A PILGRIM'S HOSTEL

FOR JERUSALEM, JORDAN

A thesis report submitted in
partial fulfillment of the
requirements for the degree of
Bachelor in Architecture
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May 23, 1955

Dean Pietro Belluschi
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Dear Dean Belluschi:

In partial fulfillment of the requirements for the degree of Bachelor of Architecture, I submit this thesis report entitled: "A Pilgrim's Hostel for Jerusalem, Jordan."

Sincerely,

Francois Vigier

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i Introduction

As a result of the Arab-Israeli conflict ending in 1948 by a series of armistices sponsored by the United Nations Organization, the British Trust territory of Palestine was divided roughly in half between what is now Israel and the Hashemite Kingdom of Jordan. The city of Jerusalem found itself in the awkward position of being separated in two by the armistice line, the new city built largely by the British since 1920 and containing most of the modern housing, and hotels, the commercial, business and manufacturing sections, and the railroad station being controlled by Israel, while the old city containing the Christian Holy Places, the Holy Sepulchre, the Mount of Olive, the Tomb of the Virgin, etc, as well as most of the convents and religious orders became part of the Kingdom of Jordan.

Six years after the end of the conflict, the political and military situatioh remains tense along the Israeli Jordanian border and despite the efforts of the United Nations Truce Supervision Organization, incidents occur from time to time in the vicinity of Jerusalem, A state of war still exists technically between the two countries, and the border is closed to traffic. At the present, it seems unlikely that Jerusalem will be internationalized as was called for in the original United Nations resolutions ending the Palestine conflict and partitioning Palestine between Israel and the Palestinan Arabs. It is also doubtful that a peace treaty will be signed and normal relations resumed between the two countries in the immediate future.

During a two months stay in Jerusalem, Jordan, over the summer of 1954, I became acquainted with an order of French Missionaries, residing at the Monastery of Ste. Anne of Jerusalem. The order is principally concerned with the training of new missionaries, archeological studies, with special attention to places of biblical interest, the administration of a number of holy places-they own a large part of the Mount of Olives-and of course the sponsoring and organization of numerous pilgrimages to the Holy Land. It is with this last part of their work that I became connected.

As I have already stated, the partition of Jerusalem has resulted in the separation of two functions previously closely connected, the Holy Places and the thousands of pilgrims and tourists that visit them yearly, and the hotel industry that served, and profited from, these tourists and pilgrims. At the present, there are but four or five small hotels in the Arab zone of Jerusalem that are reasonably priced and therefore attractive to pilgrims coming from soft currency countries (France, Italy, etc.) to whom it is already a financial effort to travel by air to Jerusalem, and who are further burdened by staying in a country located in the Sterling zone, where their native currency loses a great deal of its purchasing power. These hotels cannot house but a maximum of two hundred and fifty to three hundred pilgrims. Moreover, they lack to a great extent the sanitary conveniences to which one is accustomed in Europe and that becomes so important, from a health point of view, in a sub-tropical climate. There are four fairly modern hotels in the Arab zone, one of which is still under construction, the American Colony Hotel, the Shepherd Hotel, and the City Hotel, but they are all in the higher price bracket, 1.250 JD to 2.000 JD* per day, and therefore are too expensive for the majority of pilgrims.

At the present, the excess of pilgrims is housed by the Religious orders, either within the convents, or in private homes, at great inconvenience both to the orders and the pilgrims.

The shortage of facilities is even further aggravated by the fact that Jerusalem is considered holy by numerous other rites, Greek Orthodox, Armenian Orthodox, etc, as well as by the Muslims who consider it the third most sacred city, coming after Mecca and Medina, and who have establised there numerous Mosques and religious

*The Jordanian Dinar, or pound is at par with the pound sterling, and therefore worth about $2.87. It is subdivided into 100 piastres. One piastre is further divided into 10 mils.

institutions, the most famous of which is the Haram ash-Sharif, or Dome of the Rock. It often happens that a coincidence of date of religious festivals attracts simultaneously to Jerusalem pilgrims of many faiths, thus taxing beyond hope the meagre facilities of the city.

The situation is especially awkward for Europeans due to the often difficult task of making advance reservations and the comparatively small number of hotels that Europeans find it possible to stay at because of the usually lower local standards of sanitation and cleanliness.

It may be well at this point to examine the different types of foreigners coming to Jerusalem and the reasons for their doing so.

Foreigners coming to Jerusalem can be classified into four general groups as to reasons and interests;

1. Catholics or Greek Orthodoxes coming for a religious festival, Christmas, Easter, etc. They come from all over the world, in great numbers, but mostly from the predominently Catholic or Greek Orthodox countries, France, Italy, Greece, and the Near East countries.

2. Catholics, Greek Orthodoxes and Protestants coming to Jerusalem at a time other than Christmas or Easter, probably during the summer months, and combining a pilgrimage to Jerusalem with side trips in the immediate vicinity, Jericho, Bethlehem, etc. These people combine a certain amount of sight-seeing with their religious experience. Predominant among this group are organized tours of young people of school or college age, mostly from France and Italy, who come by bus, through Jugoslavia, Greece, Turkey, Lebanon and Syria. They travel very cheaply, camping a good deal of the time. The sight-seeing aspects of their trip is probably as important to them as the final pilgrimage as the trip takes the better part of their summer holidays.

3. Regular tourists who come to Jerusalem because of the historical, visual, climatic attraction of the place. These people do visit the Holy Places, but more as tourists than as pilgrims, and in much the same spirit

Than in seeing any other place, say Venice, Chartres, Paris, or Rome. As a general rule, these people are in far better financial position than the two preceeding groups and stay at the three "luxury" hotels mentioned above.

4. The small group of people coming for a particular reason, and usually staying a great deal longer than the three previous groups Business men, members of the diplomatic corps, of the various missions form this group. They live either at the better hotels, in homes of their own, usually leased, or are housed by their government.

The first two groups mentioned are those that now have the greatest difficulty in finding suitable temporary accomodations in Jerusalem because of their number, the standards to which they are accustomed, and lastly their often difficult financial situation due to the currency regulations of the sterling zone. Before the war, they were used to staying in European style "pensions" in the new town, that provided food as well as sleeping accomodations. This resource is of course impossible today, and even in the future, assuming that normal conditions prevail once again and free transit across the border is once again feasible, might well be difficult due to the annoyance of passport checking at the border, etc. Even if by some agreement these formalities were greatly simplified, it seems likely that the shortage of moderately priced transient facilities would remain due to the large population increase in the Israeli sector of Jerusalem that has overtaxed the existing pre-war facilities.

The missionary order of the Peres Blancs one of whose functions is, as I have already mentioned, the sponsoring and organization of pilgrimages, has for some time been interested in remedying this situation by providing its own accomodations for pilgrims coming to Jerusalem under its sponsorship. I have therefore undertaken as my thesis to design, with the help of the Rev. M. Blondel, P.B., Father Superior of the Order, and the Rev. A. Laily, P.B., Bursar of the Order, a hostel that would be owned and operated by the order, and located in the immediate vicinity of Jerusalem, Jordan.

ii. The Problem

The erection of a building in the Jerusalem area at the present is complicated by a number of factors beyond the control of the architect or the owner. Foremost among these is of course the local political and military situation which is at the present unstable at all times and often erupts into violence. But even after assuming that the immediate future will be characterized by relative calmness in the relations between Israel and Jordan a number of difficult material problems still remain. These are:

The lack of land suitable for construction purposes in the Arab section of Jerusalem. The general topography of the area, closely packed hills, often terraced by man, otherwise sharply eroded by the driving winter rains, makes it difficult to find a piece of land flat enough, to build without going to the excessive expense of grading and terracing, a long and difficult job in an area where a bulldozer is unknown.

