

STUDY OF SOLAR PASSIVE SYSTEMS IN TRADITIONAL
AND MODERN ARCHITECTURE

Project Report Submitted by

NICOS ECONOMOU
and
PANAYIOTIS PANAYIOTOU

In part satisfaction of the award of Diploma of
Technician Engineer in Civil Engineering of the
Higher Technical institute, Cyprus.

Project Supervisor : D. Sergidou
Lecturer in Civil Engineering,
H.T.I

External Assessor : Mr N. Messaritis
Architect.

Type of project : Individual

Group

June, 1985

project No.	C - 372
-------------	---------

918

A B S T R A C T

This Project deals with the passive systems used in Traditional and Modern Cypriot architecture. For this purpose a study of the human thermal comfort and the weather conditions in Cyprus was made.

Then a general study of passive systems that can be used in building to achieve the required conditions for human thermal comfort was made.

Analysis of passive systems used in Cypriot Traditional architecture was then carried out. In order to facilitate this analysis cypriot traditional houses are classified in three main categories:

- The houses built on plains
- The houses built on hills, and
- The houses built on mountains.

At last the analysis of passive systems used in modern Cypriot architecture was carried out.

C O N T E N T S

CHAPTER ONE: THERMAL CONDITIONS IN A BUILDING FOR BODIES THERMAL COMFORT.

A. <u>BODY'S THERMAL COMFORT</u>	
A.1 Forms of body's Heat Gains and Losses	1
A.1.1. Metabolic processes	1
A.1.2. Radiational and conductional convectional heat exchanges	2
A.1.3. Evaporation losses	2
A.2. Thermal Comfort Zone	3.
B. <u>CLIMATIC CONDITIONS IN A BUILDING</u>	
B.1. Heat Gains	4
B.1.1 Heat gains from the sun (production of solar energy, solar energy in- Cyprus. Radiational heat gains, convectional- conductional heat gains.)	4
B.1.2 Heat gains from other sources (occupants, lighting devices)	9
B.2 Heat Losses	10
B.2.1 Radiational heat losses	10
B.2.2 Conductional -convectional heat losses	10
B.2.3 Heat losses due to ventilation	10
C. <u>CONCLUSIONS</u>	11

CHAPTER TWO : PASSIVE SYSTEMS OF THE BUILDING FOR OBTAINING THE CONDITIONS FOR HUMAN THERMAL COMFORT

A. <u>ORIENTATION AND SHAPE OF THE BUILDING</u>	
A.1 Study of the Orientation	13
A.1.1. Study of the Sunpath	13
A.1.2. Study of the insolation on the various faces of the building round the year.	21
A.1.3 Orientation of the building for obtaining optimum solar energy in winter and min in summer.	23
A.2. Study of the shape of the building for obtaining max solar energy in winter and min in summer.	23

B. SHADING TO MINIMISE HEAT GAINS IN SUMMER

B. 1. Horizontal Overhanging.	26
B.1.2. Design of horizontal overhangings.	28
B.2. Vertical Fins	29
B.2.1. Types of vertical fins	29
B.2.2. Design of vertical fins.....	31
B.3 Movable Shading Devices.	31
B.3.1. Types of movable shading devices.	31
B.3.2. Efficiency of movable shading devices.....	35
B.4 Conclusions.	35

C. OPENINGS OF THE BUILDING.

C. 1. Study of the orientation of openings with respect to Sun..	37
C.1.1. South facing openings	37
C.1.2. East, West, North facing openings.....	37
C.1.3. Roof openings - skylights.	38
C.2 Study of the Orientation of Openings	
With respect to Wind.	39
C.2.1. wind directions in Cyprus.	39
C.2.2. Orientation of openings for optimum ventilation in summer, and min in Winter.	46
C.3. Construction Details of Openings to minimise Heat losses.	
In winter and Heat Gains In summer.	49
C.3.1 Heat gains and losses by conduction-convection	49
C.3.2 Heat gains and losses by radiation (direct heat gain)	53
C.3.3 Draught insulation	54
C.3.4 Double glazing	57

