SETTING UP SOLAR PASSIVE HOUSING DEMONSTRATION UNIT

FINAL REPORT

Submitted to:

The Department of Science & Technology (DST) Govt. of India,
Technology Bhavan, New Mehrauli Road,
New Delhi - 110016

Submitted by:

MANIPUR SCIENCE & TECHNOLOGY COUNCIL
CENTRAL JAIL ROAD, IMPHAL-795001
Phone: 2230037, 2443451; e-mail: mastec@sancharnet.in

SETTING UP SOLAR PASSIVE HOUSING DEMONSTRATION UNIT

Project Title & DST No.: Setting up Solar Passive Housing Demonstration Unit.
No.DST/Manipur S&T/98-SPH dated 7/7/98.

Principal Investigator : Executive Director, Manipur Science & Technology Council, Central Jail Road, Imphal-795001.

Broad Area : Technology Demonstration

Specific area : Technology Demonstration and Popularisation of Passive Solar Architecture and Building Technologies

Objectives:

The objectives for the construction of the proposed MASTEC office building in Imphal are to demonstrate the following concepts of energy efficient buildings in the north eastern region of India.

1. Passive solar technologies (orientation, shading, earth-berming, intelligent seasonal control of solar gain and losses by building form, use of appropriate building materials, micro-climate modifications, day lighting etc.) to be used in the building to reduce thermal loads and to increase the levels of comfort for the occupants.

2. RETs suitable for buildings (solar air and water heating, solar lighting, solar cooking etc.) and their integration in the building design to reduce constructional and operational costs.

3. Optimization of energy savings in the building energy consumption by exploring the potential of daylight integration.

4. Importance of planning and design analyses prior to actual construction of a building.

Project Details:

The buildings, as they are designed today, contribute significantly to serious environmental problems in the country because of excessive consumption of energy by them. The close connection between the energy use in buildings and environmental damage arises because we still look to energy – intensive solutions to meet our demands of heating, cooling and lighting in buildings. Passive solar architecture and building technology is an emerging discipline of studies which promises 40% relief to electrical load requirements of government and private buildings. Therefore, it is imperative to cause a widespread application of Solar Passive building technologies particularly in the energy deficient areas like Manipur.

The widespread use of passive solar technologies and integration of renewable energy systems in buildings requires awareness at all levels. The lack of awareness about these concepts in the north – eastern regions of India is proved by the fact that not a single building constructed during the last two decades exhibits the energy efficiency measures or the concepts of passive solar architecture. Therefore, there is an urgent need to make people aware, at all levels, of the fact that buildings can be made more comfortable and energy efficient by using the available passive solar and other renewable energy technologies (RETs). The use of demo-buildings is considered the most effective method of causing awareness.

Both the Ministry of Science & Technology (DST), Govt. of India and Ministry of Non-Conventional Energy Sources (MNES), Govt. of India have specific schemes for propagating the Solar Passive Building Architecture and Technologies. The assistance from these Ministries include awareness campaigns, training workshops, DPR development fees, consultancy tie ups, demo-buildings and subsidy financing etc.

Since the **Solar Passive Demo Building** was projected as the office building of MASTEC, this would give the following advantages:

1. Constructing a usable building would have more demonstrability than constructing just a test building using Solar Passive technology.

2. The constant use of the Demo building as office building will facilitate the performance monitoring in a realistic way.

The proposal was submitted to the Dept. of Science & Technology, Govt. of India for construction of a Solar Passive Demo-building at a project cost of Rs. 29.00 lakhs during March 1998.

DST, GOI accepted our proposal. However, sanctioned a sum of Rs. 6.00 lakhs during 1998-99 for setting up a passive solar demonstration housing unit at Imphal.

Duration	: 2 (two) years.
Date of start	: August 1, 1998.
Date of Completion	: Extended upto 31st March 2003 (as per the recommendation of the Group Monitoring Meeting held on 7/5/2002 at New Delhi.