The general lack of water during the majority of the year, roughly eight out of twelve months. This problem is prevalent in Arab Jerusalem. Before 1948, The water supply of Jerusalem was piped from Ras al-Ain which lies in the maritime plain north of Tel Aviv at a distance of thirty five miles from the city. The water had to be pumped up to a height of over two thousand feet by a series of pumping stations in the plain and through the hills. This is now inside Israeli territory and the water has been cut off from the Arab section of Jerusalem. Water is now piped in from springs in the general vicinity of Ramallah, but the supply is insufficient during the summer months. As things now stand, water is provided only eight hours out of every fourty-four during the summer months, nedessitating either the extensive use of storage tanks, a private supply of water, cistern of well, or the combination of the two.

The local limitations on construction materials available. As a rule all local construction is executed in one of three types of construction: locally extracted limestone, locally manufactured bricks, and concrete. Steel structural shapes, reinforcing steel, hardware, piping, enamel fixtures, wood, etc. have to be imported from Europe by way of Beirut and are therefore quite expensive. (see the price list of bld'g materials in Appendix 1).

Lastly, the location of a site was made difficult by the recent enactment of the Jordanian Law No. 61, forbidding anyone not a Jordanian citizen from buying land.

There were however a number of factors that made this problem of particular interest to me as an architect. Foremost was the design of a building in a sub-tropical climate with the possibility of attempting to find a solution to the very important problems of natural ventilation and climate control-mechanical air conditioning being out of the question owing to the excessive cost of equipment having to be imported from England or the United States- these being problems that are becoming prevalent today due to the considerable amount of work now being, or about to be done in under-developed countries having climatic conditions similar to those of Jerusalem. I felt that here would be an excellent opportunity for me to undertake a fairly extensive research in the problems of natural climate control and familiarize myself with these problems and their solutions.

I also felt that the fairly heavy restrictions imposed by a limited choice of available materials-cost and the consideration of what could be accomplished by local labourers being further restrictions imposed upon me-would make the problem a challenge to my imagination. I was further attracted by the visual and spiritual aspects of the problem. These will be described further on.

Following an extensive correspondance with the Rev. A. Laily, P.B., the following program was arrived at.

The hostel would be located in the immediate vicinity of Jerusalem, Jordan on property to be acquired by the Order or already owned by them.

It would be intended to house and feed pilgrims coming to Jerusalem. As it is to be owned and operated by the Order, its principal users would be the pilgrims coming on tours sponsored or organized by the Order. These tours would occur at the religious festivals, Christmas and Easter, as well as during the summer. At other times, the hostel would be open to anyone or could possible be closed, totally or partially. The number and types of pilgrims coming to the hostel varying greatly over the year, maximum flexibility is desired to make the hostel financially successful.

Its users would fall into three general groups: The pilgrims coming for the religious festivals; the organized summer tours for young people of high school and college age; and finally anyone who might chance to want to stay there, possibly in the off season. A maximum number of a hundred people was arrived at with the understanding that in all probability this number would be housed only during Christmas and Easter. Over the summer, the tours comprise of about thirty people, but it is not unusual to have two groups staying in Jerusalem together for a short period of time. During the off season, it is anybody's guess as to the average number of people that would stay at the hostel. It would be small in any case, perhaps even so small that it would warrant the closing of the hostel during certain months.

I therefore felt that the solution might well lie in extreme flexibility, making it possible to close off any portions of the hostel at any desired time and with great ease, thus cutting down on the overhead expenses. It would also be necessary to be able to reopen the hostel easily and quickly. I also felt that the type of people coming to the hostel might well warrant two different kinds of accomodations and two different price ranges. I felt that the tours of young people coming over the summer might well be housed in dormitory type accomodations provided a certain amount of privacy and comfort standard was maintained. This would result in the hostel being able to provide extremly inexpensive accomodations that could compete successfully with even the cheapest Arab hotels while maintaining a high standard of sanitation. The main body of the users would be housed in double rooms with private baths at a somewhat higher price. Both groups would share the dining facilities. The following figures were arrived at somewhat empirically: fourty in the dormitory type accomodations; sixty in private rooms. We felt that this subdivision of the facilities would allow a maximum useage of both kinds of accomodations, the dormitory type being filled during most of the summer months and possibly overflowing into the private rooms when necessary, and the private rooms operating at full capacity during the religious festivals with a possible, and probable overflow into the dormitories. In the off season, if it was decided to keep the hostel open, one or the other of the facilities could be closed, as desired.

It was also considered necessary to provide dining facilities both from a point of view of convenience and because of the possibility of a dislike or distrust of arab food on the parts of Europeans coming to the hostel. While it would always be possible for them to eat in restaurants offering european or arab style food, the expense involved might well be above their means. We felt that the inclusion of dining facilities would not prove to be an additional burden in administering the hostel if they were kept small, that is serving a single menue three times daily. Residents of the hostel not wanting to eat there could of course be free to eat at a place of their choosing. But by some financial arrangement, it should be possible to encourage a fixed, known number of residents of the hostel to eat there as well, thus making it possible to operate the dining room inexpensively.

Lounge space, both indoors and outdoors- the Jerusalem climate making it possible to remain outdoors most of the year- was to be provided though kept very simple and informal. Throughout the design, the fact was to be emphasized that this was not a luxury hotel, but a refuge for pilgrims coming to the Holy Land primarily, if not exclusively, to enjoy a religious experience. I felt that the hostel could, and should be a place conducive to religious feelings or at least to meditation, not through any formalized schedule or organization, but through a suggestive use of spaces and volumes, of materials, of living habits. I thought it to be a link between the religious life of the Holy Land and the activities, noise, and disorder of everyday life. This was to be the major point to be stressed in the design

I have already mentioned some of the technical problems that are particular to this problem. It might be well to restate them in full at this point.

<u>1. The shortage of water.</u> As already stated, water is provided by the municipality but is inadequate during the summer months, May to November, being supplied approximately eight out of every fourty-four hours depending on the quantity of the winter rainfall. It often happens that even this meagre supply fails, the delivery of water on schedule being held up for a number of hours for unknown reasons. The problem of storing water is therefore of primary importance in buildings housing a large number of people. The availability of water on the site becomes a highly desireable, though fairly rare

occurence. The possibility of rationing water in bathrooms during certain hours of the day becomes a worthwhile solution that should not be discarded by the architect without considerable thought.

2. The problem of sewage disposal. A sewage system draining both the old and the new city was built and put into operation during the British Mandate but never caught up with the continual building of new suburbs. The problem of sewage disposal is a prevalent one on any site located outside the walls of the Old City. The usual practice is to build on the site a septic tank that is serviced and emptied at intervals by a private concern.

3. Natural Ventilation and Climate Control. This problem is vital in a building destined to house Europeans unused to the sub-tropical climate of the area, when prohibitive cost makes it impossible to resort to the use of mechanical solutions to the problem. The general principles of natural climate control were studied carefully and outlined in Part V of this thesis.

4. Methods of construction adapted to native techniques and resources.

The lack of local industry has more or less eliminated the use of steel as a material of construction primarily for reasons of cost as it has to be imported through Lebanon from England, France, Belgium or Germany. As a rule, construction in Jerusalem uses three types of material: the very beautiful, golden yellow locally quarried limestone used either as facing on concrete construction (this method seems prevalent in the Israeli section of the town) or as bearing walls; reinforced concrete that can be left exposed due to the mild climate and the lack of freezing-thawing cycles; locally manufactured clay bricks. This last type of construction is used on a number of native houses and is probably the cheapest though least resistant type of material due to the lack of production standards of the small concerns manufacturing the bricks. Wood construction is totally lacking due to the total shortage of wood. Wood for furniture, doors, trimmings, concrete forms, etc. is imported through Lebanon from Sweden and is therefore rather costly.

As a rule and from what I have been able to observe, the native workers are very able and hard working. Though of course unacquainted with many of the more modern methods of construction, they are quite capable if well directed to erect any type of structure. Within the last year and a half, a movie theater was build in Arab Jerusalem by a Lebanese architect with a rather daring concrete shell type of construction. All of the work was executed locally and was quite successful. A tradition of craftsmanship still prevails among the builders that seems to make up for any lack in training they may have.

iii. The Site.

