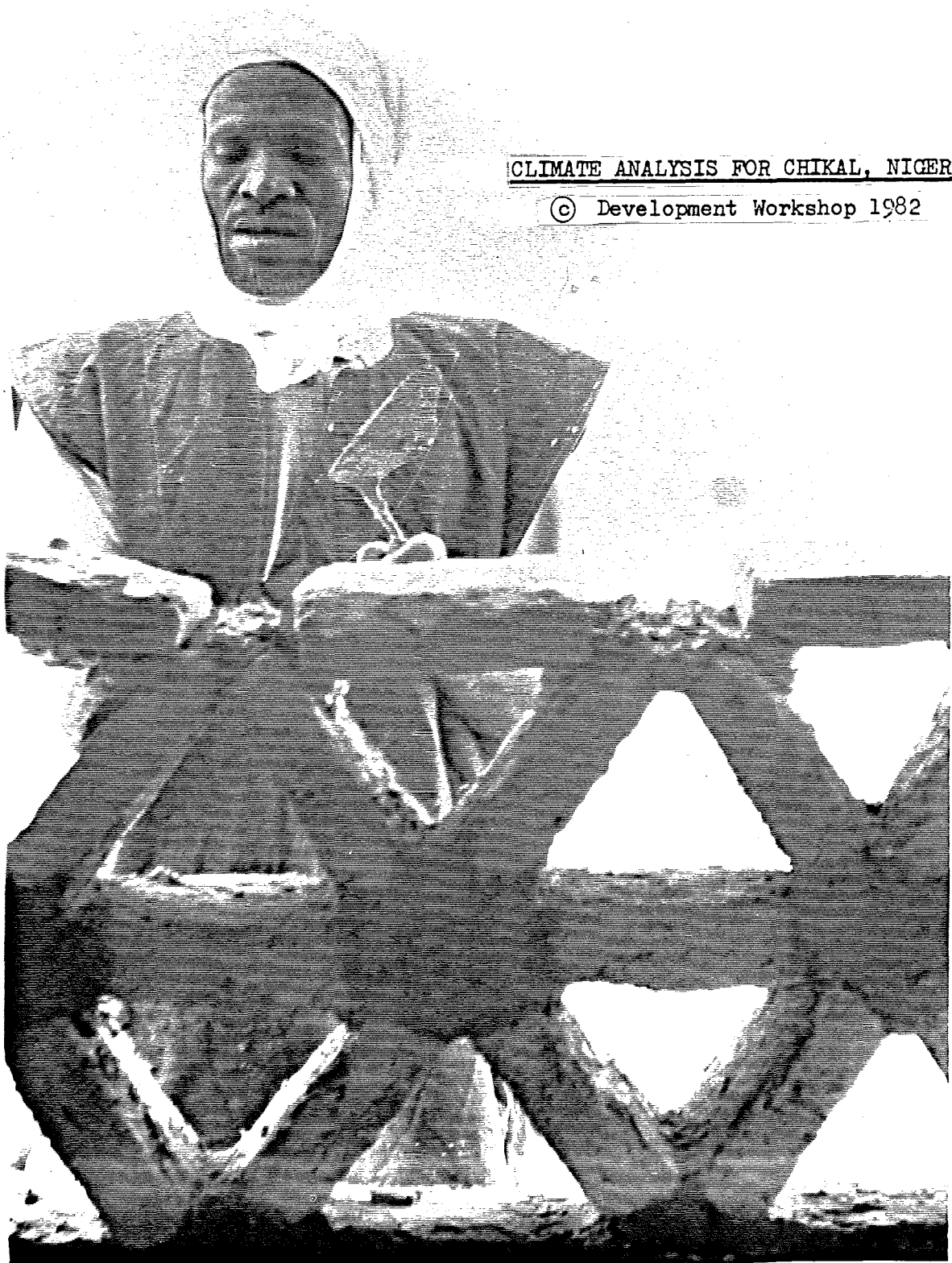


Development Workshop

on Building & Planning in the Third World

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CLIMATE ANALYSIS FOR CHIKAL, NIGER

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Canadian Federal Incorporation Number 123277

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CLIMATE ANALYSIS FOR CHIKAL, NIGER

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CLIMATIC ANALYSIS

The base data for this analysis comes from, firstly, the meteorological data collected at Chikal, which unfortunately was somewhat incomplete since the station has not been running long enough to give good averages.

We have therefore taken the data for Tahoua and Niamey *¹ and looked at how these compare with each other and with the Chikal data. Niamey's micro climate is affected by the proximity of the Niger River and associated vegetation, which raises the humidity levels. There is on average a higher annual rainfall in Niamey than Tahoua, to be expected since the overall precipitation decreases from SSW to NNE (fig. 'a').

However, the analysis of both stations produces similar characteristics.

The figures given here for Chikal are thus a combination of:

- a. local data, confirmed and completed by
- b. an extrapolated climate profile using Niamey and Tahoua data.

You will see that the molcator totals (which are one way of identifying climate design parameters) shown here at the bottom of the Niamey and Tahoua data analysis sheets (charts 9 and 10) are actually very similar to those of the Chikal analysis (chart 2).

The documents we have included are:

Chart 1. The basic climatic data histogram.

A combination of the dry bulb temperature and the relative humidity and air movement give the effective temperature - ie the temperature which the human body experiences. This is shown graphically in the mid column, and overlaid on it, are the upper and lower limits within which a person wearing ordinary clothing will feel comfortable. This comfort zone is calculated using the specific characteristics of the station.

It is easy to see which months are critically hot.

Chart 2

A numerical analysis using the Mahoney system. *²

Chart 3

For simplicity we have taken all the main design characteristics that need to be followed in order to have a comfortable environment

and presented them graphically. It is meant to serve simply as a guide.

Chart 4

In order to calculate shading requirements it is necessary to know at what times of day for any period of the year the effective temperature will be too high for comfort.

