

**HEAT GAINS TO BUILDING INTERIORS THROUGH
ROOFS: A STUDY BASED ON SELECTED
CONFIGURATIONS IN SRI LANKA**

Malambage Pubudu Gayan Sirimanna

(09/8087)



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DECLARATION OF THE CANDIDATE AND SUPERVISOR

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The above candidate has carried out research for the Masters under my supervision.

.....

Professor R.A.Attalage

.....

Date

.....

Professor K.K.C.K. Perera

.....

Date

DEDICATION

To

My project supervisors and

The Department of Mechanical Engineering, University of Moratuwa.



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ABSTRACT

Roofs of residential buildings play a crucial role in the context of building heat gains and thermal comfort, since they are exposed to a significant portion of insolation during the day. Therefore, it is important to develop a generalized model to evaluate thermal performance of roof structures under local conditions. This modeling becomes complex due to the dynamic nature of the parameters and various configurations, orientations of the roof surfaces in 3-D space. To address this issue a numerical approach was used to determine view factors of roof surfaces of a generic configuration. Consequently, a thermal model was developed to represent roof structures with four roof surfaces and a ceiling. Model is capable of incorporating insolation on roof surfaces, environmental conditions, roof configuration and materials and obtaining thermal responses of roof surfaces. A computational tool was finally developed based on the model. In order to validate the computational tool, an experimental setup was build and readings were recorded for several days. Same system was simulated using the computational tool and the results were compared. Furthermore, a commercial software and the developed computational tool were used to simulate a selected case and the results were compared with each other.

Keywords: Roof heat gain, View factor, Attic temperature, Solar irradiance, Thermal response



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TABLE OF CONTENTS

Declaration of the candidate and supervisor	i
Dedication	ii
Acknowledgements	iii
Abstract	iv
Table of Contents	v
List of Figures	viii
List of Tables.....	x
List of Abbreviations.....	xi
List of Appendices.....	xiii
1. INTRODUCTION.....	1
1.1. Background	1
1.2. Roof Element in Building Simulations	2
1.3. Objectives.....	4
1.4. Scope	5
1.5. Thesis Outline.....	5
2. STATE OF THE ART	6
2.1. Introduction	6
2.2. Existing Roof Models and Simulations.....	6
2.3. Radiant Heat Exchange	10
2.3.1. Radiosity and radiant heat exchange	10
2.3.2. Radiant heat exchange between surfaces in an enclosure	12
2.4. Determination of View Factor.....	13
2.4.1. Direct integration.....	15
2.4.2. Monte Carlo method.....	16

2.4.3. Special methods.....	19
2.5. Solar Irradiance	21
2.5.1. Isotropic diffuse model.....	22
2.5.2. HDKR model for anisotropic sky.....	23
2.5.3. Perez et al. model for anisotropic sky	23
2.5.4. Estimation of solar irradiance.....	24
2.6. Convection Heat Exchange of a Roof Structure	27
3. APPROACH.....	30
3.1. Introduction	30
3.2. Calculating the View Factor.....	30
3.2.1. Vectorial form of the view factor integral.....	30
3.2.2. Matrix transformations.....	32
3.2.3. Numerical calculation for differential areas	34
3.2.4. View factor of the entire surface	38
3.2.5. Surface discretization.....	40
3.3. Energy Balance and Thermal Response.....	41
3.3.1. Heat balance of a roof surface	41
3.3.2. Outside radiant exchange of a roof structure.....	43
3.3.3. Inside radiant exchange of a roof structure	44
3.3.4. Convection heat exchange of a roof structure	45
3.4. Development of Software Tool (ROTSIM 1.0)	46
4. RESULTS AND DISCUSSION	52
4.1. Introduction	52
4.2. Capabilities and Limitations of the Model and the Software Tool	52
4.3. Experimental Results.....	54
4.3.1. Experimental setup.....	54

4.3.2. Comparison of modeled results and experimental results	55
4.3.3. Analyzing sensitivities of parameters.....	62
4.4. Simulated Results	68
4.4.1. Comparison with a commercial software	68
4.4.2. Effect of changing roof configuration	72
5. CONCLUSIONS AND RECOMMENDATIONS.....	74
5.1. Conclusions	74
5.2. Recommendations for Future Work	76
REFERENCES	77
Appendix A: Approach to the radiation heat exchange	80
Appendix B: A sample view factor code.....	86
Appendix C: Measuring equipments.....	94
Appendix D: Developed software tool (ROTSIM)	96