After considerable difficulty and delay a site was finally agreed upon that seemed suitable as far as size, location, contours, and presence of water. It is located on the road to Jericho about 1.8 miles from the gates to the old city of Jerusalem, on land already owned by the Order at Koupsa. The decision to build on land already owned by the Order was forced by the passage by the Jordanian Parliament of its Law No. 61 that forbade the Order, as foreigners, to acquire any new land.

It is about two and a half acres in areas and is planted along three sides with young olive trees. A cistern collecting the winter rain has recently been built and while not being sufficient to supply the demand of the hostel could be used as a reserve and possible as a supply for cooking and drinking water, its purity being known. Located on the ledge of a hill, it has a magnificent view on three sides: towards the Dead Sea on the East, the hills of Bethlehem to the South, and the city of Jerusalem on the North-West.

Bordering on the excellent main highway between Jerusalem and Jericho, it is of easy access by car. A regular bus services it along this road. It can even be considered within walking distance of Jerusalem. It is certainly with in easy (fifteen minutes) walking distance from the Mount of Olives to which it is directly connected by a secondary road. At the entrance of the village of Bethany, it is close to a number of churches.

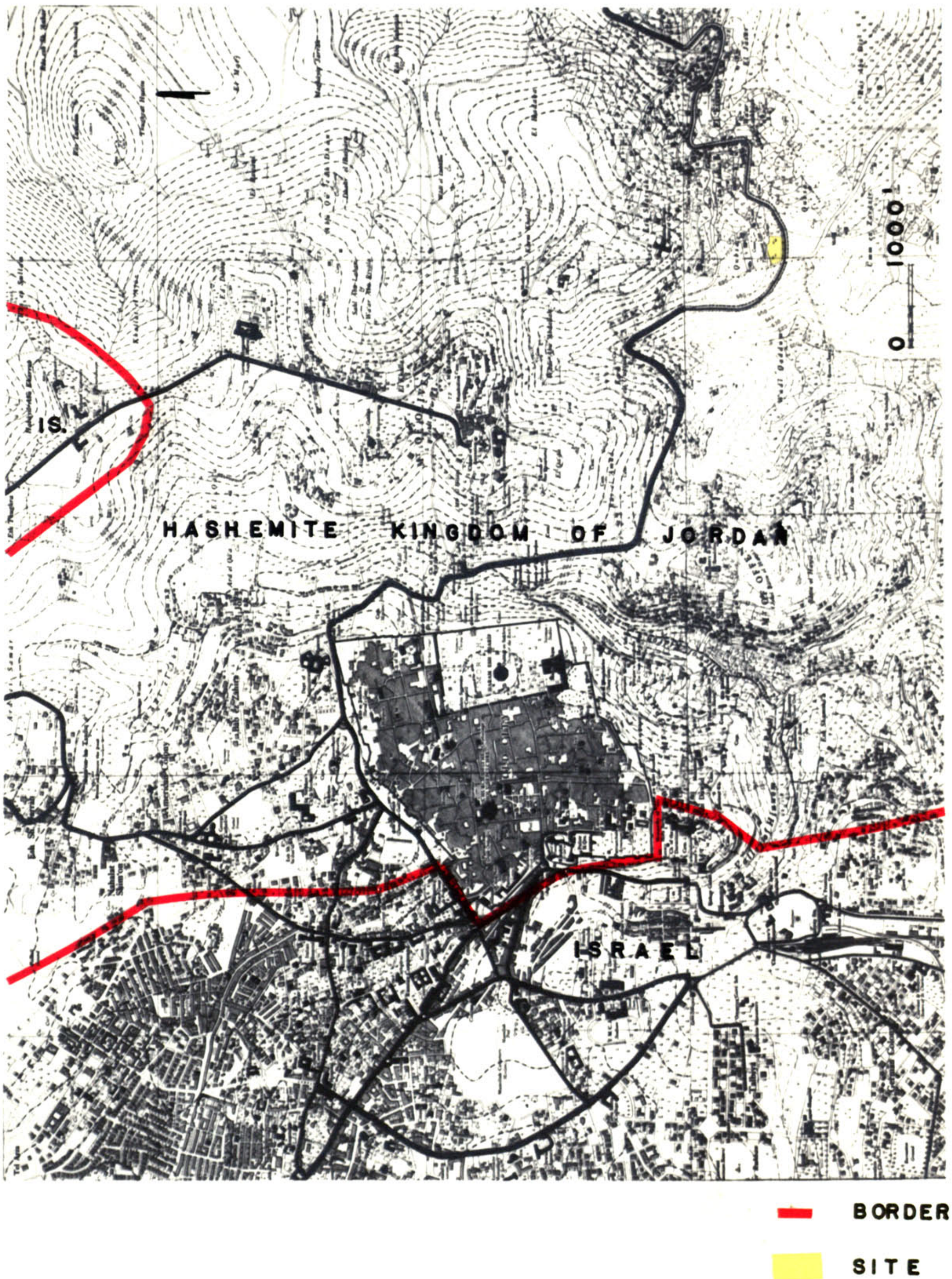
Its natural topography seemed highly suitable, composed as it was of a flat area of land gently sloping on two sides. An existing terrace has already solved the problem of a sharp rocky drop on the north side of the site. Little remodelling of the land seemed necessary at first sight.

Like the whole Jerusalem region, the site is essentially rocky, with a foot or two of top soil. The geology starting with the upper layer runs as follows: Limestone (hard cryst, masive with marls, ferruginous with clay beds, sandstones); dolomitic limestone; hard flint limestone chalk with nodules, grey and brown flints; lithographic stone and fine grained limestone; rudist "meleke" beds, north, and dolomits and chalk, south; flinty chalk and marl, north, and dolomite, south; hard chalk- chalky marl; chert beds and bituminous limestone; bed rock, bituminous rock, limestone.*

A map showing the location of the site with respect to the city of Jerusalem, as well as a site plan and photographs of the site are included in this chapter.

* From the geological study of the Jerusalem region in <u>Rebuilding the Land of Israel,</u> by Gershan Canaan, pg. 78.

Location of the site in relation to Jerusalem



SITE PLAN 1/40" = 1'

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

FIG. 8

FIG. 9

FIG. 10

iv. The Jerusalem Climate.

Located 2500 feet above sea level in the middle of the Central Mountain Range of Palestine that runs parallel to the Jordan Valley, Jerusalem and the hill areas around it enjoy a very pleasant and healthy climate. The summer is drier than in the coastal areas or the Jordan Valley and not so hot. In January the mean temperature reaches 46° F. The daily range is smaller in the rainy season than in the summer. It is 6° F. to 9° F. in the months of November to March and 10° F. to 13° F. from April to October.

Thermal Analysis.

53.83% hours per year are in the warm temperature range and permit open-door and outdoor living. The average temperature occurs as daytime temperature within this range for six months (May to October)of the year. August is the hottest month with a mean temperature of 74° F. During Hamsins* the temperature goes up to the extreme and reaches the 'hot' temperature range.

The cool temperature range with 38.25% hours per year recommends indoor living with openings closed to eliminate draft. This range is typical of the winter months from November to April. Dewpoint temperatures accompanying dry-bulb shade temperatures, generally in

*Hamsins are the hot, dry winds blowing from the desert. They are the only winds blowing from the East.

cooler months, create a most enjoyable climate.

The chilly temperature range with 7.29% hours per year points to indoor living. The month of December is typical for this range. Frost and freezing may occur during the night for a very few days but will usually thaw the following morning. December has a mean temperature of 44° F. The elevation of Jerusalem causes these lower daytime temperatures. Thunderstormes are often associated with the passage of an intense cold front.

Solar Analysis:

The sky is clear throughout the year and even in January cloudiness is not above 52%. The average percentage of cloudiness per year is 31% with a minimum in July of 8%. All surfaces receive a large amount of radiation from the hot, unclouded sun.

