DEVELOPING A ROOF SLAB INSULATION SYSTEM FOR TROPICAL CLIMATIC CONDITIONS

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Declaration

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Abstract

Global Warming is proven to be one of the biggest issues that the current world is facing. Greenhouse gas emission due to the extensive energy usage has been identified as the primary cause for that. Hence, the world is on its path to investigate ways and means of reducing energy consumption in the world.

On the other hand, due to the rapid urbanisation took place in recent history, land prices have escalated significantly. Hence, flat roof slabs become popular day-by-day due to the possibility of land recovery by that. Further, it has many additional advantages like cyclonic resistance, the possibility of future vertical extension and the possibility of utilising as an extra working space. However, a serious matter of concern is its thermal discomfort, for which air-conditioning the corresponding spaces is the most common remedy used. However, it has led to extensive use of energy, increasing the operational cost of the buildings and contributing to global warming, which is the issue that the world is attempting to mitigate. Hence, the current trend is to go for passive techniques. In this process, insulating roof slabs has been identified as a better passive way to make buildings thermally comfortable.

In this study, several existing roof slab insulation systems and their performances were investigated, and the most efficient system for tropical climates was identified. Since that system had an issue in durability as it had poor drainage arrangement, an optimised system with a structural arrangement of discontinuous strips was found out by computer simulations. A physical model developed to verify the results showed that the newly developed system could withstand a point load of 4MT at its most critical locations.

A comparison of thermal performance between the new system and the existing system was carried out by small-scale model testing. It resulted in finding that the newly designed system performs better than the most recent and efficient existing insulation system. An actual scale model testing was carried out to check its performance under real conditions. The results suggested that this newly developed system performs well in thermal aspects under actual conditions, and performs better than even a calicut tiled roof with a timber ceiling. Results suggested that this system can produce a peak cooling load reduction of about 20%.

The performance of an air gap as an insulator was checked in the process of trying to replace the insulation material and found out that air gap is marginally less effective than polystyrene. Further, it was proven that the thickness of the air gap does not have a significant effect on the thermal performance. Further, a confined air gap with bamboo strips was also proven to have a similar thermal performance. An added vegetation layer on these systems further enhanced the thermal conditions of the building.

A life cycle cost analysis suggested that the overlaid vegetation performs slightly better than the cases without vegetation in economic aspects. But the life cycle costing values lie in the same order, proving that all the systems considered are almost equally effective in terms of economic performance. However, due to the advantages like local and natural availability, bamboo, as an insulation material, is very favourable to be used in local context.

Keywords: Global Warming, Thermal Comfort, Energy Efficiency, Strength, Durability, Rooftop Vegetation

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Contents

Declaration i

Abstract ii

Acknowledgements iii

Table of Contents iv

List of Figures viii

List of Tables xiv

1 Introduction 1

1.1 General 1

1.2 Objectives 2

1.3 Methodology 3

1.4 The Main Findings 4

1.5 The Arrangement of the Report 5

2 Literature Review 6

2.1 General 6

2.2 Global Warming and Its Effects 7

2.3 Thermal Comfort in Tropical Countries 9

2.3.1 Climate in Tropical Countries 9

2.3.2 Comfort Models Developed in the World 10

2.4 Energy Consumption and Thermal Comfort 14

2.4.1 Energy Consumption in Tropical Countries 14
2.4.2 Energy Consumption in Buildings 18
2.5 Insulation as a Passive Technique 19
2.5.1 Passive Techniques in General 19
2.5.2 Insulation as a Passive Strategy 21
2.6 Roof Insulation 22
2.6.1 Different Roof Slab Insulation Systems 22
2.6.2 Roof Insulation with a Vegetation Layer on Top 23
2.7 Economic Feasibility of the Systems 26
2.7.1 General 26
2.7.2 Life Cycle Costing of Slab Insulation Systems 28
2.8 Summary of the Literature Survey 39

3 Public Perception on Roof Slabs 40

3.1 General 40
3.2 The Selected Sample 41
3.3 Results Obtained by the Questionnaire Survey 42
3.4 Summary of the Questionnaire Survey 52

4 Structural Arrangement and Performance 53

4.1 General 53
4.2 Methodology 56
4.2.1 General 56
4.2.2 Finding the Moment Capacity 57
4.2.3 The optimisation Process 57
4.3 Results Obtained by Numerical Modelling 61
4.3.1 Step 1: Removing Strips in One Direction 61
4.3.2 Step 2: Discontinuing the Strips 63
4.3.3 Step 3: Flat Slab Arrangement 64
4.4 Selecting a Suitable Width 65
4.5 Selecting the Optimum Arrangement 66