This page produces a two hourly breakdown of effective temperatures by month for Chikal.

Charts 5 and 6

These are sunpath diagrams. Each one is for six months. The data from the previous page allows one to plot hourly effective temperature in relation to the exact position of the sun in the sky for any given daytime moment. With the use of a shadow angle protractor shading angles can be calculated which will exclude solar radiation during those times when it is undesirable.

Because surface temperature rises faster than air temperature, direct solar radiation is excluded from the time that temperatures enter the lower end of the comfort zone. On the other hand, the intensity of radiation decreases as the sun gets lower in the sky and in calculating the shading angles for each respective orientation, the lower solar radiation intensity of the late afternoon period has been taken into account.

Chart 7

This chart shows recommended optimum horizontal and vertical shading angles with explanatory notes.

Chart 8

Shows you some ways of interpreting the shading angles in physical design terms. Because it is in fact possible to design for extremely accurate shading if one wishes, the suggestions given here are a few of the more obvious solutions.

1. Niamey and Tahoua meteorological data from periods 31 - 40, 49 - 55. Dakar, Service Meteorologique de l'Afrique Occidentale Francaise Meteorological Office tables of temperature, relative humidity and precipitation for the world, Part IV, HMSO, London.

2. C Mahoney. 'Climate and House Design'. UNCHBP, New York.

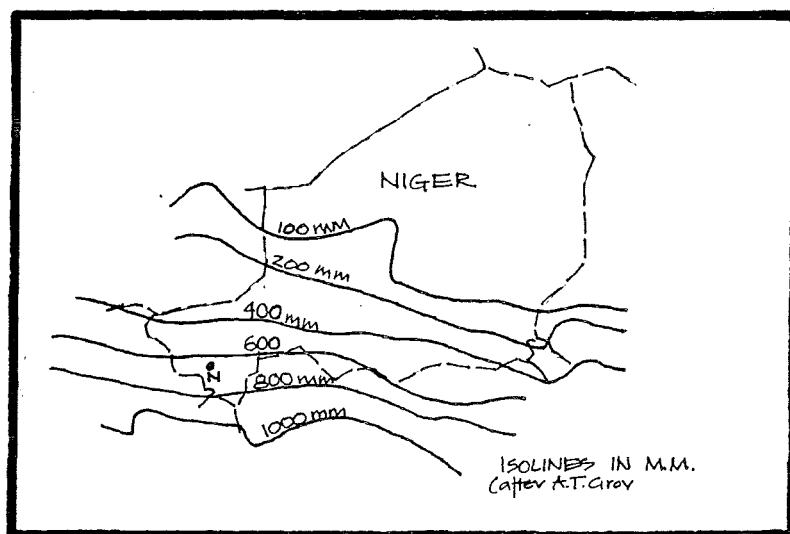
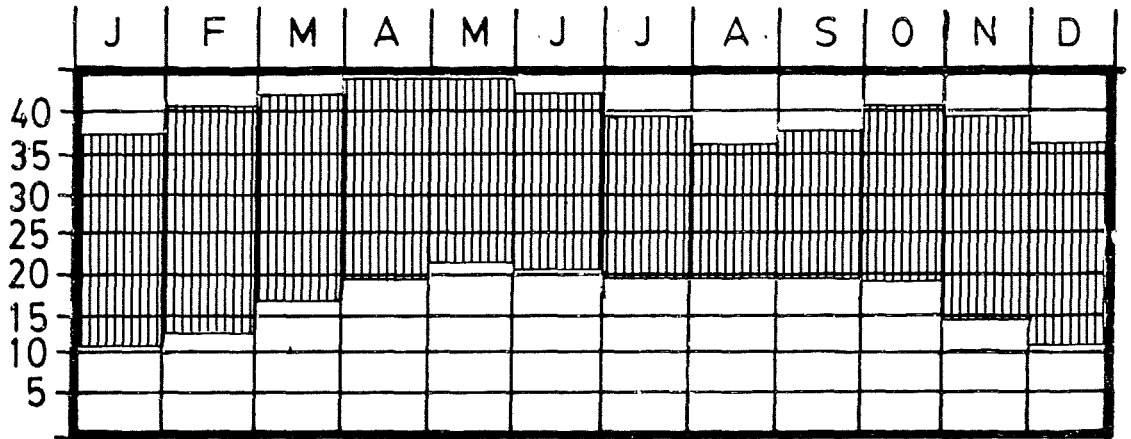


Fig. 'a' Precipitation in Niger.