Methodology

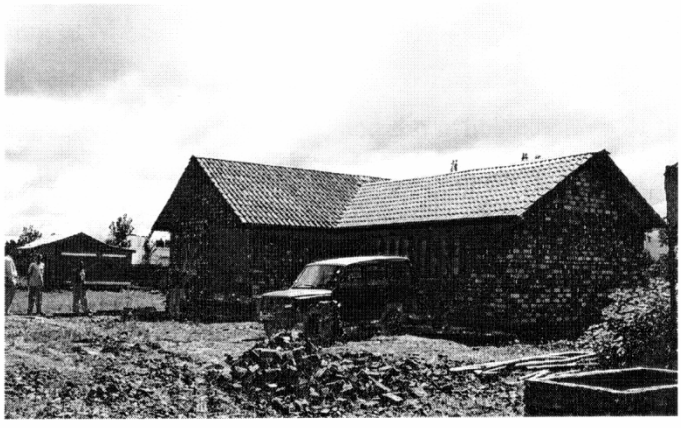
1. Preparation of Detailed Project Report (DPR)
2. Construction of proposed building
3. Monitoring and evaluation

Summary of Progress

MASTEC started the Solar Passive programmes by organising 2 (two) workshops on Solar Passive Building Technology during February 1999 and June 2000 at Imphal for building engineers, designers, architects etc. for creating awareness about passive solar technologies, integration of RETs, planning and design. Both the workshops were sponsored by MNES, GOI.

MASTEC engaged Tata Energy Research Institute (TERI), New Delhi for preparation of DPR and TERI had prepared DPR.

MASTEC consulted the local architect who involved at the preparation of architectural and structural drawings of the existing DPR and trained at TERI New Delhi for construction of a building of about 1983 sq. ft. based on the DPR. The architect accordingly prepared drawing of a solar passive building in two phases of 1128 sq. ft.(Phase –I) and 855 sq. ft. (Phase –II). MASTEC had given order to a local firm M/S Imphal West Building (a firm recognized by HUDCO) for construction of the demo building on turnkey basis during the 1st week of January 2003. The construction of the building (phase – I) with the available funds under the project had been completed (photograph enclosed).



MASTEC Solar Passive Building: Side View

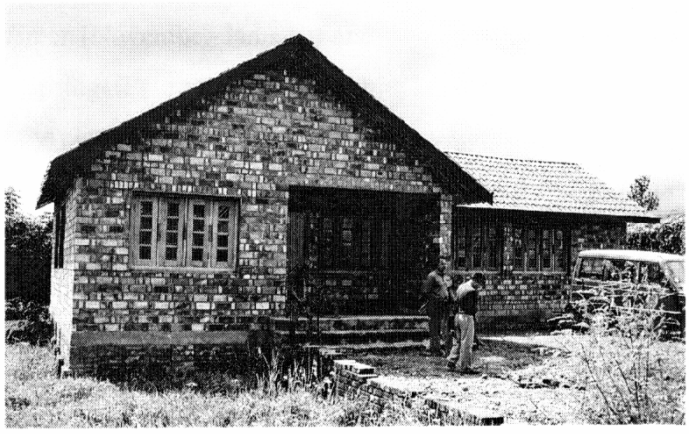
Replication Potential

The existing buildings in the state suffer serious problems

from heating, cooling, lighting effects. The solar passive becomes a successful building technology in Himachal Pradesh. MASTEC building is a demonstration building and after its successful commissioning the technology can be replicated in the state and NE states.

Works remains to be done

i) Installation of RETs such as SPV systems and Solar Hot Water systems etc.
ii) Commissioning of the building and evaluation.



MASTEC Solar Passive Building: Front View

Expected Benefits

1. Live demonstration of the Solar Passive technology at work for replication in Manipur and other NE states.
2. Substantial energy solution to Manipur through widespread replication of the demo building.
3. Better living environs in cities, towns and villages in the region given by the higher aesthetic values of Solar Passive building.

Anticipated Follow ups.

a) to launch research on the utilisation of locally available building materials in solar passive buildings/energy efficient buildings.
b) to prescribe building designs for schools, hospitals, office etc. using solar passive technologies in the state.

MASTEC office building

The site for the office building of MASTEC is located at Takyelpat, which is about 4 kms. away from the central Imphal city. It is surrounded by the office complex of State Academy of Training on the south, paddy fields on the west, and the office complex of the Sports Authority of India(SAI) on the east. With the lush green Langol Hills at the back drops, the site offers a picturesque view.

