void). The advantages are better ventilation due to the elevated space and maximum benefit of the slightly lower night temperature.
should have a light heat capacity. East and west walls should preferably be shaded. 

High reflective qualities are desirable for both thermal and solar radiation.

Walls, both external and internal, should be as light as possible with a minimal heat storage capacity. These should obstruct the airflow as little as possible and should reflect radiation, at least in places where solar radiation strikes the surfaces.

The outer surface should be reflective, light colored.

The cooler the climate, the better the thermal insulation and air-tightness of the outer walls should be. A medium heat storage capacity of internal and outer walls is appropriate to avoid overheating in the daytime and keep the night temperature at comfort level. Surfaces should generally have medium colors. In warmer regions a bright surface with higher reflectivity is appropriate. Absorptive, dark surfaces are possible in recessed areas, where the summer sun does not reach.

In upland regions joints between construction elements should be well-sealed against air penetration. The application of a wallpaper to the inner surface is efficient in this respect.
use of exterior or interior insulation has to be considered carefully and its suitability depends on the particular requirements and technical possibilities.

Openings and windows

Openings and windows

During the daytime, the absence of openings would be desirable, especially on the west side; or the openings should be as small as possible and be shielded from direct radiation and located high on the walls to protect from ground radiation.

At night, the openings should be large enough to provide adequate ventilation for the dissipation of heat emitted by the walls and the roof. Hence larger openings should be closed during the day with insulated shutters and opened at night. (this also depend on the difference of diurnal temperatures, which means that opening should still be small if the difference is big to keep the heat inside)

In warm humid areas openings are important elements for the regulation of the indoor climate. They should be large and fully openable, with inlets of a similar size on both sides of the room allowing a proper cross-ventilation. Windows are preferably equipped with flexible louvres allowing a regulation of ventilation. Door shutters may also incorporate louvres or grills. Windows with fixed glass panes are of no advantage and should be avoided.

Windows should be of medium size with openings on opposite walls for proper cross-ventilation during the humid period.

On the west and north side windows should be small. As a rule of thumb, the total window area should not exceed 25% of the floor area.

In upland areas, as many windows as possible should be located on the south side of the building to utilize the heating effect of solar radiation. However, the glazed area should not exceed 50% of the south elevation because of extensive heat loss at night.
Appropriate natural lighting is important. The depth of rooms and the size of windows have to be coordinated. Glare of direct natural lighting can also be avoided by the use of internally reflected light.

To avoid direct solar radiation and glare, openings should be shaded by an overhanging roof, screens, lattices, grills etc.

All these measures have to be designed to give minimal resistance to the airflow. Mosquito-screens, which are essential in these regions, but reduce the airflow considerably, are therefore best installed away from windows, e.g. around the verandah or balcony.

Excessive glazing can lead to overheating. This can be counteracted by

- the provision of adequate shading,
- the provision of ventilation,
- sufficient heat storage capacity.

Windows should be equipped with tightly closing glazed panels, which provide protection against heat loss during the cold season and also against flow of heat and dusty air during the dry and hot season.

Details

Construction details for windows

a) Joints

Appropriate natural lighting is important. From the smallest window to the largest turret, and from the shallowest recesses to the deepest alcoves, and from the smallest room to the widest hall, the neighboring steam, and the adjoining clairvoyance, are all combined to produce this shrouded light, which is a temporary and changing phenomenon.

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Details

Construction details for windows

a) Joints
devices. A moderate, south-facing glass area catches the solar radiation during the cold season, but should not be affected by direct radiation during the summer.

Window glass

A difficult problem is the design of large openings which at the same time protect from driving rain.

Ordinary louvres direct the wind upwards above body level. Furthermore they are not safe against driving rain.

A very efficient, but rather expensive solution is the use of insulated internal

The joints between the window frames and the adjoining walls should be airtight and, therefore, carefully sealed.
in a horizontal position towards the human body. Outlet openings should be located at a high level where hot air accumulates.

Another alternative is the use of a second set of louvres to direct the air down to the occupants.

In warm-humid areas the roof is preferably pitched to allow heavy rains to run off.

Large overhangs protect the walls and openings from radiation and precipitation.

The roof should protect the building from precipitation and therefore be carefully waterproofed.

The roof should provide protection against heat gain in summer and heat loss in winter. The roof should, therefore, have thermal insulation properties.
The rounded form of a hemispherical vault (dome) has a larger surface area than its base. Solar radiation is thus diluted and re-radiation during the evenings is also greatly facilitated. (principle of domes in shading and ventilation)

The flat roof is practical in areas where it seldom rains. It is also a good reflector and re-radiates heat efficiently, especially if it consists of a solid, white painted material. High solid parapet walls along the edge of the roof can on the one hand provide daytime shade and privacy, but can have the disadvantage of creating an undesired stagnant pool of hot air.