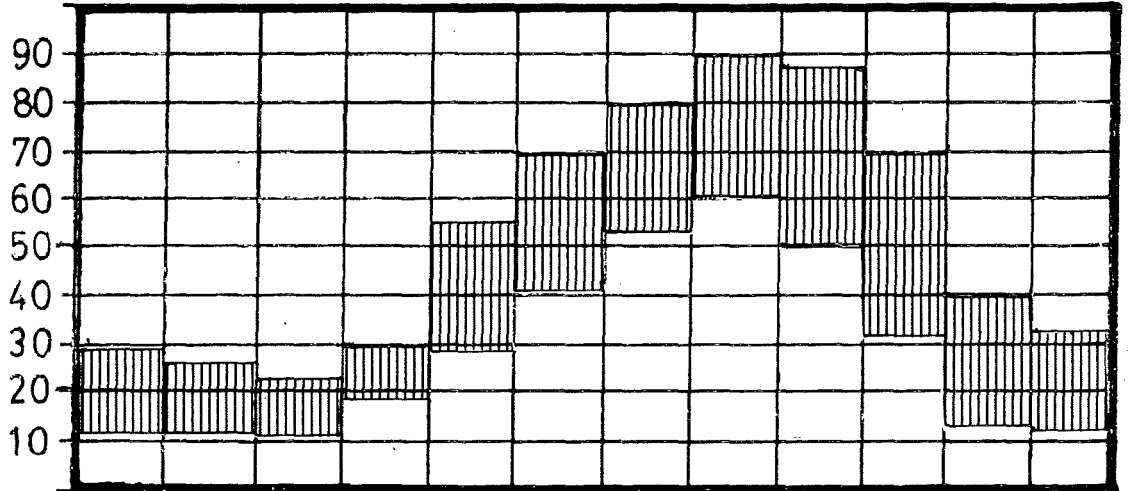
CHIKAL

Chart 1

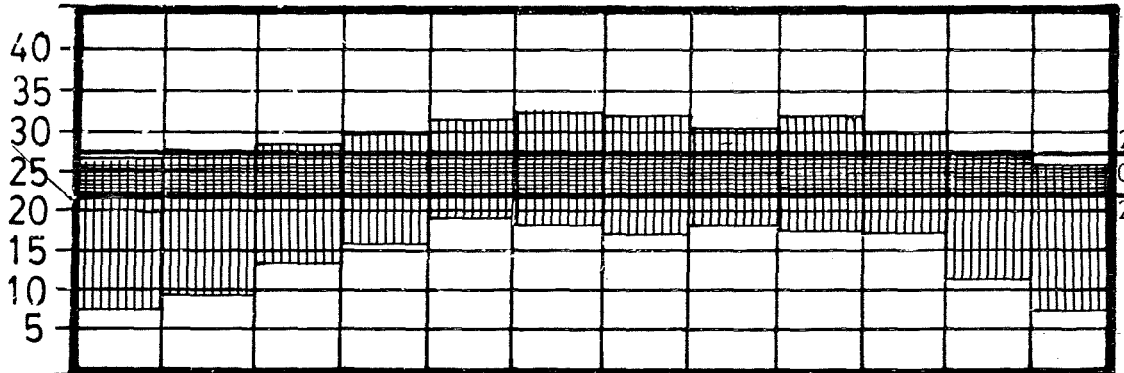
TEMPERATURE °C



RELATIVE HUMIDITY %

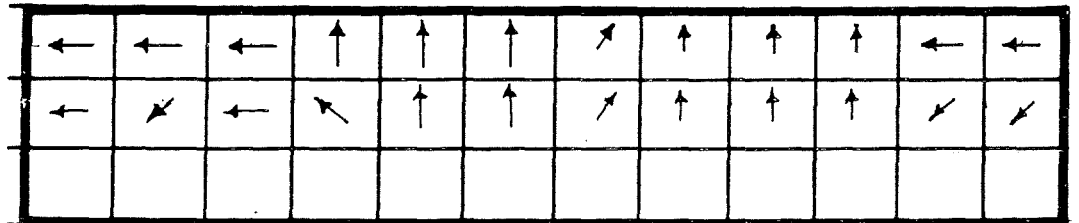


EFFECTIVE TEMP.



27°CET
COMFORT
21.5°CET

WIND



RAIN

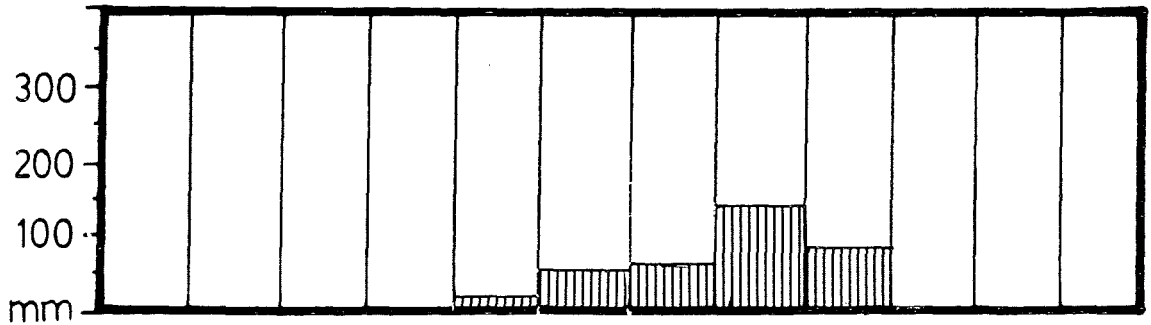


Chart 2

Location: CHIKAL		
Longitude	Latitude	Altitude

Air temperature °C	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max.	38	40	42	44	44	42	39	36	38	40	39	36
Monthly mean min.	10	12	17	19	21	20	19	19	19	19	14	10
Mean range	28	28	25	25	23	22	20	17	19	21	25	26

high AMT
44 27
low AMR
10 34

Relative humidity %	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. a.m.	29	26	22	30	55	70	80	90	87	70	40	32
Mean min. p.m.	12	12	11	18	28	41	53	60	50	32	14	13
Average	20.5	19	16.5	24	41.5	55.5	66.5	75	68.5	51	27	22.5
Humidity group	1	1	1	1	2	3	3	4	3	3	1	1

Rainfall mm	-	-	-	-	12	44	55	131	73	-	-	-
-------------	---	---	---	---	----	----	----	-----	----	---	---	---

315 total

Wind, prevailing	E	E	E	S	S	S	SW	S	S	S	E	E
Time												
Wind, secondary		NE		SE						SE	N	NE
Time												

BASE CLIMATIC DATA

Diagnosis: °C	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. temp.	38	40	42	44	44	42	39	36	38	40	39	36
Day comfort; max	34	34	34	34	31	29	29	27	29	29	34	34
min	26	26	26	26	25	23	23	22	23	23	26	26
Mean min. temp.	10	12	17	19	21	20	19	19	19	19	14	10
Night comfort max	25	25	25	25	24	23	23	21	23	23	25	25
min	17	17	17	17	17	17	17	17	17	17	17	17
Thermal stress; day	H	H	H	H	H	H	H	H	H	H	H	H
night	C	C	O	O	O	O	O	O	O	O	C	C

DIAGNOSIS

Humid: H1								✓				
H2												
H3												
Arid A1	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
A2			✓	✓	✓							
A3												

1 total
0
0
11
3
0

INDICATORS

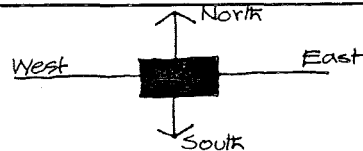
CLIMATIC DESIGN RECOMMENDATIONS

Location: CHIKAL			
Longitude	E	Latitude	N.
Altitude			

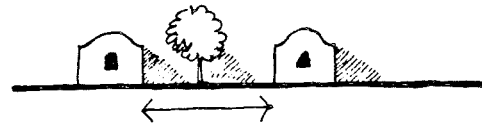
NOTE: Variations will be necessary according to detailed micro-climate conditions and must be taken into account.