Climate

From the solar point of view, understanding the environment requires a working knowledge of the site's climate, which can be defined in terms of the following parameters:

- Temperature
- Humidity
- Wind speed and direction
- Precipitation
- Solar radiation
- Degree-day

The climate of Imphal is characterized by three main seasons- Summer (May-June), Monsoon (July-September), and Winter (November-January) and two secondary seasons of Autumn (October-November) and Spring (February-April). Table 1 listing the important weather parameters give an ideal of the climate and the following observations can be made.

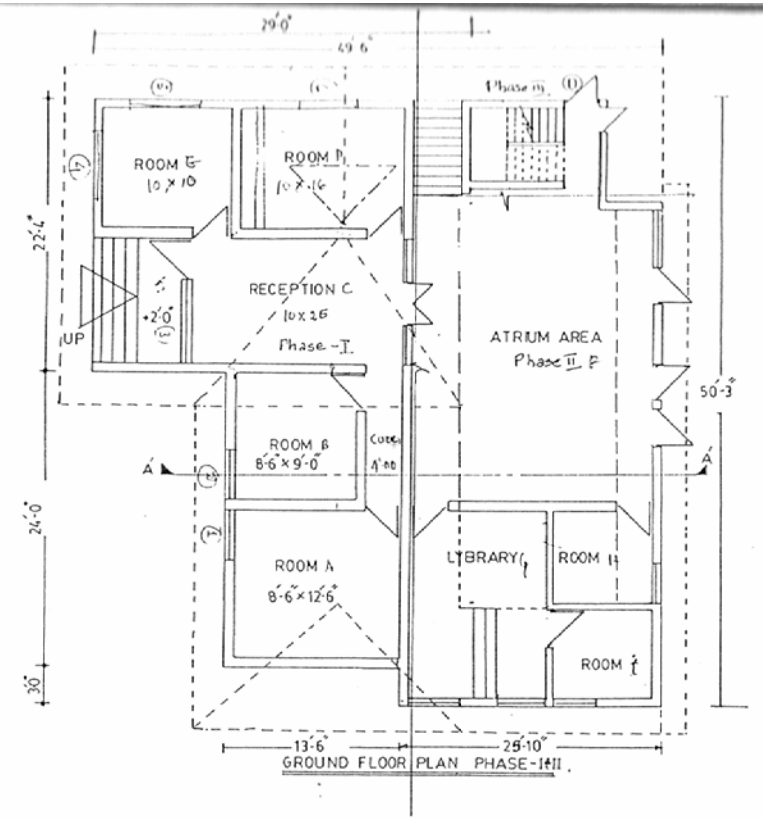
1. Monthly average temperature does not exceed 26^0 C during the year, but monthly average of daily maxima remains close to 30^0 C from June to September. Low temperatures are found during the winter months of December and January.
2. Relative humidity is generally high in the morning throughout the year, while is low (about 50%) during the afternoons (when temperature is maximum, and lowest values are found during winter).
3. Moderate wind spreads of about 1 m/s prevail during 6 months (March – August), but remain low for the rest of the year. Wind direction seems to be following definite patterns from January to December (prevailing direction is mostly east).
4. Imphal receives good amount of sunshine throughout the year, and daily solar radiation remains fairly uniform at about 15 MJ/m^2.

The basic responses to a given climate and the site characteristics lead to orientation, building form, design and fenestration sizing and placement. The air movement caused by the uneven heating/cooling of the building or by the outdoor prevailing winds can be predicted in the designed space, using standard techniques and manipulated to create comfortable indoor environment.