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LIST OF FIGURES

Figure 1: Representation of radiosity	11
Figure 2: Radiant energy balance at a surface.....	11
Figure 3: Radiant heat exchange for an enclosure with non participating medium ...	12
Figure 4: Geometry associated with the view factor between two arbitrary elemental areas	14
Figure 5: Comparison of Monte Carlo and conventional methods Source: (Mahan, 2002).....	16
Figure 6: Block diagram to obtain total diffuse-specular view factor using MCRT method	18
Figure 7: A typical configuration for the use of cross string method.....	19
Figure 8: Surface projection for the unit sphere method.....	20
Figure 9: Components of solar irradiance on a tilted plane (Adapted from Duffie & Beckman (2006)).....	21
Figure 10: Basic angles required for solar irradiance calculations.....	26
Figure 11: Orientation of two elemental areas in a vector space	31
Figure 12: Two coordinate systems defined on two surfaces of an object.....	32
Figure 13: Changing the orientation of a coordinate system with respect to another coordinate system	33
Figure 14: Defining coordinate systems on each of the surface of the enclosure	34
Figure 15: Division of elements of the surfaces of the enclosure (a) surface 1 (b) surface 2	36
Figure 16: Numbering of an arbitrarily element of a surface.....	37
Figure 17: Discretization of a triangular surface.....	40
Figure 18: Basic angles and temperatures used to obtain the energy balance of a roof	42
Figure 19: Flow chart of the main routing (part 1).....	47
Figure 20: Flow chart of the main routing (part 2).....	48
Figure 21: Experimental Setup.....	54
Figure 22: A closer view of painted roof.....	55

Figure 23: Variation of attic temperature for the ordinary roof in 1 st of July	56
Figure 24: Variation of attic temperature for the painted roof in 1 st of July	57
Figure 25: Experimental and Simulated temperature variations for 1 st of July.....	58
Figure 26: Experimental and Simulated temperature variations for 30 th of June.....	59
Figure 27: Experimental and Simulated temperature variations for 29 th of June.....	59
Figure 28: Experimental and Simulated temperature variations for 28 th of June.....	61
Figure 29: Experimental and Simulated temperature variations for 3 rd of June.....	61
Figure 30: Effect of varying solar absorptivity on attic temperature (Original in Color).....	63
Figure 31: Effect of varying emissivity of inner roof surfaces on attic temperature (Original in Color).....	63
Figure 32: Effect of varying emissivity of outer roof surfaces on attic temperature (Original in Color).....	64
Figure 33: Effect of varying convection coefficients of inner roof surfaces (Original in Color)	64
Figure 34: Effect of varying convection coefficients of outer roof surfaces (Original in Color)	66
Figure 35: Effect of varying effective sky temperature on attic temperature (Original in Color)	66
Figure 36: View of simulated building by DEROB-LTH	68
Figure 37: A comparison of results between ROTSIM and DEROB-LTH	69
Figure 38: A comparison between total heat gain and roof heat gain	70
Figure 39: Percentage contribution of roof heat gain to the total heat gain	71
Figure 40: Effect of changing roof orientation to ceiling temperature.....	72
Figure 41: Effect of changing roof angle to ceiling temperature	73

LIST OF TABLES

Table 1: Material properties of the experimental model	56
Table 2: Material properties of modeled building.....	69



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LIST OF ABBREVIATIONS

List of Symbols

A	Surface area
a	Thermal diffusivity
E_b	Black body emissive power
E_q	Equation of time
F_{ii}	View factor between i^{th} and i^{th} surfaces while energy leaves i^{th} surface
F_{ij}	View factor between i^{th} and j^{th} surfaces while energy leaves i^{th} surface
F_{ji}	View factor between i^{th} and j^{th} surfaces while energy leaves j^{th} surface
G	Irradiance
h	Convection coefficient
I	Radiation intensity
$I_{\lambda, e+r}$	Spectral intensity of emitted and reflected radiation
J	Radiosity
L_{loc}	Longitude of the location
L_{st}	Local meridian for the standard time zone
n	Day number over the year
q	Heat exchange
$q_{i \rightarrow j}$	Radiation leaving i^{th} surface intercepted by j^{th} surface
T	Absolute temperature
t_{so}	Solar time
t_{st}	Standard time
α	Total hemispherical absorptivity
β	Slope angle
γ	Surface azimuth angle
δ	Declination angle
ϵ	Emissivity
θ	Incident angle
θ_z	Zenith angle
ρ	Total hemispherical reflectivity
σ	Stefan- Boltzmann constant
τ	Total hemispherical transmittivity
ϕ	Latitude angle
ω	Hour angle
Ω	Solid angle

Subscripts

abs	Absorbed by a surface
be	Beam
bh	beam horizontal
bi	i^{th} surface of a black body
bn	beam normal
d	Diffuse
e	Emitted radiation
e+r	Emitted and reflected radiation
en	Environmental
i	i^{th} surface
in	Inside
ir	Radiation of inner surface
j	j^{th} surface
on	Extraterrestrial normal
or	Radiation of outer surface
r	Reflected radiation
ref	Reflected by a surface
s	Solar
T	Indication of a tilted surface
th	total horizontal
tr	Transmitted by a surface
λ	Spectral(Wavelength depended)

LIST OF APPENDICES

Appendix A: Approach to the radiation heat exchange	80
Appendix B: A sample view factor code.....	86
Appendix C: Measuring equipments.....	94
Appendix D: Developed software tool (ROTSIM)	96



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