Specification

Building should orientate towards north and south, with minimal wall area towards east and west.



Distance between buildings can be small, and shaded areas should be maximised. Large open spaces heat up more and are dustier, so should be avoided.



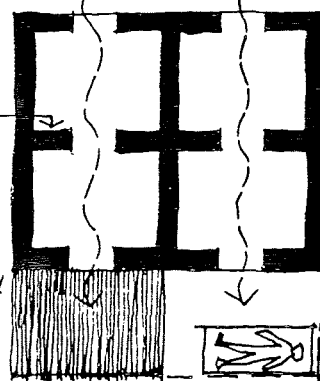
Can have double rows of rooms but allow for temporary provision of cross-ventilation during humid season. Openings in internal as well as external walls

Walls should be of massive construction to provide at least 8 hour time lag for delayed heat transfer to interior.

Provide outdoor shaded area

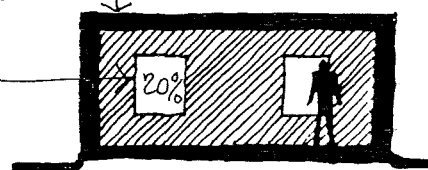
Small shaded courtyards also valuable for conserving cool nighttime air during day.

cross ventilation



Roof should be heavy with 8 hour time lag for delayed heat transfer to interior.

Windows small, about 20% of wall area at maximum.

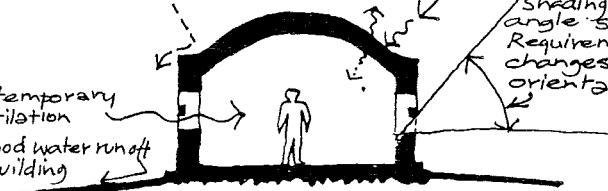


Ensure good rainwater run off from building

allow temporary cross ventilation
allow good water runoff from building

Root to provide slow heat transfer rate

Shading essential. For the angle see 'Shading Requirements' Page. Angle changes according to orientation.



Location: CHIKAL		
Longitude	Latitude	Altitude

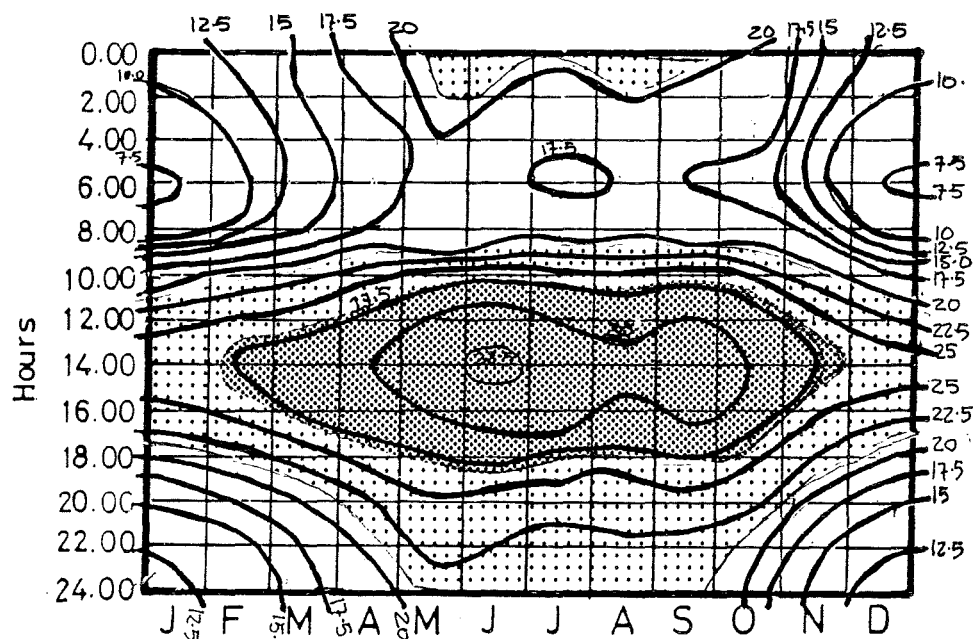
BASE DATA

	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. DBT °C	38	40	42	44	44	42	39	36	38	40	39	36
R.H. p.m. %	12	12	11	18	28	41	53	60	50	32	14	13
WBT °C	18	19.5	20.5	24	27	29.5	30	29	31	26	20	17.5
ET max °C	26.5	27.5	28.5	30	31.5	32.5	32	30.5	32	30	27.5	26
Mean min DBT °C	10	12	17	19	21	20	19	19	19	19	14	10
R.H. a.m. %	29	26	22	30	55	70	80	90	87	70	40	32
WBT °C	3.5	5	7.5	10.5	15.5	16.5	16.5	18	17.5	15.5	7.5	4.0
ET min °C	7.5	9.5	13.5	16	19	18	17	18	17.5	17	11	7.5