D. MATERIALS AND CONSTRUCTION OF THE BUILDING

D.1. Application of Thermal insulating materials and analysis of their properties.....	62
D.1.1 Thermal insulation to external walls.	64
D.1.2 Thermal insulation to roofs.	72
D.1.3 Thermal insulation to floors.	74
D.1.4. Analysis of the properties of insulating materials.....	77
(aerated concrete, expanded perlite.	
Glass fibre, expanded polystyrene.	
D.2 Heat storage materials.....	84
D.3 SURFACING MATERIALS	86
D.3.1. Absorbance and emittance of surfacing materials.	86
D.3.2. External surfacing materials for optimum heat gains in winter and minimum in summer.	87
D.4. Tromb wall.	88
D.4.1. Construction (mass wall, Glazing, insulating, shade,vents)	88
D.4.2. Operation	93
D.4.3. Advandages and disadvantages	96
D.5. Systems to obtain natural ventilation	97
D.5.1. Fire place	97
D.5.3. Earth pipes	99
D.5.2. Stacks and roof openings.....	98

CHAPTER THREE: ANALYSIS OF PASSIVE SYSTEMS OF CYPRIOT TRADITIONAL HOUSES.

<u>INTRODUCTION</u>	100
<u>A. ANALYSIS OF PASSIVE SYSTEMS OF TRADITIONAL HOUSES BUILT ON THE PLAINS</u>	
A.1. General.....	101
A.1.1 Type of houses built in Villages	102
A.1.2 Type of houses built in towns	105
A.2 Orientation and Shape.....	107
A.3. Openings.....	108
A.3.1 Opening of houses built in Villages (orientation, construction, opening for ventilation)	109
A.3.2 Openings of houses built in towns	110
(orientation, construction, openings for ventilation)	
A.4 Materials and construction	113
A.4.1 Construction of walls	114
A.4.2 Construction of roofs	118
A.4.3 Floor construction	120
<u>B. ANALYSIS OF PASSIVE SYSTEMS OF HOUSES BUILT ON THE HILLS</u>	
B.1. General.....	121
B.2. Orientation and shape	123
B.3. Openings (orientation, construction)	125
B.4. Materials and Construction	125
B.4.1. construction of walls	126
B.4.2. construction of roofs	128
B.4.3. construction of floors	129
<u>C. ANALYSIS OF PASSIVE SYSTEMS OF HOUSES BUILT ON THE MOUNTAINS</u>	
C.1. General	130
C.2. Orientation and shape	132
C.3. Openings (orientation, construction)	133
C.4. Materials and Construction	133
C.4.1 construction of walls	134
C.4.2. construction of roofs.....	134
C.4.3. construction of floors	136

CHAPTER FOUR ANALYSIS OF PASSIVE SYSTEMS IN MODERN CYPRIOT ARCHITECTURE

A. MRS VERA PANTELIDES' HOUSE IN YERMASOYIA

A.1. General.....	146
A.2. Orientation and Shape	147
A.3. Openings	151
A.3.1. South facing openings	151
A.3.2. East,west and North openings	153
A.3.3. Skylight	154
A.4. Materials and construction.....	156
B.4.1. Materials and construction of walls	156
B.4.2. Materials and construction of roof and floor	157
B.4.3. Construction to achieve ventilation (stack effect, fire place)....	160

B. MRS M. PATTIHIS HOUSE IN NICOSIA

B.1. General.....	165
B.2. Orientation and Shape	166
B.3. Openings	167
B.3.1. South facing openings	167
B.3.2. East-west and North facing openings	167
B.3.3. Construction of openings.....	171
B.4. Materials and Construction.....	173
B.4.1. Materials and construction of walls	173
B.4.2. Materials and construction of roofs	175
B.4.3. Materials and construction of ground floor	176
B.4.4. Techniques for ventilation.....	177

C. P. PAPADAKIS' HOUSE IN NICOSIA

C.1. General.....	180
C.2. Orientation and Shape	180
C.3. Openings	
C.3.1. South facing openings (shading, construction).....	186
C.3.2. East-West and North facing openings (shading, construction)....	187
C.4. Materials and Construction	190
C.4.1. Materials and construction of the walls	190
C.4.2. Materials and construction of the roof and floor	191
C.4.3. Constructions to achieve ventilation (fire place).....	193

D. UNIVERSAL TOWER (Nicosia)

Designed by the architect (David & Dikaios)

D.1. Orientation and Shape	194
D.2. Materials and construction.....	195
D.3. Openings	198
D.4. Techniques for ventilation	199
D.4.1. Experimental work and Air flow results	204

CONCLUSIONS 205

REFERENCES

210