Wind Analysis:

The prevailing winds throughout the winter blow from the west and in summer from the northwest. There are no local winds during all the summer and the wind direction is always that of the general circulation thus pointing to the use of summer winds as a cooling factor in building design. The velocity of winds is at a minimum in Jerusalem because of its pronounced hill protection though strong winter winds occur during some twenty to thirty days throughout the winter in the hill areas. Their direction is chiefly from the west.

The sea breeze from the coast reaches Jerusalem about six hours after sunrise. Hamsins are very strong and prevail in the mountains although they may be unknown in the coastal areas. Most people feel debilitated during the spans of three to nine days when they occur, but the heat is still very dry. When cool air formed by the radiation near the earth surface rolls down gentle slopes into the valleys, it becomes a cool breeze. This air drainage effect is important in keeping the generally pleasant temperatures in the hill areas and Jerusalem.

Precipitation Analysis:

Most of the precipitation occurs during the end of January and the early part of February. Heavy rains may fall in the early winter accompanied by strong westerly winds and thunderstorms. Rain falls steadily for two to four days in succession, followed by a spell of fair and sunny weather lasting five to ten days. A steady decrease in precipitation was observed during the first half of the century. The average rainfall is 622 millimeters (25 inches) with the maximum rainfall of 162.9 millimeters (6½ inches) in January. Practically no rain falls from May to October.

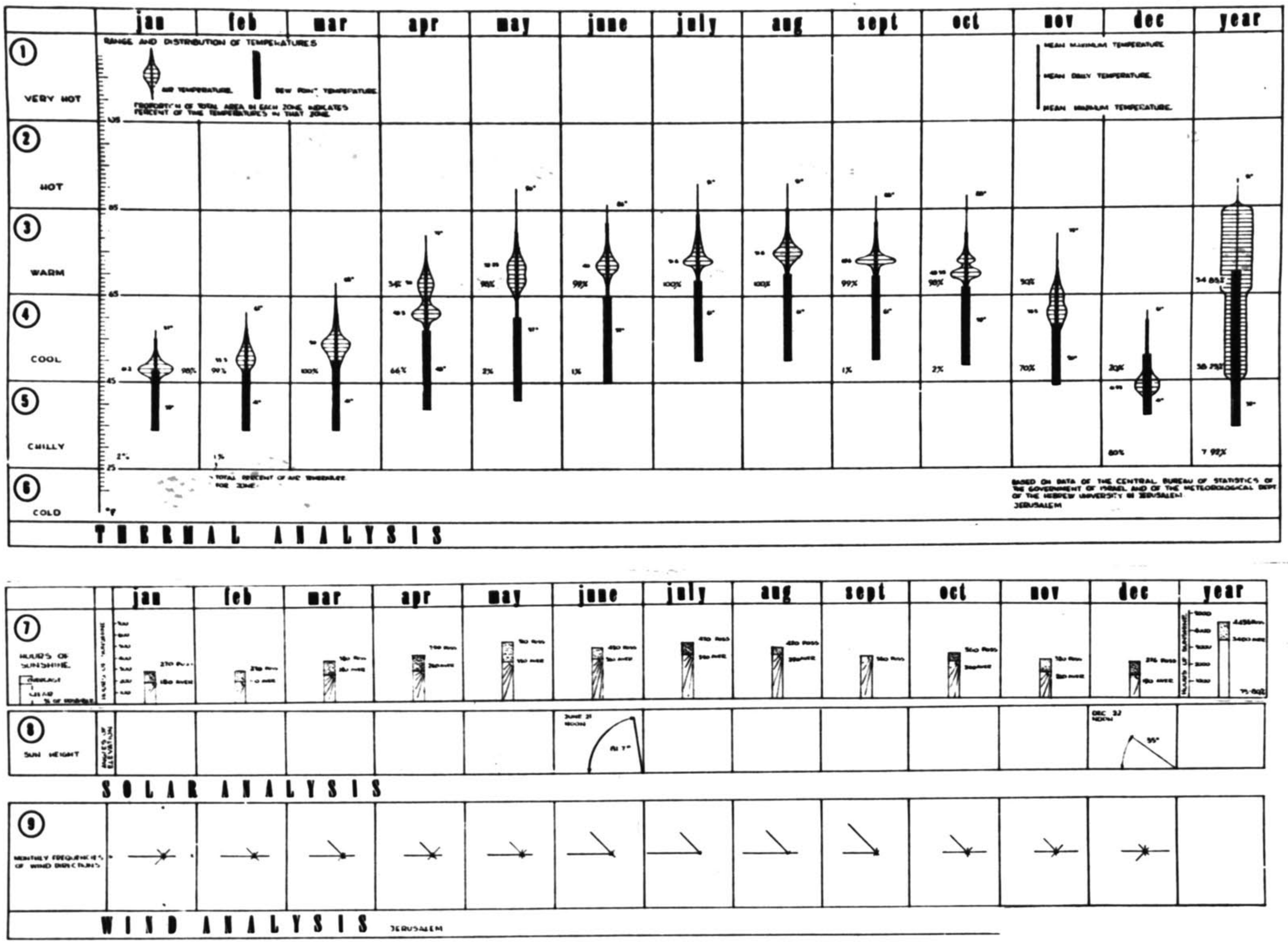
There is a little snow that falls from one to three days in the western hill regions. It rarely falls around Jerusalem. Once in five to ten years, extensive areas are snow covered for several days.

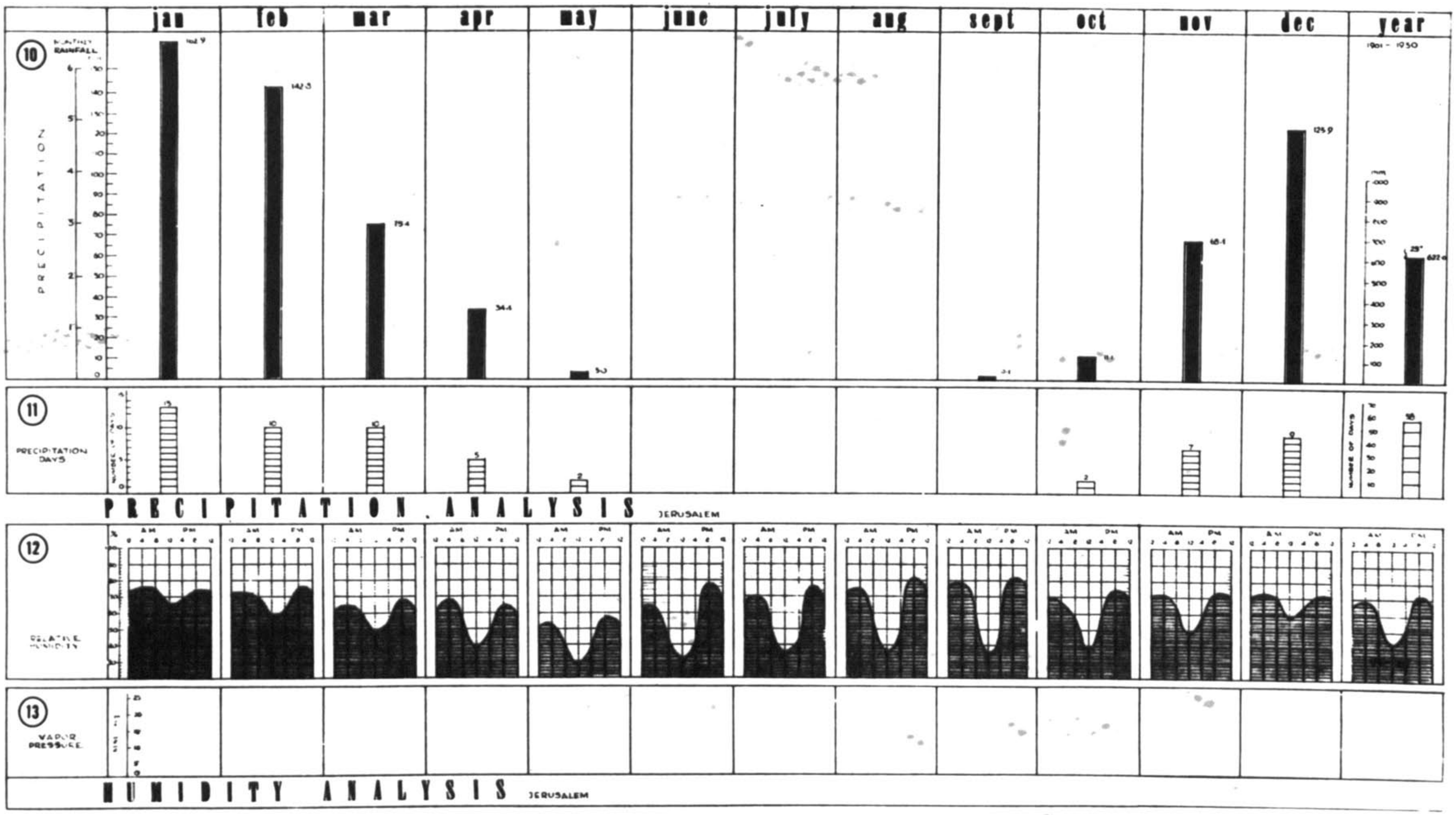
Humidity Analysis:

Relative humidity is low and medium throughout the year. It is around 42% during the day and 70% during the night. The yearly average is 65%. The mean relative humidity drops from 74% in January to 46% in May and June with a secondary minimum of 59% in October. If strong hamsins occur it may even drop to 3-5%.

A complete outline of the Jerusalem climate based on data compiled by the Central Bureau of Statistics of the Government of Israel and of the Meteorological Department of the Hebrew University in Jerusalem appears in Table I.

Table 1. The Jerusalem Climate





jan
feb
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nov
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year
1901 - 1950
10
MONTHLY RAINFALL
PRECIPITATION
11
PRECIPITATION DAYS
PRECIPITATION ANALYSIS
JERUSALEM
12
RELATIVE HUMIDITY
AM
PM
13
VAPOR PRESSURE
HUMIDITY ANALYSIS
JERUSALEM

v. A study in the general principles of natural climatic control.

One of the important aspects of design that was to be investigated and seriously considered in this thesis was the influence of climate and climate control in the design of buildings. Because of the financial restrictions imposed by the program and also because it must be recognized that like financial limitations are prevalent today throughout most of the regions where climate control is desired, it became necessary to investigate what could be achieved in the way of climate control without resorting, if at all possible, to the use of mechanical cooling or heating units.

I felt very strongly that such an investigation would be valuable in any work done in underdeveloped countries. Recent political and economic changes have made it likely that there will be a need for architects having some concept of the natural solutions to climate control in many areas of the world where such problems are of great importance and where public housing will have to be put up quickly and cheaply. India and Pakistan are two countries where such changes are already taking place. Africa is likely to be faced with the same problem in a few years when its territories will have received their autonomy.

It may be worthwhile after having gone into a detailed analysis of the climatic conditions of Jerusalem to examine the general problem of natural climatic control and to study some of the solutions that have been formulated so far.

The principal aim of climate control is to remedy a local thermal condition that proves to be uncomfortable to man. It may be done by keeping out rain, snow, wind and sunlight by means of enclosures such as roof and walls, by lowering the indoor temperature by means of ventilation, natural or artificial, and/or by the introduction of natural or mechanical cooling devices; by raising the temperature by means of natural or mechanical heat generators; by lowering or raising the relative humidity by natural or mechanical means. Climate control is therefore primarily concerned with the establishment of a condition of 'climatic comfort' for man. This aim can be further divided into the establishment of a condition of 'gross climatic confort' or a thermal equilibrium without excessively unpleasant sensations but not excluding unpleasant sensations due to excessive humidity, dryness, drafts, etc., and a condition of 'finer qualities of climatic comfort' that would result in the elimination of the conditions not excluded in a condition of 'gross climatic comfort'.

It will easily be realized that due to local climatic conditons it may not be possible to provide the finer qualities of climatic comfort without resorting to artificial means. In such a case, the decision to limit oneself to a gross comfort condition obtainable by natural means will be determined largely by the economic characteristics of the situation. This may particularily hold true in a hot-humid climate where the main cause of discomfort is high humidity rather than excessive temperatures, and therefore difficult to remedy by natural means only.

It is also true that the necessity for controlling the climatic conditions inside a building will be influenced by its use and by the conditioning of its users. For example, it is more important to control the temperature and humidity in buildings where certain peculiarities of their use makes such a control almost indispensable, be they an industrial process whose success depends to a large extent on climatic conditions, or a building where large accumulation of people would make the place unbearably hot, such as a movie theater, a large department store, etc., than to attempt to control indoor climatic conditions in locations where one stays but for a short time, a small store, a streetcar or bus, etc., or where the number of people using the space is very small such as in a private home. In the same way, the temperature to which the users are accustomed will play an important part in deciding the need for climatic control. It would certainly prove unnecessary to artificially reduce the temperature of a building whose sole users were accustomed from birth to the climate in which the building is located and where no large seasonal variations force a yearly re-aclimatation, beyond providing for an adequate amount of ventilation, shade, etc. But if the building is to be used by persons having lived all their lives in a cool or cold climate and having moved suddenly and for a short period of time to a zone of tropical or sub-tropical conditions, it becomes almost vital to adequatly control the building's climate. That our idea of comfortable temperatures is influenced by our conditioning is further illustrated by the following examples: we feel uncomfortable when moving South in the middle of the summer or even when experiencing the season's first heat wave; Englishmen and Europeans feel that our buildings are overheated in the winter and we have a tendency to feel that the reverse is true in England and on the Continent; a person coming from a tropical climate will find one of our mild spring days uncomfortably cool while we bask in the sun.

It is evidently part of the architect's role when designing a building having a special use to study conditions very carefully and, if not to solve them completely, as the cost may be prohibitive, at least to arrive at a partial solution affording conditions of gross climatic comfort. His solution's worth will then have to be estimated with respect to the financial cost and the cost in terms of compromising other architectural objectives, such as the looks of the building, its circulation, its structure, etc.

The architect will further have to realize that in the case when the structure is the only mean used for climate control, that is when no mechanical means are used, certain characteristics will tend to prevail. These are: that inside conditions will roughly follow the outside conditions, that is the temperature will rise when the outside temperature rises, fall when it falls, etc; that these phenomena will occur after a definite time lag varying from a few minutes to several hours; and finally that the inside cycle will not vary as greatly as the outside one- it will be damped.

These last two conditions depend entirely on the type of structure used as a 'climatic skin'. It is evident that the possibility of using the time lag element as a mean of heating the space could be quite advantageous in a climate with large variations of day and night temperatures.

The heat storage capacity of a material depends on two characteristics: its coefficient of overall heat transfer (symbol:U) measured in BTU/hr./sq ft./deg F., and its heat storage capacity, this being equal to its mass times its heat capacity. For instance, a good insulating material has a low value of U and a very slight heat storage value. It would therefore be useless if a recuperation of the heat absorbed by the wall was desired after a definite time lag. On the other hand, materials with a higher U value, but very dense and having a large mass per unit volume, like rammed earth, concrete, stone, and brick, have a considerable storage value.

It has been found that the use of insulation materials (low U, low heat storage value) will not give satisfactory results when no mechanical means are employed to help maintain the temperature inside a building at the desired level. By their nature, they slow down the transmission of a temperature differential from outside to inside only as long as their inside face is kept at the desired temperature by artificial means. If no such mean is employed, the inside face will become hot fairly rapidly due to the low value of heat storage potential of the material and start to transmit heat to the inside face. As a rule, they are to be used in conjunction with other means of climatic control.