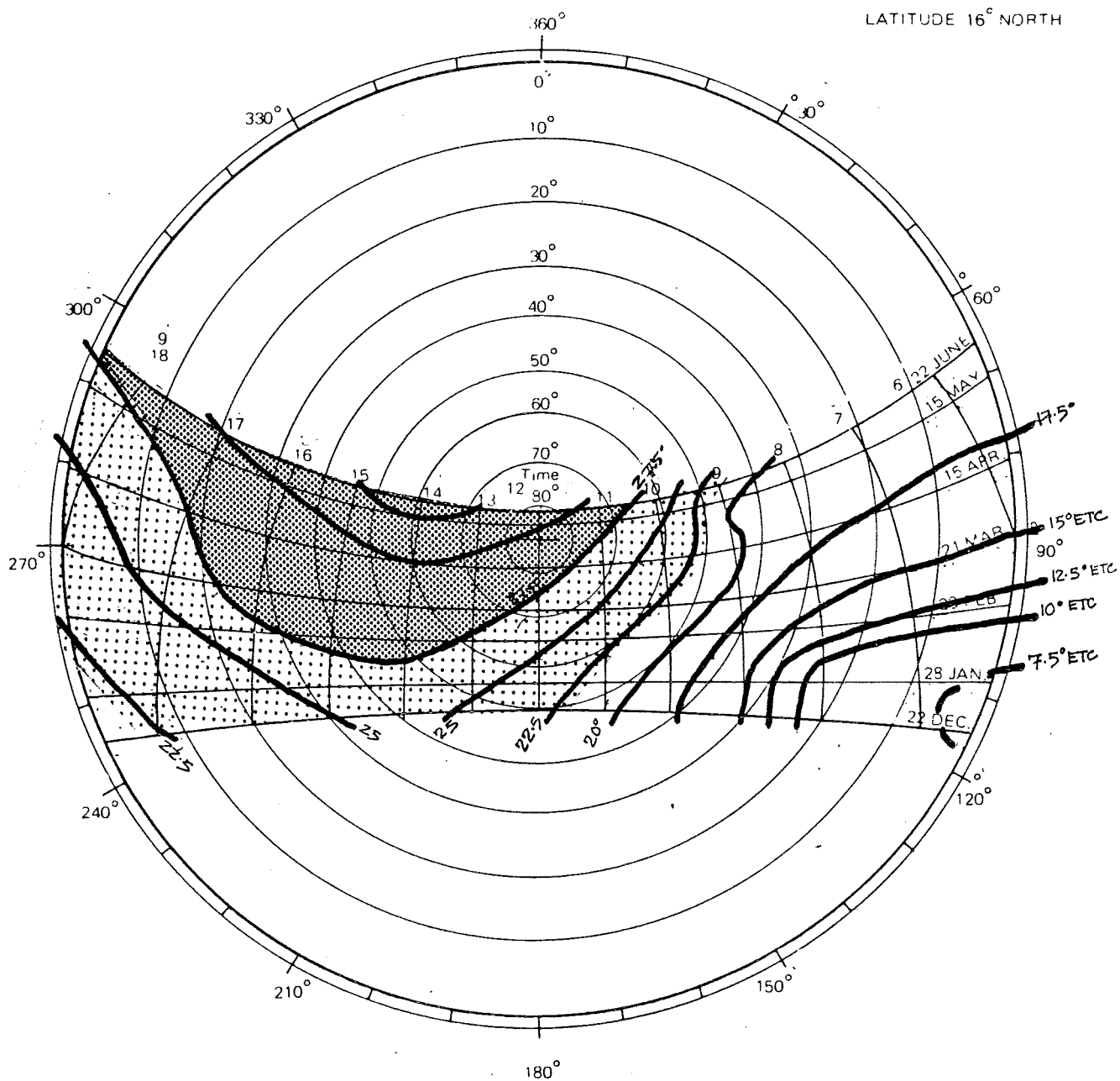
HOURLY EFFECTIVE TEMPS.

Hours	J	F	M	A	M	J	J	A	S	O	N	D
0.00	11.5	13.5	16.5	19	21.5	21	20.5	21	20.5	20	15	11.5
2.00	10	12	15.5	18	21	20	19	20	19.5	19	13.5	10.0
4.00	8.5	10.5	14.0	17	20	19	18	19	18.5	18	12	8.5
6.00	7.5	9.5	13.5	16	19	18	17	18	17.5	17	11	7.5
8.00	9	11	15	17.5	20.5	19.5	18.5	19.5	19	18.5	13	9
10.00	18.5	20	22	24	26	26.5	26	25.5	26	24.5	21	18
12.00	23.5	25	26.5	28	30	30.5	30	29	30	28	25	23
14.00	26.5	27.5	28.5	30	31.5	32.5	32	30.5	32	30	27.5	26
16.00	25	26	27.5	29	30.5	31.5	31	29.5	31	29	26	24.5
18.00	20.5	22	24	25.5	27.5	28	27	26.5	27.5	26	22.5	20
20.00	16.5	17	20	22	24.5	24	23.5	23.5	23.5	23	18	15.5
22.00	13	15	18	20.5	23	22.5	21.5	22	22	21	16.5	13.5

E.T. ISOPLETH.