4.6 Selecting a Suitable Concrete Mix 67
4.7 Physical Model Testing 70
4.8 Summary of Structural Arrangement and Performance 72

5 Thermal Performance of the System 73

5.1 General 73
5.2 Theoretical Analysis of Thermal Performance 75
5.3 Results of Physical Model Testing 77
5.3.1 General 77
5.3.2 Small Scale Physical Model Testing 78
5.3.3 Actual Scale Physical Model Testing 84
5.4 Computer Simulation 89
5.4.1 Model Calibration 89
5.4.2 Calculation of Cooling Loads 91
5.5 Summary of the Thermal Performance 93

6 Developing a Natural Insulation Material 94

6.1 General 94
6.2 Air Gap as an Insulation material 95
6.2.1 Effectiveness of the Thickness of Air Gap 95
6.2.2 A Comparison with Polystyrene as an Insulator 97
6.3 Bamboo Cut in Transverse Direction as an Insulation Material 99
6.3.1 The Designed Experimental Setup 99
6.3.2 Effectiveness of Bamboo as an Insulation Material 101
6.4 Effectiveness of a Vegetation Layer on Top for the Insulation Properties 103
6.4.1 The System with Air Gap and Vegetation 103
6.4.2 The System with Bamboo and Vegetation 105
6.5 Summary of the Effort on Developing a Natural Insulation Material . 106

7 Life Cycle Cost Analysis 108

7.1 General 108
7.2 A Comparison with Traditional Roofing Materials 109

7.3 Method of Comparing Different Insulation Options 110
7.3.1 The Approach 110
7.3.2 Factors Considered in the Analysis 112
7.4 Results of the Life Cycle Cost Analysis 114
7.4.1 Option 1: When the Operational Period is from 0800h -1700h 114
7.4.2 Option 2: When the Building is always Operational 119
7.5 Summary of the Life Cycle Costing Analysis 123

8 Conclusions, Recommendations and Future Works 124
8.1 Main Conclusions 124
8.2 Recommendations 126
8.3 Future Works 126

A The Questionnaire Form Used 128

B Mix Design Calculations Performed 138

C Theoretical Calculations of Thermal Conductivities of the Systems 144

D Details of the Simulation Model Used to Calculated Cooling Loads 148

References 151

List of Figures

1.1 Isometric View of the Developed System 4

2.1 Global Mean Temperature Rise in Last 150 Years 8
2.2 The Climate Zones in the World 10
2.3 Comfort Models Developed in the World 11
2.4 A Typical Psychrometric Chart 15
2.5 Comfort Zone for a Building without HVAC for a Neutrality Temperature of 26^0C 16
2.6 Comfort Zone for a Building with Different Air Velocities for a Neutrality Temperature of 26^0C 17
2.7 A Summary of Passive Techniques Used in Buildings 20
2.8 Thermal Resistances of 5 cm Thickness of Common Building Insulation Materials 30

3.1 The Distribution of the Existing Roofing Materials in Sri Lanka (2015) 42
3.2 The Distribution of the Field of Work of the Selected Sample 43
3.3 The Distribution of the Existing Roofing Materials of the Selected Sample 43
3.4 The Satisfaction Levels of the Calicut Tile Users on their Roofing Material 44
3.5 The Satisfaction Levels of the Asbestos Sheet Users on their Roofing Material 45
3.6 The Satisfaction Levels of the Concrete Slab Users on their Roofing Material 45

3.7 The Preferred Roofing Material of the Selected Sample 46
3.8 The Reasons Expressed to the Choice of Preferred Roofing Material . 46
3.9 Users of Asbestos Sheets: Reasons for not Choosing a Concrete Slab as a Roof 47
3.10 Users of calicut Tiles: Reasons for not Choosing a Concrete Slab as a Roof 47
3.11 Users of Concrete Slabs: Issues Associated with Roof Slabs 48
3.12 Actions for Thermal Discomfort of those who have calicut Tiles as the Roofing Material 49
3.13 Actions for Thermal Discomfort of those who have Asbestos Sheets as Roofing Materials 49
3.14 Actions for Thermal Discomfort of those who Concrete Roof Slabs . . 50
3.15 Durations that Fans are Used in Residences with Different Roofing Materials 51