On the other hand, the inside face of a structure having a large heat storage capacity will remain cool for a long time and therefore tend to absorb heat from the interior space. However, such a structure will accumulate a large amount of heat during the daily sunny hours and radiate it back when the outside air temperatures have fallen, probably during the night. A comparative study of the characteristics of various building materials will be found in table 2.

Table 2. Heat Transmission Characteristics of Various Building Materials

Material	Thickness in in.	Coefficient of Transmission U(BTU/hr/sq.ft/°F.)
Solid brick	8	0.50
	12	0.36
	16	0.28
Hollow tile with stucco exterior finish.	8	0.40
	10	0.39
	12	0.30
	16	0.24
Stone.	8	0.70
	12	0.57
	16	0.49
	24	0.37
Poured concrete.	6	0.79
	8	0.70
	10	0.63
	12	0.57
Hollow concrete blocks		
Gravel aggregate.	8	0.56
	12	0.49
Cinder aggregate.	8	0.41
	12	0.38
Light wt. aggregate	8	0.36
	12	0.34
Concrete slab, insulation and built-up roofing (½" of insulation)	2	0.36
	4	0.34
	6	0.33
(1" of insulation)	2	0.24
	4	0.23
	6	0.22
Vertical glass sheets		1.13
Double pane of vertical glass, ¼" airspace.		0.61
Wood doors.(nominal thick	1	0.69
	1¼	0.59
	1½	0.52
	2	0.46
	2½	0.38
	3	0.33

A means of climate control that has too often been ignored by the architect is the use of exterior obstacles to cut the effects of direct solar radiation. Trees, vines, leafy plants, artificial barriers, sun louvers, etc., are effective means of controlling the temperature of exterior walls as they cut out a great deal of radiation. They have the added advantage of being easily controlled in size, shape and placement by the architect, thus enabling him to mask direct solar radiation only during definite hours of the day, and during the seasons when solar heat is objectionable.

The use of plants as natural sun barriers has the further advantage of being probably the cheapest possible way of cutting out direct radiation if care is taken to choose plants that are native to the soil and climate of the region. It is also true that plants have a psychological cooling effect due to the cool appearance of their abundant and multi-shaped leaves and shadows. Like other shading devices, artificial or natural, they will further improve comfort by cutting out glare.

In the same connection, an appreciable decrease in radiation can be achieved by controlling the color and texture of the ground around a building. A fairly large proportion of solar radiation is reflected by the ground, going up to a high of 48% for white paving. A comparison of the incident solar radiation reflected by different materials is given in table 3.

Table 3: Percentage of Incident Solar Radiation Reflected by Different Soil Treatments

Nature of Surface Materials	Estimate of % Reflected
Bare ground, dry	10 to 25
Bare ground, wet	8 to 9
Sand, dry	18 to 30
Sand, wet	9 to 18
Rocks	12 to 15
Dry Grass	32
Green fields	3 to 15
Green leaves	25 to 32
Dark Forest	5
Desert	24 to 28
Salt Flats	42
Brick, depending on color	23 to 48
Asphalt	15
City Area (average)	10

Perhaps the most ancient means of controlling the indoor climate in hot countries has been the orientation of the building. This, in conjunction with controlled openings is one of the more efficient ways of reducing the solar heat load. The Mediterranean region, in Africa, in Asia, in South America, the narrow streets of cities, always in the shade, the crowded buildings and the resulting exploitation of neighboring buildings shadows bear testimony to this fact. Even in our temperate climate, we have a tendency to orient our houses so that as much as possible of the hot summer afternoon sun will be kept away from the main living spaces while, if at all possible, we are anxious to receive the winter sun in these spaces. The patio, the Arab riad, or landscaped inner court, are applications of this principle of making use of the cooler shadow cast by a building.

But equally important in hot climates, is the orientation relative to the main prevailing winds. The usual lack of adequate winter heating provisions in hot climates where the winter temperature drop is still appreciable makes this principle of orientation relative to prevailing winds a two-fold proposition as it becomes important to shield the building from the winter winds while taking advantage of the summer winds. The patio and the riad are here again examples of a solution to this problem.

The summer cooling effects of winds and light breezes is especially appreciable in hot-humid climate where the high relative humidity will negate to a great extent cooling of the human body by evaporation in the absence of air movement.

In trying to take advantage of prevailing breezes, it should be remembered that locale and site topography may greatly affect the direction of local breezes. The presence of natural obstacles, buildings, trees, hills, etc., must be considered and their effect analyzed.

In relation to natural ventilation, the general principles are to attempt to take advantage of the positive pressures created by prevailing winds on the windward side of a building and the negative pressures on the leeward side to help force air into the building. A further means of forcing air into a building is the size and location of openings. It is good practice to provide inlets on the windward side that are smaller than the outlets on the leeward side as the pressure differential thus created will force air circulation. The location of inlet openings close to the ground will take advantage of the generally greater wind flow along the ground plane. Locating outlets high up will take advantage of the pressure differential caused by indoor temperatures and tend to help the rapid evacuation of air that has become relatively hot.

Another factor that has to be considered in the use of air movement as a cooling agent is the speed of the air current or draft. While a higher air speed usually means a better cooling potential, due to the cooling sensation caused on the human body by air movement, too high to speed will prove uncomfortable. We have all experienced this fact when sitting too close to a fan, in the draft of an open door, etc. Outlined in table 4 are the effects on the human body of air currents of varying velocities.

Table 4. Probable effect on the Human Body of Air Currents of Various Velocities

Velocity in ft/min.	Probable impact on the human body
up to 5	unnoticed
50 to 100	pleasant
100 to 200	generally pleasant but causing awareness of air movement.
200 to 300	from slightly drafty to annoyingly drafty.
above 300	requires corrective measures.

Having spoken so far of the different means by which certain undesireable or extreme climatic conditions could be controlled and remedied, a brief outline of the climatic characteristics of tropical and sub-tropical regions might prove helpful in understanding better the reasons why these methods were suggested.

As one moves away from the equator, the average angle made by the sun with the earth's surface, and thus the intensity of its heating effects, decreases. On the other hand, the length of day during the period of the year when that angle is greatest, namely the summer, increases. Moreover, when that angle is large, a small decrease in the value of that angle becomes unimportant. As a result of these conflicting influences, the maximum receipt of solar radiation on the earth's surface over the whole of a clear summer day is somewhere between 30° and 45° of lattitude. The highest total receipt for a year is in the neighborhood of latitude 15°. Table 5 gives for different latitudes the total amount of solar radiations in BTU/sq.ft. received by a horizontal surface on a clear day in the middle of the month. The effect of solar radiation on a tilted surface can easily be found by the use of a corrective formula taking into account the tilt of the surface.

Table 5 Total Amount of Solar Radiation Received by a Horizontal Surface on a Clear Day in the Middle of the Month at Various Latitudes.

Lat. in °	Jan	Feb.	March.	Apr.	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	1806	1917	2028	2009	1869	1751	1770	1880	1954	1899	1844	1788
15	1475	1678	1954	2157	2231	2231	2231	2194	2028	1770	1549	1383
30	1032	1327	1770	2120	2378	2452	2397	2195	1844	1456	1143	940
45	516	866	1327	1844	2249	2452	2360	2083	1567	1032	645	442

Table 5 does not take into account the reductions caused by smoke, dust, high water vapor content of the atmosphere, etc. Therefore the heating effect of the sun is less in hot-humid climates and around urban complexes than it is in hot-dry regions.

The topography of the region will tend to influence the general climatic characteristics, thus forming 'micro-climates', Foremost as an example of this phenomenon is the influence of large tracts of dry lands such as deserts that tend to cause fairly large annual as well as diurnal variations in the air temperature. Of course, the occurence of mountains or hill will have a great deal of effect in the regional climatic characteristics, thus pointing to a careful study of local rather than regional climatic data.