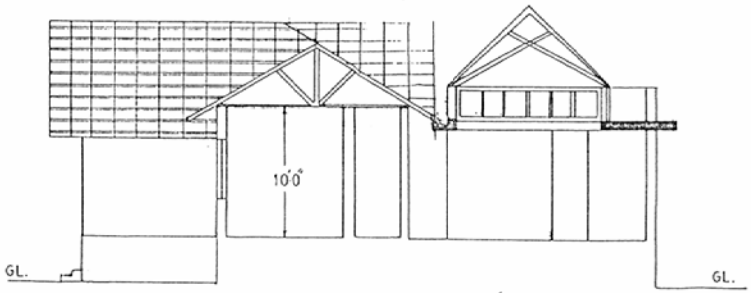
Layout Planning

The office building of MASTEC has been planned so as to segregate the public areas from the office area. The building has two entry points-one from front side(east) and the other from the side of the building (south). The building is rectangular in plan. A daylit atrium will be erected in the Phase – II construction and the space below the atrium will house about 10 staff members of MASTEC office.

The heat gain from the south is controlled by providing rattrap bond for wall construction. The west is protected by suitable landscaping, fenestration less façade and rattrap wall construction. The construction material is burnt brick for wall and Micro Concrete Roofing tiles. Locally available wood is used for doors and windows. The indoor temperature of the building remains around 26^0C whereas the outside temperature is 31-32 ^{0}C.



GROUND FLOOR PLAN PHASE-I&II.

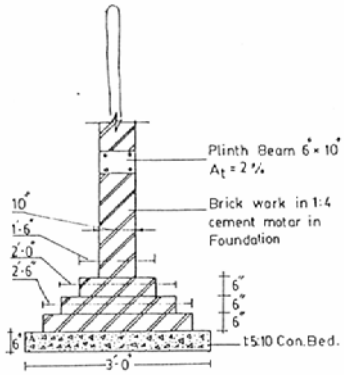


SECTIONAL ELEVATION-A A'

FOUNDATION DETAILS:- ISOLATED FOOTINGS CHANGED TO STOB FOUNDATION IN ALL SINGLE STORIED AREAS IN ORDER TO CUT COST.

WALL DETAILS :- RAT-TRAP BOND TO BE USED IN ALL SUPERSTURE WALLS. (ENERGY EFFICIENT WALL)

ROOFING :- MCR-PAN TILES IN ORDER TO CUT COST IN ROOFING



FOUNDATION DETAILS

SOLAR PASSIVE BUILDING (Phase: I-II) AT TAKYEL, IMPHAL

CLIENT: MASTEC

NOTES:

ALL DIMENSTIONS ARE IN FEET & INCHES. DIMENSTIONS TO BE READ & NOT TO BE MEASURED.

WORKING DRAWINGS

GROUND FLOOR PLAN

SCALE : 1"=8'-0"

Ar.M. BHAVANANDA

B. ARCHITECT & ASSOCIATES
ORCHID BUILDING
KWAKEITHEL THOKCHOM LEIKAI IMPHAL.

SEAL: DATE:
PLACE:

Table 1 Monthly climatic data for Imphal

Month	Dry-bulb temperature (°C)		Relative humidity (%)		Wind speed (m/s)	Wind direction (Degrees, North-0°)		Cloud amount (Octas)	Rainfall[e] (mm)	Radiation (MJ/m²)			
	Average[a]	Maximum[b] (average)	Morning[c]	Evening[d]		Morning	Evening			Direct normal	Direct[f]	Diffuse[f]	Total
Jan	12.5	21.3	95	34	0.9	30	51	2.4	4.4	217	122	259	382
Feb	14.9	23.2	97	34	0.1	44	138	2.1	5.7	261	169	239	408
Mar	18.7	26.2	93	34	1.5	76	173	2.6	33.5	375	277	243	521
Apr	20.9	25.4	97	55	1.3	83	103	5.7	193.3	303	239	224	464
May	23.4	28.8	95	54	1.4	51	118	4.8	184.1	490	314	213	528
Jun	24.8	28.3	98	70	1.0	62	71	6.7	166.3	406	238	222	460
Jul	25.1	28.3	98	67	1.1	97	106	6.5	72.9	418	248	230	479
Aug	25.2	28.7	97	66	1.1	93	106	6.7	85.7	371	244	226	471
Sep	24.1	28.3	98	64	0.8	63	74	6.3	100.7	239	184	245	429
Oct	22.2	28.4	97	53	0.7	30	55	3.3	12.5	312	207	274	482
Nov	17.0	23.4	98	51	0.3	24	29	3.2	29	227	130	273	403
Dec	13.1	21.9	96	40	0.4	18	48	2.1	5.2	229	122	271	393