4.1 One of the Most Common Insulation Systems Used in Tropical Countries 54
4.2 The System with Continuous Concrete Strips 55
4.3 The Plan View of the Supporting Arrangement of the System with Continuous Concrete Strips 56
4.4 A Typical Plan View of the Supporting Arrangement after Removing strips in One Direction 59
4.5 Variables to be Considered in Optimising the Strips in Longitudinal Direction 60
4.6 The Process Followed to Optimise the System 60
4.7 A Typical Bending Moment Diagram for an Arrangement of Discontinuous Supports 61
4.8 A Typical Model Obtained by Computer Simulations with Strips Only in One Direction 62
4.9 Actual Bending Moments and Moment Capacities of Different Reinforcing Arrangements When the Strips in One Direction is Removed 62

4.10 Bending Moments and Moment Capacities of the Protective Concrete Layer for a Discontinued Strip Arrangement with a Strip Spacing of 500mm 63
4.11 Bending Moments and Moment Capacities of the Protective Concrete Layer for a Discontinued Strip Arrangement with a Strip Spacing of 500mm for Different Support Lengths when the Clear Spacing between them is $100mm$ 64
4.12 Bending Moments and Moment Capacities of the Protective Screed with a $50mm \times 50mm$ Gauge 12 Mesh for a Flat Slab Arrangement with Different Support Spacings 65
4.13 Isometric View of the Selected System 67
4.14 Experimental Setup of the Actual Scale Testing 71
4.15 The Graph of Load Vs. Deflection Obtained by Actual Scale Testing . 71

5.1 The System with Continuous Concrete Strips 74
5.2 Isometric View of the Newly Developed System 74
5.3 The Cross-Section of a Typical Insulation System 76
5.4 GL820 Midi Data Logger 78
5.5 Experimental Setup of the Small Scale Physical Models to Compare Thermal Performances 79
5.6 Experimental Setup of the System with Continuous Supporting Strips to Compare Thermal Performance 80
5.7 Experimental Setup of the Small Scale Physical Model of the Newly Designed System to Compare Thermal Performance 80
5.8 Slab Top and Slab Soffit Temperatures of the Control Experiment over a Period of 24 Hours 81
5.9 Slab Top and Slab Soffit Temperatures of the System with continuous-strip supports over a Period of 24 Hours 81
5.10 Slab Top and Slab Soffit Temperatures of the System without supporting strips over a Period of 24 Hours 82

5.11 Slab Top and Slab Soffit Temperatures of the Newly Developed System over a Period of 24 Hours 82
5.12 Slab Soffit Temperatures of Different Arrangements Considered . . . 84
5.13 The Actual Scale Physical Model Used to Compare Thermal Performances 85
5.14 Slab Top and Slab Soffit Temperatures of the Uninsulated Slab of Actual Model Testing over a Period of 24 Hours 86
5.15 Slab Top and Slab Soffit Temperatures of the Insulated Slab of Actual Model Testing over a Period of 24 Hours 87
5.16 Top and Bottom Surface Temperatures of the calicut Tiled Roof of Actual Model Testing over a Period of 24 Hours 88
5.17 Top Surface Temperatures of the Insulated Slab, Uninsulated Slab and calicut Tiled Roof over a Period of 24 Hours 88
5.18 Bottom Surface Temperatures of the Insulated Slab, Uninsulated Slab and calicut Tiled Roof over a Period of 24 Hours 89
5.19 Results After Calibration for Slab Top Temperatures of the Small Scale Model 90
5.20 Results After Calibration for Slab Soffit Temperatures for the Small Scale Model 90
5.21 The Computer Model Used for Computer Simulations 91
5.22 Predicted Cooling Energy Required for Insulated and Uninsulated Slabs over a Period of 24 Hours 92

6.1 The Physical Model Used to Test Air Gap as an Insulator 95
6.2 Observed Slab Top and Slab Soffit Temperatures of the System with 25mm Air Gap 96
6.3 Observed Slab Top and Slab Soffit Temperatures of the Systems with 25mm and 75mm Air Gaps 97
6.4 Observed Slab Top and Slab Soffit Temperatures of the Systems with 25mm Polystyrene Layer and an Air Gap 98
6.5 Planned arrangement in the Construction of Bamboo Insulation Layer 100