Table 6 outlines the important characteristics of hot-dry climate. The Jerusalem climate in general was found to follow these characteristics

Table 6 Important Characteristics of Hot-Dry Climates

Item:	Magnitude:	Effect on human heat balance:
Direct solar radiation	High, with little natural shade	Marked addition to heat Gains.
Solar radiation reflected from clouds, etc.	Moderate	Some addition to heat gains.
Solar radiation reflected from ground, etc.	High to moderate	Marked to moderate addition to heat gains.
Thermal radiation exchange with ground, etc.	Moderate toward human body	Some addition to heat gains.
Thermal radiation to sky	Moderage	Moderate addition to heat losses.
Air temperature	Often above skin temperature	May represent moderate addition to heat gains.
Air vapor pressure	usually low	Important chamel for heat losses essential to restore body heat balance.
Air movement	Variable. Often high.	Promotes heat losses when vapor pressure is high, but heat gain when temperature is very high.

In conclusion to this study in the general principles of natural climatic control, I would like to outline a typical investigation that should be carried out by an architect faced by the problem of building in tropical or sub-tropical climates and desiring to take advantage in his design of the climate of the region. He should investigate carefully the following points.

1. The general outline of the boundaries of the climatic comfort zone for the region under consideration.

2. Identification of comfort and danger zones, that is the presence, if at all, of conditions of heat and humdity that may be dangerous to the human beings destined to occupy his building.

3. An evaluation of the effects of:

   a. Wind and high temperatures.

   b. Air movement and vapor pressure.

   c. Evaporative cooling and high temperatures.

   d. Radiation and dry-bulb temperatures.

4. The effects of the climate and the advantages or disadvantages of the prevolent:

   a. Air temperature.

   b. Solar radiation

   c. Air movement.

   d. Humidity.

5. The ways in which the human body reacts to a

climatic envireonment and their use in climatic design, namely through:

a. Evaporation

b. Conduction.

c. Convection.

d. Radiation.

6. The presence of the so-called "national" standards of climatic comfort, namely:

a. The British standard- 58°F. to 69°F.

b. The U.S. standard- 69°F. to 80°F.

c. The tropical standard- 74°F. to 85°F.

7. The use of natural means of climatic control:

a. Natural ventilation

b. Natural shading (trees, other buildings, etc.)

c. Artificial shading (louvers, overhangs)

d. Ground texture control.

e. Solar radiation and its effects on:

i. type of roof
ii. thickness of walls
iii. location and size of openings.

f. Use of transmission "time lag" factor.

vi The Solution

The main ideas that guided the design of the hostel were the best possible utilization of the site, the available building materials, the required flexibility of plan, and the climate and the ways in which it would be naturally controlled. Moreover, I felt very strongly that I should attempt to create an environment that would be conducive in an unobstrusive way to meditation and religious thought. I attempted to accomplish this not by setting apart certain areas for religious worship- the proximity to the site of existing churches rendered this unnecessary- or by making the design follow a monastic tradition- the aim of a good percentage of the patrons, especially during the summer, being tourism, I felt that such a solution was uncalled for- but by arranging and scaling the buildings in such a way as to create a number of enclosed or semi-enclosed areas that would allow a variety of parallel uses without mutual disturbance. The Jerusalem landscape being composed of countless dramatically eroded hills which, while being very beautiful, have a certain savageness in their rockiness-they are reminiscent of the Dakota Bad Lands- I felt that it would be a pleasant relief to achieve a design as self-contained as possible, with the main emphasis turned inward on the quietness and visual selfsufficency of the spaces created within the site. The actual condition of the site-complete enclosure by a stone wall, the presence of olive trees on three sides, a retaining wall and terrace planted with trees on the north side- already indicated a certain amount of self-containment that was further emphasized by the presence of a natural water supply, a well fed by the winter and spring rains that had been collected in a cistern.

These ideas, plus the need for extreme flexibility and the natural contours of the land- an essentially flat central part sloping in two directions, towards east and west- led me to discard some early schemes that had consisted in erecting a four story building on stilts containing the sleeping facilities and surrounded by an L-shaped one story building containing the lounge, administration, dining-room, kitchen and services. I felt that while such a solution might be made to work adequately plan- and circulation- wise, it lacked any appreciation of the purpose of the building, the character of the local building types, the topography of the land. It was a design that could essentially have been located anywhere, on any site.

I was therefore led to attempt the design of a grouping of buildings that would respect and take advantage of the topography of the site and that would tend to subdivide the site into a number of smaller areas, much on the same principle as the arab riad. Such an approach also seemed to indicate the possibility for a much greater flexibility in use as any number of these buildings, or units, could be closed without disabling the functioning of the whole. Construction wise, limiting the size and height of these units seemed rational in a country where a crane is totally unknown and where all transport of materials on the site is done by hand. Furthermore, the creation of small units opened up the possibility of designing individual structures best suited for the use of each unit. Ease of construction could also be achieved by limiting the amount of excavating and grading that has to be done by hand and is fairly difficult in the rocky Jerusalem region.

My decision to break up the project into a grouping of small buildings was further influenced by the consideration that I could thus fully take advantage of the prevailing summer breezes coming from the north-west as a cooling factor in my attempt at solving the climate control aspects of the problem. There was also the possibility of shielding to a great extent the majority of the buildings from the winter winds coming from the west and the south west. The shadows cast by a grouping of the buildings could also be exploited either to protect some of the buildings themselves from direct solar radiation or at least by creating a large number of shady areas on the site that would be pleasantly cool to sit in during the hot summer months. The different orientations of buildinga that could be obtained by grouping them could lead to some varied solutions of the shielding of direct solar radiation according to the individual needs of the buildings.

Lastly, I felt that such a grouping had immense possibilities in the creation of visually interesting and pleasant spaces. These could then be emphasized by adequate ground treatment in the form of coloured gravels, paving, some planting that would have to be rigidly contained in buried concrete troughs to preserve water. Such a method of ground treatment being the only one possible in the Jerusalem climate- for it is impossible due to the lack of water to keep a lawn during the greatest part of the year- I felt that while it might be dreary in large areas, could become quite interesting and pleasant if kept at a small scale.

My solution therefore was to subdivide the project into six buildings, two of them containing the dormitories, two the private rooms, one the lounge and administrative space, and the sixth the dining room, kitchen, and service areas.

The comparatively small size of the different buildings allowed me to considerably reduce the amount of cutting and filling that had to be done. The contours were further exploited by essentially cutting the site in two with an irregularily shaped three foot high retaining wall. In one case, for one of the private rooms buildings, I was forced by lack of space to ignore the contours, but found that by elevating the building on stilts, I could override the differences in levels by adjusting the height of my columns in such a way that two-thirds of the space under the building was high enough to be utilized, while the other third was not.

The different buildings are connected by paved walks, some of which are covered by a simple structure consisting of a 12'x6' precast concrete slabs 3" thick supported at their ends by 3" diameter steel pipe-columns. The decision to use these covered walks was reached only after a long period of hesitation, because of the added expense that they would involve. I felt however that they might serve three important purposes: as a protection against rain in the winter time- thunderstorms are not infrequent during December which is one of the busiest times for the hostel,- as a shade giving element in the summer time- they would act as a transition zone between the coolness and relative darkness of the interior spaces and the brilliant, often blinding sun,- and finally they would help to unify visually the different spaces that had been created in between the buildings.

I felt that these covered walks should not imply definite circulation patterns but, while leaving other possibilities, would suggest direction due to the fact that they offered a shaded, and therefore cooler, way of getting from one building to another. The fact that I was not trying to establish definite routes allowed me to limit to a great extent the number of these walks. It is always possible to get from one building to any other along one of these walks. It is not necessarily the shortest- it usually isn't- but it may well be the most pleasant way in case of rain or unbearably strong sun.

The remaining ground was treated very simply as gravel areas with a few contrasting paved areas. The impossibility of keeping a lawn in the summer due to the shortage of water made me decide against any large scale planting. I felt that an orderly, clean expanse of gravel would be preferable to what would essentially be bare, unkempt ground nine months out of twelve. The natural beauty of the Jerusalem gravel, it is made from crushed limestone and is of a deep honey color, as well as its reflection characteristics (12-15% of the incident solar radiation reflected for crushed rock vs. 10-25% for dry bare ground, see table 3, makes it compare advantageously) was a further incentive to use gravel.