[a] Average of all hourly dry-bulb temperatures measured during the month
[b] Monthly average of daily maximum dry-bulb temperatures
[c] Monthly average of the daily mean of relative humidity during morning hours (6 am to 10 am)
[d] Monthly average of the daily mean of relative humidity during evening hours (6 p.m. to 10 p.m.)
[e] Total rainfall measured during the month
[f] On horizontal plane

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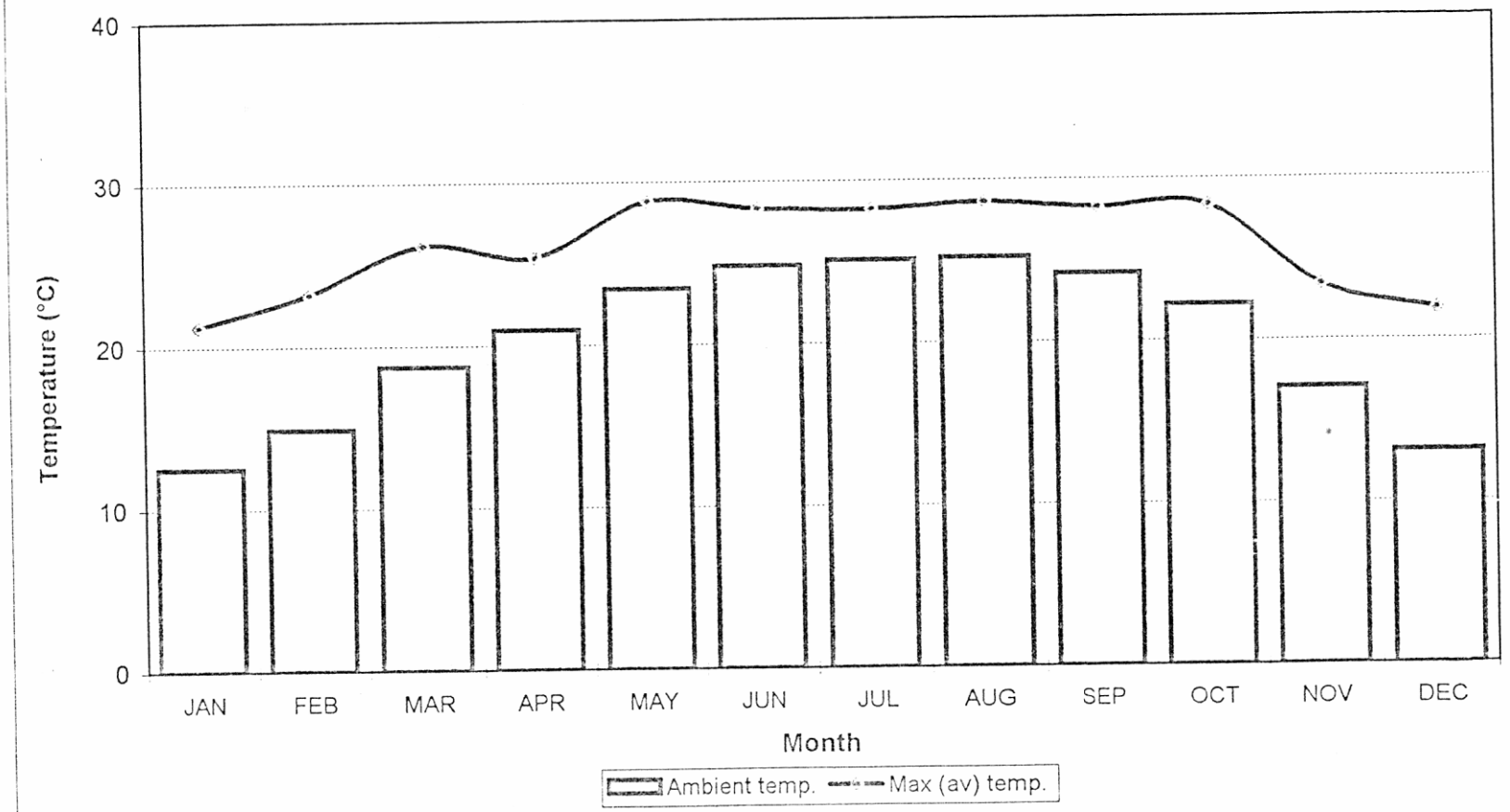
Figure 1: Dry-bulb temperature