6.6 Panel Units Used in the Construction of Bamboo Insulation Layer . . 100
6.7 Construction of the System with 25mm Bamboo Insulation 101
6.8 Observed Slab Top and Slab Soffit Temperatures of the System with a 25mm bamboo strip Layer as an Insulator 101
6.9 Observed Slab Top and Slab Soffit Temperatures of the System with a 25mm Polystyrene Layer and a 25mm Bamboo Layer 102
6.10 Construction of the System with 25mm Bamboo Insulation 103
6.11 Observed Slab Top and Slab Soffit Temperatures of the System with a 25mm Polystyrene layer and a 25mm-Air Gap with a 50mm Vegetation Layer on Top 104
6.12 Observed Slab Top and Slab Soffit Temperatures of the System with a Bamboo Strip Layer as an Insulator and a 50mm-Vegetation Layer on Top 105
6.13 Observed Slab Top and Slab Soffit Temperatures of the System with a 25mm Polystyrene Layer and a 25mm Bamboo Layer with a 50mm-Vegetation Layer on Top 106

7.1 The Model Used to Compare life cycle Costs 112
7.2 Cumulative Heat Gains other than Roof Solar Gains in the Building when the Building is Operational from 0800h-1700h 115
7.3 Sensible Cooling Loads for each of the Options Considered for Insulation 115
7.4 Total Cooling Loads for each of the Options Considered for Insulation 116
7.5 Case 1- Life Cycle Costing Analysis for Different Insulation Systems Considered for a Lifespan of 10 years when the Office is Operational from 0800h-1700h 117
7.6 Case 2- Life Cycle Costing Analysis for Different Insulation Systems Considered for a Lifespan of 20 years when the Office is Operational from 0800h-1700h 118
7.7 Case 3- Life Cycle Costing Analysis for Different Insulation Systems Considered for a Lifespan of 50 years when the Office is Operational from 0800h-1700h 118

7.8 Cumulative Heat Gains other than Roof Solar Gains in the Building when the Building is always Operational 120
7.9 Total Cooling Loads for each of the Options Considered for Insulation when the Building is always Operational 120
7.10 Case 1- Life Cycle Costing Analysis for Different Insulation Systems Considered for a Lifespan of 10 years when the Office is always Operational 121
7.11 Case 2- Life Cycle Costing Analysis for Different Insulation Systems Considered for a Lifespan of 20 years when the Office is always Operational 121
7.12 Case 3- Life Cycle Costing Analysis for Different Insulation Systems Considered for a Lifespan of 50 years when the Office is always Operational 122

List of Tables

2.1 Insulation Techniques Tested throughout the World 23

2.2 A Summary of Literature on Heat Gain Reduction of Rooftop Vegetation 25

2.3 Economic Benefits and Barriers to be Considered in Life Cycle Cost Analysis 27

2.4 Properties of Different Insulation Materials 32

2.5 Properties of Natural Insulation Materials 37

4.1 The Optimum Arrangements for Each Strip-Spacing Considered . . . 64

4.2 Calculations for Finding Minimum Width of Strips 66

4.3 Calculations for Finding Minimum Width of Strips 68

4.4 Weights of Each Material as per the Mix Design Calculations Performed for Different Water-Cement Ratios for $1m^3$ of Concrete . . 69

4.5 Mix Design Options Tested by Varying Water-Cement Ratio 69

4.6 Volume Proportions of the Different Mixes Tested in Table 4.4 70

5.1 Theoretical Analysis on the Thermal Performance of the Systems Mentioned in Section 5.1 77

5.2 Peak Temperatures and Their Times of Occurrences for Each System . 83

5.3 Time Lags and Decrement Factors of Four Types of Insulation Systems 83

6.1 Time Lags and Decrement Factors of Four Types of Insulation Systems 97

6.2 Summary of the Results Obtained of the Systems Tested to Replace Insulation Material 107

B.1 The Mix Design Calculation Performed to Obtain a Strength of $15N/mm^2$ with Chip-Concrete with Water-Cement Ratio of 0.78 . . . 139
B.2 The Mix Design Calculation Performed to Obtain a Strength of $15N/mm^2$ with Chip-Concrete with Water-Cement Ratio of 0.75 . . . 140
B.3 The Mix Design Calculation Performed to Obtain a Strength of $15N/mm^2$ with Chip-Concrete with Water-Cement Ratio of 0.70 . . . 141
B.4 The Mix Design Calculation Performed to Obtain a Strength of $15N/mm^2$ with Chip-Concrete with Water-Cement Ratio of 0.65 . . . 142
B.5 The Mix Design Calculation Performed to Obtain a Strength of $15N/mm^2$ with Chip-Concrete with Water-Cement Ratio of 0.60 . . . 143

C.1 Thermal Conductivities of the Materials used 144
C.2 Surface Resistances of Roof Slab 145