The existing olive tree grove planted on three sides of the site, on the north terrace, along the east side, and halfway down the south side, will provide an unusually large amount of green for the area. I felt that one centrally located area that would be naturally sheltered by the three foot high retaining wall running through the site, could be lavishly planted with flowers, thus creating one bright spot of color. This could be made possible at little expense and with a small consumption of water by burying a concrete trough, in which flowers would be planted, that would act as a container for the water. I felt that, while further planting was possible using the same method, keeping the planted area small and intense would create a very pleasant oasis that would contrast with the rigid ground treatment of stone paving and crushed stone gravel that was used on the remainder of the site. The olive grove would be left as it is, hard, dry, bare ground in the summer time becoming a luscious blanket of grass and wild flowers during and immediately after the rainy season.

The buildings, their function, plan and structure are described as follows:

The entrance building contains the lounge, lobby space, public toilets, desk and office-sleeping room with adjoining bathroom for the residing administrator. Perpendicular to it is an identical building containing the dining room, the kitchen and food-storage areas, a small accounting cubicle, a loading platform, a laundry, the servants' lockers and washrooms. In the basement of this building is the hot water heater and storage tank for both buildings, the necessary plumbing running in a trench connecting them, as well as room for additional bulk storage,. Both these buildings are laid out on a modular 12'x24' bay system, each bay spanned by a $3\frac{1}{2}$" reinforced concrete barrel vault supported by 10" square, tied concrete columns at the corners of the bays. On the south side for the lounge and administration building, and on the east side forthe dining and kitchen building, the vaults have a $4\frac{1}{2}$' overhang intended to protect the interior space from direct sunlight and to provide a covered outdoor area that could be used for outdoor eating or sitting. The ceiling forthe rooms are kept high, 9' at the lowest point, in order to insure an adequate volume of air, an important factor in summer cooling. Most of the glass is kept fixed, using as a means of ventilation the space underneath the vaults as an exhaust vent and the lower panels of the window area as an intake, thus furthering natural ventilation. This also facilitated the problem of insect control since screens placed between the top of the fixed glass and the vault's edge were high enough to be protected from damage. Where glass is not desireable, 8"x8"x16" modular concrete masonry units are used because of their cheapness, availability, low heat transfer value (U= 0.56), and heat storage capacity (about six hours elapse before they give off their maximum radiation value) that becomes valuable in the winter time. All interior partitions are of 4"x8"x16" modular concrete blocks that can be either plastered on both sides or painted, as desired. The floors are of local ceramic tile laid in a ½" mortar bed on top of a 6" concrete slab poured on gravel. The columns are supported by the slab. In the case of these two one-story buildings, the rocky, flat characteristics of the site seemed to make this the easiest and cheapest way of supporting the building.

The two dormitory buildings are identical except in details. The concept directing their design was to create cheap, flexible, yet pleasant and comfortable sleeping units. Each building has two floors, thus making it possible to house boys and girl in one building if desired. Each floor contains ten bedrooms and a common washroom with two lavatories, two water-closets, and one stall shower. The building is essentially solid, pierced at intervals with floor to ceiling louvered openings allowing air and light and yet cutting down on direct sunlight and glare. The sleeping area is divided into individual cubicles containing a bed, two drawers underneath the bed, a small closet and an armchair. The cubicles are separated by 6'-6" high free standing partitions of 4" concrete block allowing an unhampered flow of air overhead. Slits, starting at the 6'-6" level and running up to the ceiling, are provided on the north side of the buildings to channel the main summer breezes. Curtains can be drawn across the front of each cubicle if privacy is desired. A wide corridor, six feet wide running the lenth of the building between the rows of cubicles can be used as common space. The building is composed of two 12'x24' end bays and a 24'x24' interior bay containing the washroom and the entrance and stairs. A 4" reinforced concrete slab resting on 12"x14" concrete beams span the end bays. The center bay is spanned by a concrete joist system using 5" joists 25" o.c. The pans are 20" wide by 8" deep and the slab is 2" deep. 10" square, tied concrete columns are used to support the slabs. The floors are of ceramic tile in ½" mortar. The walls are of 8"x8"x16" concrete blocks.

The louvers are precast, 2" thick, and inserted into notches formed in the windows' heads and sills. Projected-in, bottom-hinged windows are located inside the rooms. Fixed screens are in between the inner edge of the louvers and the windows. The louvers project out 12" and are 18" o.c. They effectively keep the sun out of the building from 9 A.M. to 3 P.M. between May and September. A basement containing the hot water heater and storage tank is located under the central bay. The columns are carried to concrete footings in the limestone stratum at or just below grade.

The private rooms buildings are also identical in floor plan and construction except that in one of them the first floor has been omitted to create a covered outdoor area to be used for ping-pong, games, etc. Each private room contains two beds, dresser, closet, desk, chairs, private bathroom, and a 4'-6" corridor runs alongthe north side of the building. A 4'-6" balcony serves as a sun breaker. High windows on the north side admit the summer breezes. All bays are 12' x 18' with two 4'-6" cantilevers, except the central bay containing the stairs that is 9' x 18'. The construction is similar to that of the rest of the scheme, 8" thick concrete blocks being used for outside partitions and 4" thick block for inside partitions. 10" square tied columns are also used, and the floor slab is 4" thick with a finished floor of ceramic tile. A basement, partially excavated, contains the hot water heater and storage tank. On top of the south building, a concrete tank running 2/3 the length of the building and 6' high contains the water necessary for two days' consumption with the hostel operating at full capacity, namely, 8,000 gallons.

It was decided after completing the climatic study of the Jerusalem region not to provide any central heating system. The two months when some heating is desirable, though not essential, January and February, being periods of little afflux when the hostel could possibly be closed. The amount of sunlight during the month of December is sufficient to heat the walls adequately, and thus would help heat the interior spaces during the night. A large fireplace in the lounge will help make the cool evenings comfortable.

In conclusion I would like to restate that throughout the design, my main concept was to arrive at a building that is appropriate to the spiritual experience its users are going to undergo, that would be conducive to meditation by the spacing and arrangement of its masses, that would act as a bridge between an emotional religious experience and the speed, noise and disorder of everyday life. At the same time, I attempted to keep my construction cost as low as possible by using simple materials and construction techniques, by keeping my buildings within the native tradition of simple, cubical volumes.

Appendix 1.

Cost of Building Materials in Jerusalem, Jordan, 3/5/55.

Material	Jordanian Dinars	U.S. Dollars
Stone:		
soft stone	.08 JD/sq.ft.	.23$/sq.ft.
hard stone	.12 JD/sq.ft.	.34$/sq.ft.
Brick:	.02 JD/sq.ft.	.05$/sq.ft.
Composite Construction:		
soft stone & mortar	.15 JD/sq.ft.	.43$/sq.ft.
hard stone & mortar	.21 JD/sq.ft.	.59$/sq.ft.
brick & mortar	.05 JD/sq.ft.	.11$/sq.ft.
reinforced concrete	.90 JD/sq.ft.	2.54$/sq.ft.
Woods:		
common white wood	.34 JD/sq.ft.	.96$/sq.ft.
Swedish import wood	.38 JD/sq.ft.	1.15$/sq.ft.
Swedish import wood (painted)	.45 JD/sq.ft.	1.25$/sq.ft.
Steel:		
formed sections	2.63 JD/kip	7.43$/kip
reinforcing bars	5.20 JD/ton	14.70$/ton
Windows:		
glass, frame & paint	.50 JD/sq.ft.	1.40$/sq.ft.
Piping:		
3/4" galvanized	.11 JD/yd.	.50$/yd.
1" galvanized	.25 JD/yd.	.70$/yd.

Appendix 2.

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