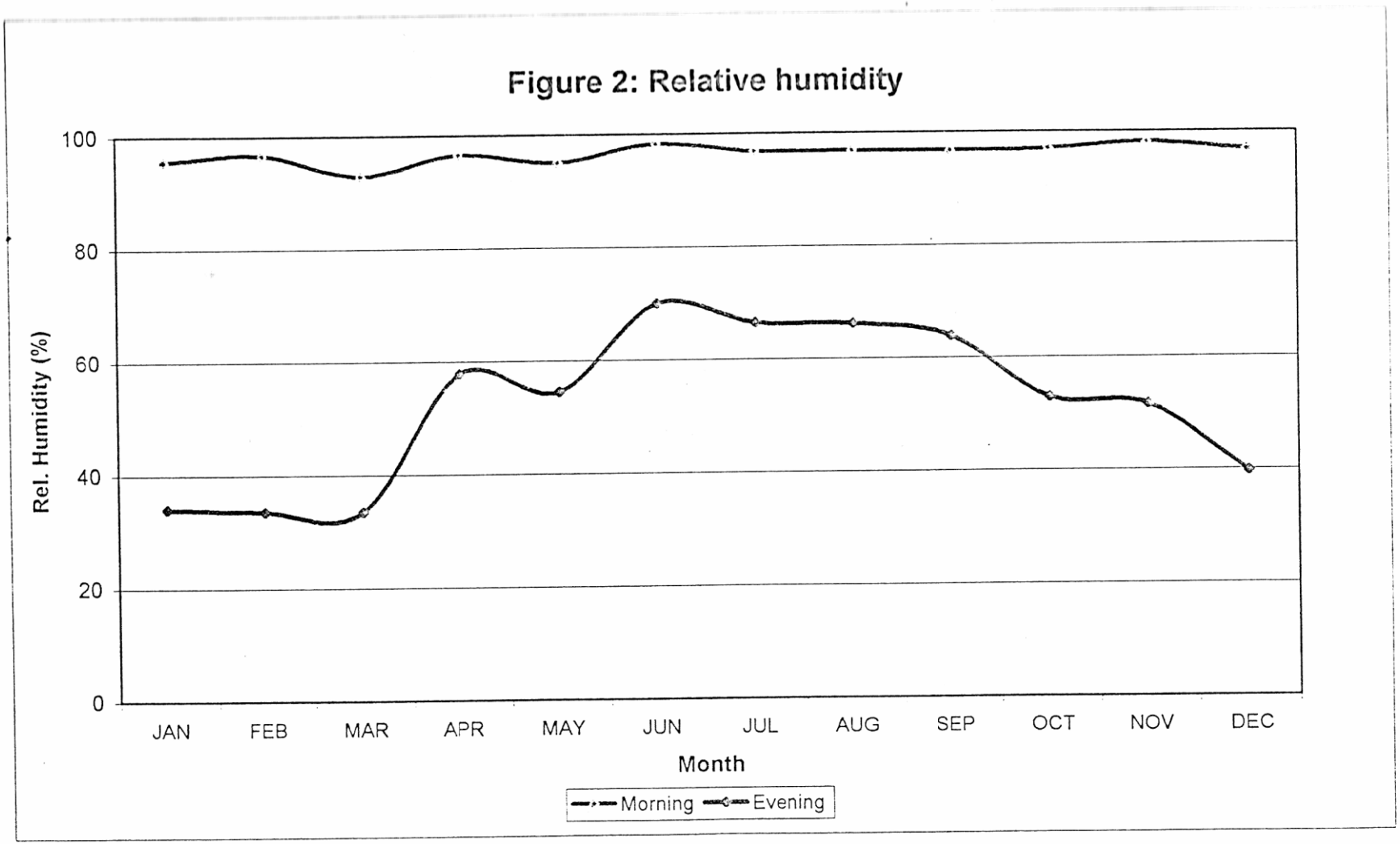


Figure 2: Relative humidity
100
80
60
40
20
0
Rel. Humidity (%)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
Morning
Evening