LATITUDE 16° NORTH

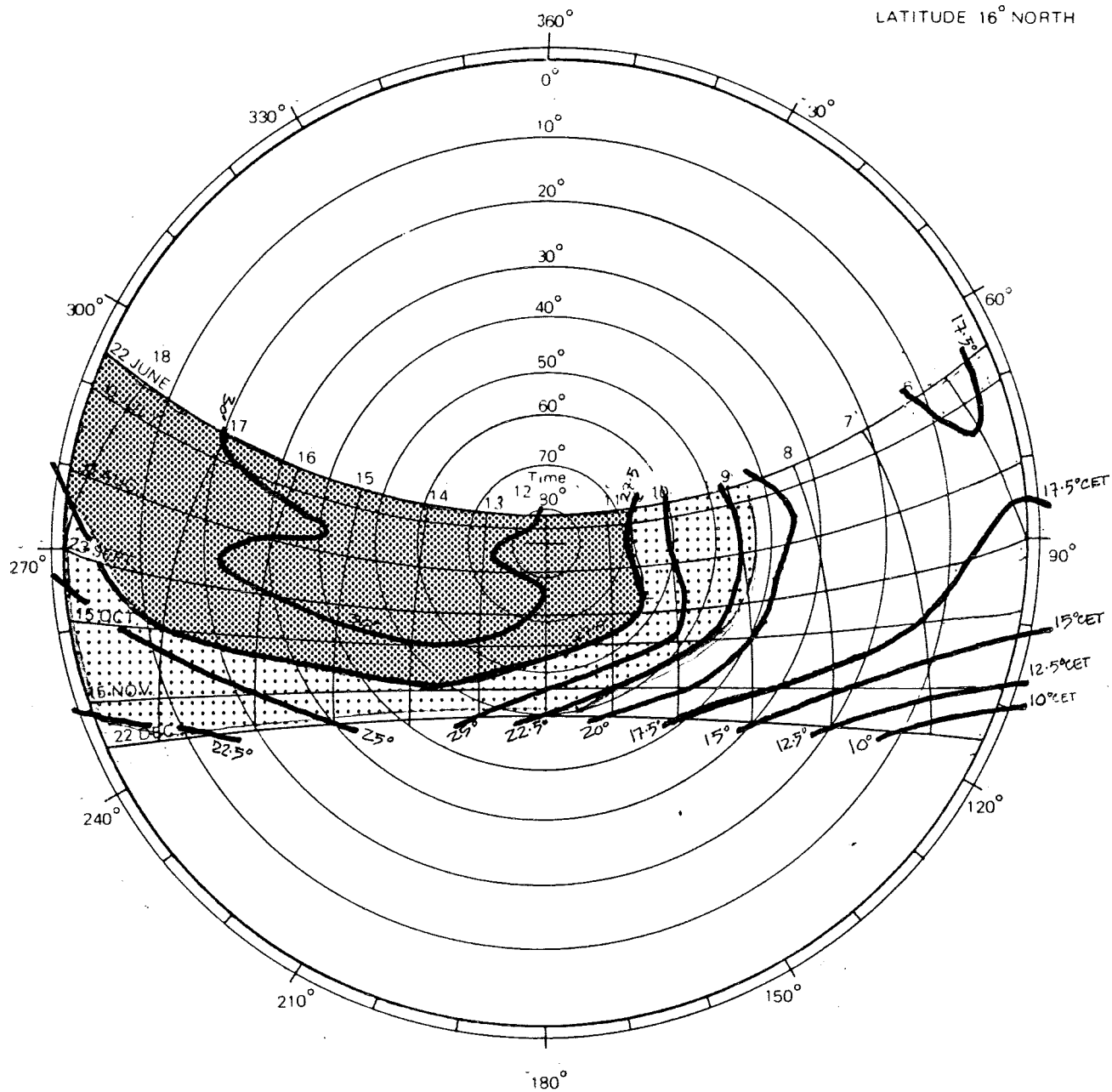


SUN PATH DIAGRAM

CHIKAL

January - June period.

- Effective temp. below comfort zone.
- Effective temp. within comfort zone.
- Effective temp. too hot



SUN PATH DIAGRAM

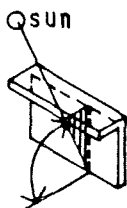
CHIKAL

July - December period.

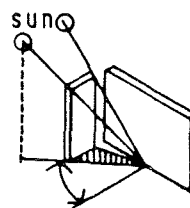
- Effective temp. below comfort zone.
- Effective temp. within comfort zone.
- Effective temp. too hot

SHADING REQUIREMENTS.

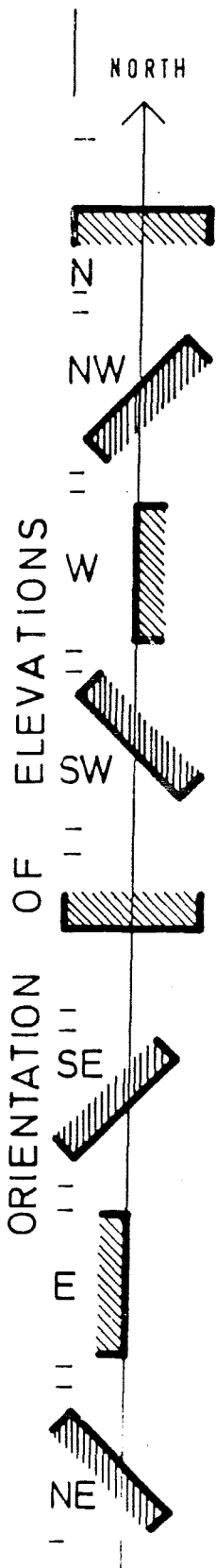
Location: <i>CHIKAL</i>		
Longitude	Latitude	Altitude



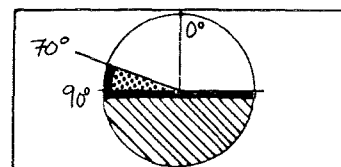
VERTICAL ANGLES.



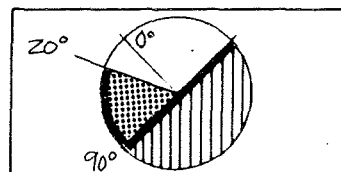
HORIZONTAL ANGLES.



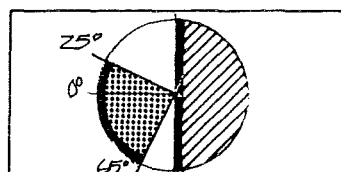
Shading required from 9am onwards, provided by vertical angle. After 15.00hrs horizontal 70° angle important for keeping interior comfortable.