The roof should be made of lightweight materials with a low thermal capacity and high reflectivity. Painting the surface in light colors, is an economical method to increase reflectivity. However, in most cases a single leaf construction will not satisfy the comfort requirements.

A more efficient solution is the properly ventilated double roof. The inner layer (ceiling) may be well insulated and provided with a reflective upper surface.

The construction should have a medium heat storage capacity to balance temperature fluctuations between the daytime and evening hours, and also in case of sudden weather changes. This storage mass must be situated inside the insulation layer.

In upland regions the construction should be airtight, the joints between construction elements requiring special care.
10 تظليل المبنى وتظليله لغيره
رِجْعَة لمحاضرات التظليل
Shading

10.a Building shading each other

يعود الأكثر فاعلية هنا حيث تكون المباني ملاصقة لبعضها. This is most effective here as buildings are adjacent to each other

Not possible as buildings are away from each other

10.b building shape

يجب أن يساهم شكل المبنى بتظليله من خلال الأحواش والمرкан ذات الأعمدة والبروزات ... الخ. مبدأ الحوش في التظليل

Building shape should contribute to its shading through (courtyards, colonnades, overhangs etc.),

Same as hot arid regions as shading is a necessity

بعض المناطق الحارة والقاحلة حيث أن التظليل يعد ضرورياً.

Same as hot arid regions as shading is a necessity

Courtyard principle of shading

يمكن دمج الحوش بوسائل التبريد التبخيري.

Courtyard could be combined with evaporative cooling

Courtyard principle of shading

ممرات الأعمدة

Colonnades

البروزات

Overhangs
### Double Shell Construction

A double shell construction should have reflective properties protecting the building from direct and diffuse radiation. The outer skin should be placed fairly close to the facade and be properly ventilated.

### Shading Devices as Attached Accessories

In coastal hot areas, traditional awnings and light-reflecting shutters are common. These windows are primarily shaded by wooden awnings over large openings that allow for cross-ventilation while filtering in natural light with privacy for dwellers.

**Add dome principle here**

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| 10.c | The prisms are a characteristic of double shell construction. A double shell construction should have reflective properties protecting the building from direct and diffuse radiation. The outer skin should be placed fairly close to the facade and be properly ventilated. |
| 10.d | In coastal hot areas, traditional awnings and light-reflecting shutters are common. These windows are primarily shaded by wooden awnings over large openings that allow for cross-ventilation while filtering in natural light with privacy for dwellers. |
In hot maritime regions, the traditional "mashrabiyas" or "rowshans" are common. These projecting, screened (bay) windows or non-projecting screened windows consist mainly of wooden, shading screens over large openings and allow cross-ventilation as well as the passage of daylight while preserving family privacy. Some contain evaporative cooling means such as an earthenware water pot.

Mashrabiyas could be combined with evaporative cooling means such as an earthenware water pot.

Focus is on shading opening and no need to shade walls.
for the improvement of the indoor climate. Another efficient solution is to grow a green cover over roofs and walls located on the east and west side of a building. Vegetation which is too dense and too close to the building should be avoided because of dampness effect. This shading should be secured in summer and not winter.

### Means of controlling ventilation

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It depends on the location of the surrounding building and topography. Street network is an important factor, hierarchal distribution of spaces contribute to allowing wind through. It also relates to the shape and orientation of the building. The courtyard (within the buildings or between them contribute to the ventilation).

Refer to ventilation lectures

To counteract the winter wind direction, evergreen windbreakers are desirable. However, trees should not block the prevailing summer breezes. Evergreen trees are best for wind protection, whereas deciduous trees are suitable for shading purposes.
Important (revise guidelines)

Windows are preferably equipped with flexible louvres allowing a regulation of ventilation. Windows with fixed glass panes are of no advantage and should be avoided.

Louvre design

A difficult problem is the design of large openings which at the same time protect from driving rain.
Windcatchers are a significant feature in the traditional structures. Wind pressure forces air down the wind catcher. Air circulation inside the building is achieved if there are openings on the opposite side allowing suction of inner air by lower pressure. Depending to the region, they have a variety of forms, details and ways of functioning, and are known in the Middle East as "malqaf" and/or "badgir".
Could be combined with evaporative cooling

b) Mid-wall and parapet windcatchers

Structurally integrated wind catchers or scoops and air ducts are a special kind of vents and selective ventilators. A recessed, horizontal niche on the external wall, e.g. on the floor level and in the roof parapet, creates a slot between two vertical, structural posts. These mid-wall or parapet wind intakes or series of them may allow for enough cross-ventilation through the internal spaces, while preserving visual privacy. Shutters are necessary to control the air movement.
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Rarely desired at winter and night

Important