Figure 3: Wind speed & direction

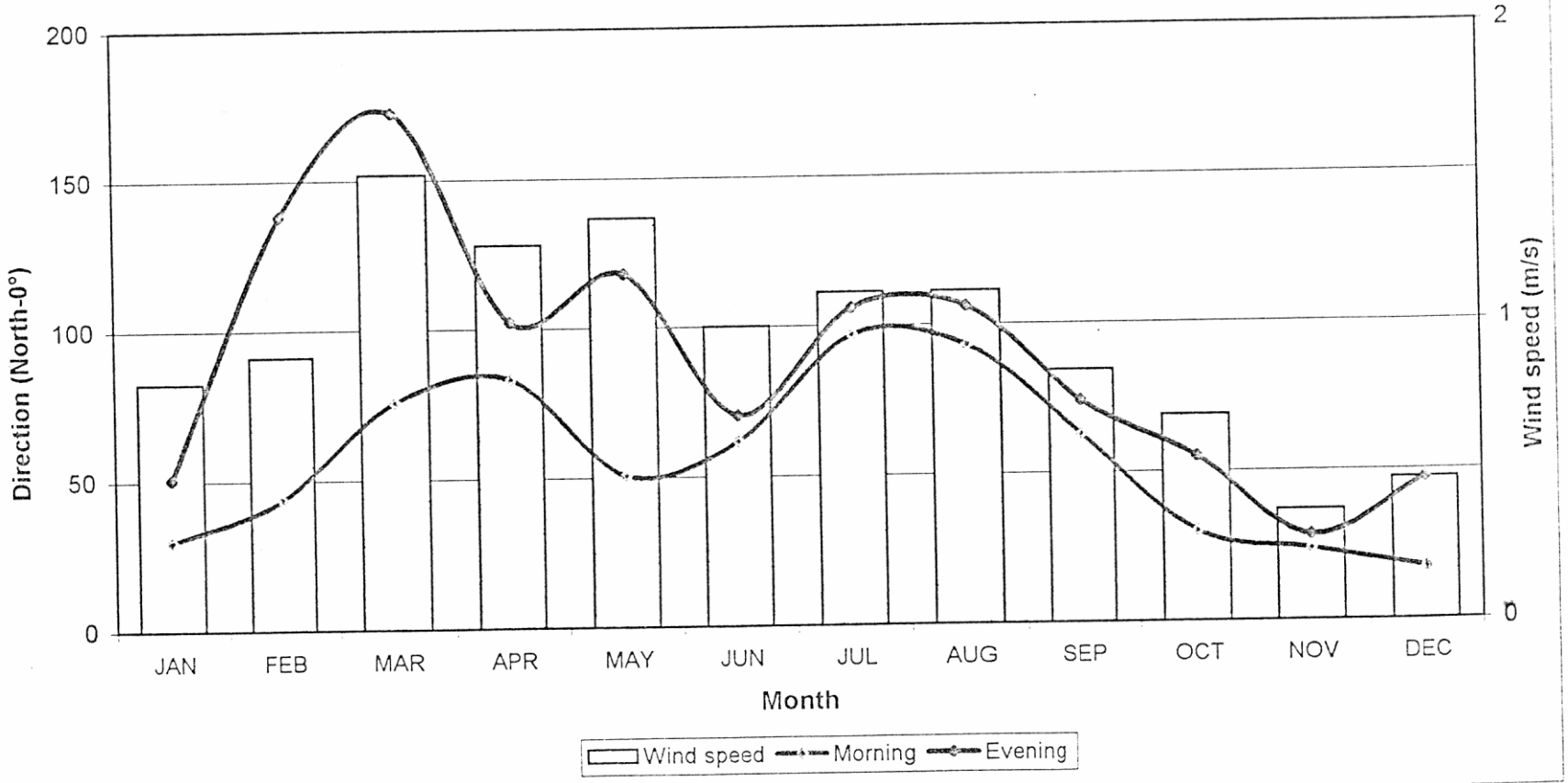


Figure 4: Solar radiation on horizontal