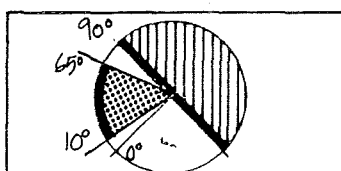
Use combination of vertical and horizontal shading angles. Horizontal angle, critical in achieving comfortable shaded conditions -



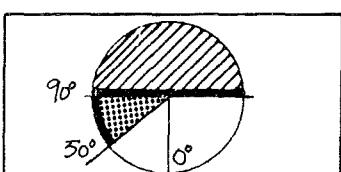
100% shade needed. If openings required for ventilation, should be completely screened from direct sunlight. 70° vertical with horizontal angles shown would give total cover.



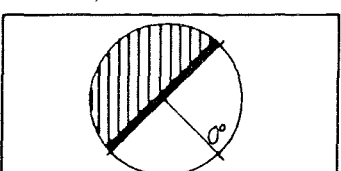
25° vertical angle provides protection up to 16.00 hrs (18.00 in July) but late afternoon sun still undesirable in hot season. Use horizontal angles.



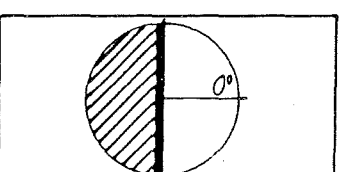
Vertical angle gives good general protection. But for late afternoon use horizontal as well. To achieve shade. Not critical.



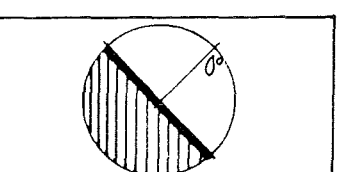
The vertical angle, provides ample shading up to 9am direct sunlight acceptable even at hottest time of year



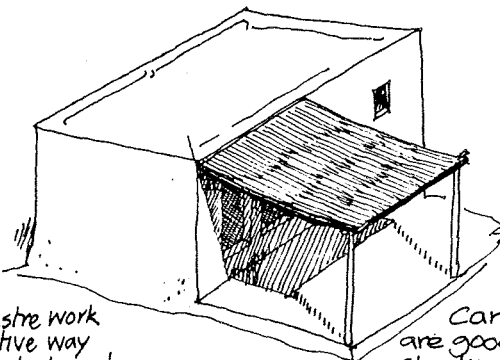
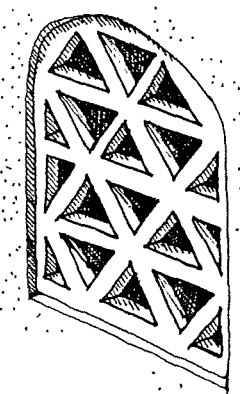
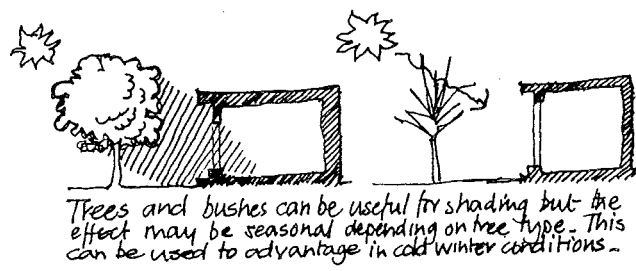
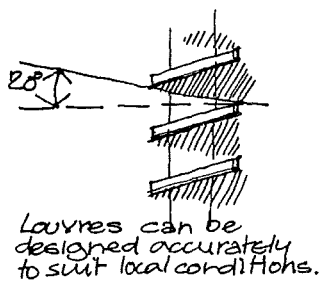
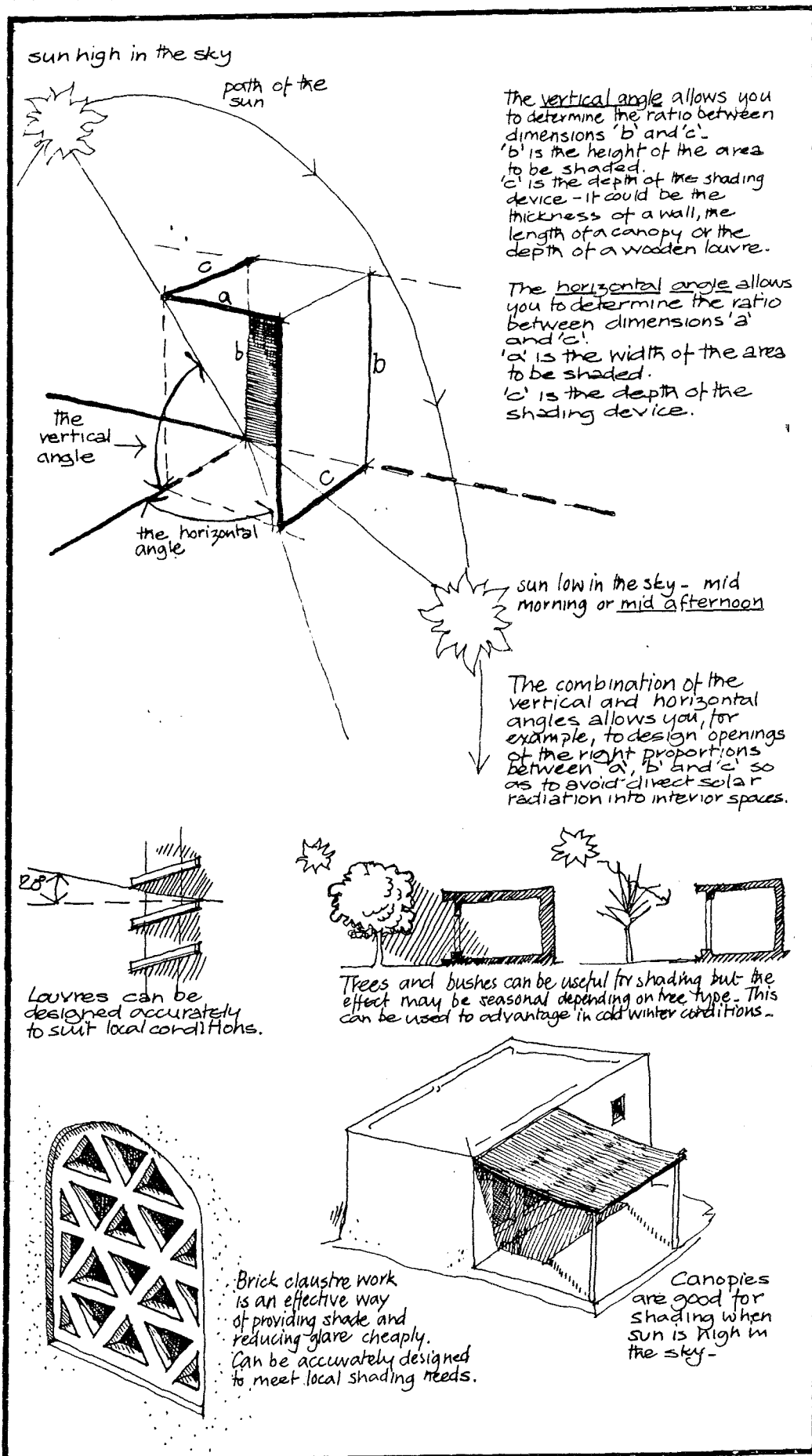
The vertical angle is sufficient. Shading before 9am not required. Horizontal angle not needed.



