

CONTENTS

	Page no.
LIST OF FIGURES	iii
LIST OF TABLES	v
LIST OF ABBREVIATIONS	vi
CHAPTER 1: INTRODUCTION	1
1.1 Climate of North-East India	2
1.2 Thermal Performance	3
1.3 TRNSYS simulation tool	6
1.4 Degree-days and their uses	7
1.4.1 Hourly method	9
1.4.2 ASHRAE formula	10
1.4.3 UKMO equations	10
1.4.4 Schoenau-Kehrig monthly mean temperature method	11
CHAPTER 2: REVIEW OF LITERATURE	13
2.1 Thermal Performance of buildings	13
2.2 Thermal Performance by using TRNSYS	14
2.3 Degree-days and building energy demand	16
CHAPTER 3: OBJECTIVES AND METHODOLOGY	18
3.1 Objectives	18
3.2 Methodology	18
3.2.1 HDD and CDD calculation	18
3.2.2 Modeling	19
3.2.3 TRNSYS model generation	21
CHAPTER 4: RESULTS AND DISCUSSION	27
4.1 Degree-days and energy consumption	27
4.2 Heating and cooling degree-days by multiple regression analysis	48
4.2.1 Warm and humid climate	48

4.2.2 Cool and humid climate	49
4.2.3 Cold and cloudy climate	51
4.3 Statistical analysis of the equations derived from multiple regression	52
4.4 Thermal performance of a vernacular house at Tezpur	56
CHAPTER 5: CONCLUSIONS	63
REFERENCES	65
PUBLICATION	68

LIST OF FIGURES

Figure	Particulars	Page No.
1.1	Bio-climatic zones of north-east India	4
1.2	Thermal simulation flow paths of a building	5
1.3	Relationship between degree-days, base temperature and mean daily outdoor temperature	8
3.1	Systematic approach for building simulation	22
3.2	Building orientations considered for the simulation	23
4.1	Annual HDD and CDD values for TMY data of Tezpur	32
4.2	Annual HDD and CDD values (UKMO method) of Tezpur	32
4.3	Annual HDD and CDD values (ASHRAE method) of Tezpur	33
4.4	Annual HDD and CDD values (Schoenau-Kehrig method) of Tezpur	33
4.5	Annual HDD and CDD values for TMY data of Shillong	34
4.6	Annual HDD and CDD values (UKMO method) of Shillong	34
4.7	Annual HDD and CDD values (ASHRAE method) of Shillong	35
4.8	Annual HDD and CDD values (Schoenau-Kehrig method) of Shillong	35
4.9	Annual HDD and CDD values for TMY data of Imphal	36
4.10	Annual HDD and CDD values (UKMO method) of Imphal	36
4.11	Annual HDD and CDD values (ASHRAE method) of Imphal	37
4.12	Annual HDD and CDD values (Schoenau-Kehrig method) of Imphal	37
4.13	Annual HDD for Tezpur by UKMO method	38
4.14	Annual CDD for Tezpur by UKMO method	38
4.15	Annual HDD for Tezpur by ASHRAE method	39
4.16	Annual CDD for Tezpur by ASHRAE method	39
4.17	Annual HDD for Tezpur by Schoenau-Kehrig method	40
4.18	Annual CDD for Tezpur by Schoenau-Kehrig method	40
4.19	Annual HDD for Shillong by UKMO method	41
4.20	Annual CDD for Shillong by UKMO method	41
4.21	Annual HDD for Shillong by ASHRAE method	42
4.22	Annual CDD for Shillong by ASHRAE method	42
4.23	Annual HDD for Shillong by Schoenau-Kehrig method	43
4.24	Annual CDD for Shillong by Schoenau-Kehrig method	43
4.25	Annual HDD for Imphal by UKMO method	44

4.26	Annual CDD for Imphal by UKMO method	44
4.27	Annual HDD for Imphal by ASHRAE method	45
4.28	Annual CDD for Imphal by ASHRAE method	45
4.29	Annual HDD for Imphal by Schoenau-Kehrig method	46
4.30	Annual CDD for Imphal by Schoenau-Kehrig method	46
4.31	Tezpur building model generated in TRNSYS	56
4.32	Temperature profile of zone 3 of the vernacular house for 45° orientation	57
4.33	Temperature profile of zone 3 for 0° and 45° orientation	57
4.34	Indoor temperature difference plots for change in U-value of external wall of zone 3	59
4.35	Indoor temperature difference plots for change in U-value of false-ceiling of zone 3	59
4.36	Simulated temperature profile of zone 3 of the optimized vernacular house at Tezpur	60
4.37	Optimized temperature profile of zone 3 in comparison to the original temperature profile for the months of January and July	62

LIST OF TABLES

Table	Particulars	Page No.
3.1	Regression Statistics	20
3.2	Parameters of the vernacular house used for TRNSYS simulation	24
3.3	Different scenarios considered for TRNSYS simulation	25
3.4	Properties of the layers used for the different scenarios	26
4.1	Annual heating-degree days and cooling degree-days of Tezpur	28
4.2	Annual heating -degree days and cooling degree-days of Shillong	29
4.3	Annual heating -degree days and cooling degree-days of Imphal	30
4.4	Yearly standard deviations and mean temperature of Tezpur	31
4.5	Yearly standard deviations and mean temperature of Shillong	31
4.6	Yearly standard deviations and mean temperature of Imphal	31
4.7	R^2 , F and t-statistics of multiple regression for HDD	53
4.8	R^2 , F and t-statistics of multiple regression for CDD	54
4.9	Parameters of the building model considered and the optimized building model	61

LIST OF ABBREVIATIONS

CDD	Cooling degree days
CDD _d	Daily cooling degree-days
DD _a	Annual degree-days
DD _m	Monthly degree-days
$f(z)$	Gaussian probability density function
F(z)	Cumulative normal probability function
FDIST	F probability distribution
HDD	Heating degree days
HDD _d	Daily heating degree-days
HVAC	Heating, ventilation and air-conditioning
LINEST	Linear estimation
N	Number of days in a month
PMV	Predicted Mean Vote
PPD	Predicted Percentage of Dissatisfied
Sd _{avg}	Yearly standard deviation of average temperature
Sd _{max}	Yearly standard deviation of maximum temperature
Sd _{min}	Yearly standard deviation of minimum temperature
T	Yearly mean temperature
T _b	Base temperature
T _d	Daily average temperature
TDI	Thermal deviation indexes
T _i	Outdoor air temperature at the i-th hour of the day
TINV	Inverse of t-distribution
T _{max}	Daily maximum temperature
T _{min}	Daily minimum temperature
TMY	Typical Meteorological Year
TRNSYS	Transient System simulation tool
U-value	Overall heat transfer coefficient