50° gives shade in latter part of morning but lets in early morning sunlight, when temperatures are lower.



WAYS OF INTERPRETING SHADING ANGLES



Location: TAHOMA		
Longitude 5°15' E	Latitude 14°54' N	Altitude 482.6 metres

Air temperature °C	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max.	37.5	39.5	42.0	44	44	42	39.5	36	38.5	40.0	38.5	35.0
Monthly mean min.	10.5	12	17.5	20.0	21.5	20.5	19.5	19.5	19.5	18.5	15.0	10.5
Mean range	27	27.5	24.5	24	22.5	21.5	20	16.5	19	21.5	23.5	20.5

high AMT
44 27.25
10.5 33.5
low AMR

Relative humidity %	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. a.m.	27	24	19	23	50	66	80	89	86	61	29	28
Mean min. p.m.	13	11	9	12	27	37	49	63	50	27	12	12
Average	20	17.5	14	17.5	38.5	51.5	64.5	76	68	44	20.5	20
Humidity group	1	1	1	1	2	3	3	4	3	2	1	1

BASE CLIMATIC DATA

Rainfall mm	0	0	2.5	2.5	18.0	48	109	137	50.5	18	0	0
-------------	---	---	-----	-----	------	----	-----	-----	------	----	---	---

385 total:

Wind, prevailing												
Time												
Wind, secondary												
Time												

Diagnosis: °C	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. temp.	37.5	39.5	42	44	44	42	39.5	36	38.5	40	38.5	35
Day comfort; max	34	34	34	34	31	29	29	27	29	31	34	34
min	26	26	26	26	25	23	23	22	23	25	26	26
Mean min. temp.	10.5	12	17.5	20.0	21.5	20.5	19.5	19.5	19.5	18.5	15	10.5
Night comfort max	25	25	25	25	24	23	23	21	23	24	25	25
min	17	17	17	17	17	17	17	17	17	17	17	17
Thermal stress; day	H	H	H	H	H	H	H	H	H	H	H	H
night	C	C	O	O	O	O	O	O	O	O	C	C

INDICATORS

Humid: H1								✓				
H2												
H3												
Arid A1	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
A2			✓	✓	✓					✓		
A3												

1 totals:
0
0
11
4
0

Location: NIAMEY		
Longitude 2°06' E	Latitude 13°31' N	Altitude 216 metres

Air temperature °C	J	F	M	A	M	J	J	A	S	O	N	D	high AMIT
Monthly mean max.	38.0	41.0	43.5	44.5	44.5	42.5	39.0	36.0	37.5	41.0	41.0	37.5	44.5 27.5
Monthly mean min.	10.5	13	16.5	19.5	21.0	20.5	19.5	19.5	20.0	20.0	14.5	11.0	10.5 34
Mean range	27.5	28.5	27	25	23.5	22	19.5	16.5	17.5	21	26.5	26.5	low AMIT

Relative humidity %	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. a.m.	32	28	26	37	61	74	83	91	89	78	52	39
Mean min. p.m.	12	12	11	18	35	44	56	68	60	40	17	14
Average	22	20	18.5	27.5	48	59	69.5	79.5	74.5	59	34.5	26.5
Humidity group	1	1	1	1	2	3	3	4	4	3	2	1

Rainfall mm	2.5	2.5	5	7.5	33	81	132	183	94	12.5	2.5	0	555 total
-------------	-----	-----	---	-----	----	----	-----	-----	----	------	-----	---	-----------

Wind, prevailing												
Time												
Wind, secondary												
Time												

Diagnosis: °C	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. temp.	38	41	43.5	44.5	44.5	42.5	39	36	37.5	41.0	41.0	37.5
Day comfort; max	34	34	34	34	31	29	29	27	27	29	31	34
min	26	26	26	26	25	23	23	22	22	23	25	26
Mean min. temp.	10.5	13	16.5	19.5	21.0	20.5	19.5	19.5	20	20	14.5	11.0
Night comfort max	25	25	25	25	24	23	23	21	21	23	24	25
min	17	17	17	17	17	17	17	17	17	17	17	17
Thermal stress; day	H	H	H	H	H	H	H	H	H	H	H	H
night	C	C	C	O	O	O	O	O	O	O	C	C

Humid: H1								✓	✓			
H2												
H3												
Arid A1	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
A2				✓	✓							
A3												

BASE CLIMATIC DATA

DIAGNOSIS

INDICATORS

high AMIT
44.5 27.5
low AMIT
10.5 34

555 total

2 total
0
0
10
2
0