Ain Shams University
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The Interrelation Between The Environmental Treatments To The Building Roof And The Design Strategies

A Thesis Submitted in Partial Fulfillment of the Requirements of
The Master of Science Degree in Architecture

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STATEMENT

This thesis is submitted to Ain Shams University for the degree of Master of Science in Architecture.

The work included in this thesis was accomplished by the author at the department of Architecture, Faculty of Engineering, Ain Shams University, during period from 2009 to 2015.

No part of this thesis has been submitted for a degree for a qualification at any other university or institute.

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ABSTRACT

The Research aim at reaching a practical design strategy for building roof design as a step for sustainable & environmental building developments for improving building performance & energy efficiency, which in return will affect the indoor air quality creating a comfort atmosphere for the building uses.

The research explores the relation between the environmental treatments to the building roof & the design strategies.

It studies the strategies & techniques used to achieve the building's optimum performance reaching a design methodology for sustainable roof design for designers to follow in order to achieve the building sustainable performance.

This thesis will show that by incorporating Sustainable roofs into the design of buildings, the built environment can provide the sustainable-system benefits normally provided by the natural environment, including cooling, insulation & even biodiversity.

OVERVIEW

It has been wide spread lately that earth faces global problems that threaten the life of living organisms. These problems would affect the earth like global warming, or affect the human life styles like energy crisis. Sustainable development concept was introduced as the solution for these problems.

This concept was applied in the construction field as sustainable urban design and green buildings, it is vital that we evolve towards sustainability in urban form, transport, landscape, buildings, energy supply, and all of the other aspects of vibrant city living.

Techniques and strategies have been developed to reach the optimum performance of the building, reaching a high level of coherence with nature and synergy with its systems.

Architects should follow a design methodology that guarantees the application of environmental strategies and concepts to produce a building that would help in the confrontation against the global problems we face.

The Research aim at reaching a practical design strategy for building roof design as a step of sustainable & environmental building development.

Research Problem:

Cities have second major contributors to global energy consumption and greenhouse gas (GHG) emissions. The urbanization process causes local climate change through excessive anthropogenic heat release and modification of land biophysical properties.

The resultant urban heat island (UHI) effects and aggravating human heat stress have second key environmental issues in city management. Buildings can be designed to be climate-conscious and energy-efficient to contribute to sustainability and address global climate-change issues at the local level .

Sustainable roofing design presents a feasible design strategy for microclimate amelioration and energy conservation in buildings which in return will build sustainable cities . Previous field and modeling studies in various climatic zones indicate that an individual Sustainable roof can reduce roof surface temperature by 15–45 °C, near-surface air temperature by 2–5 °C and building energy consumption by up to 80%.

In an extremely compact tropical city such as Cairo with severe shortage of ground-level green spaces and intense UHI effects, Sustainable roof could bring significant benefits. Large-scale installation of greenery on the spatially concentrated roofs and podiums & passive roof cooling solutions forming an elevated sustainable network could compensate for the green-space deficit, mitigate urban climate and improve quality of life.

Previous assessments of Sustainable-roof thermal effects are largely restricted to the individual building scale. Few studies cover the

wider influences of Sustainable-roof networks at the neighborhood or city scales. Besides, the conventional emphasis on temperature and energy cannot reflect the impacts of Sustainable roofs on human comfort, which is regarded as a key indicator of sustainable design.

Research Objectives:

The research main goal is reaching a design methodology for sustainable roofs in a way that restores sustainable - systems, combats the urban heat island effect & conserve energy for a greener, cleaner & cooler environment with people sharing space with nature.

To fulfill this goal, the following objectives should be achieved:

1- In order to reach a solution, the main problems should be well identified.

2- Exploring the elements of the sustainable-roof by studying the sustainable-city concepts and the relation between building envelope and sustainable-city elements.

3- Discussing the terms and theories accompanying sustainable-roof design.

4- Exploring the strategies and techniques used to achieve high performance of sustainability.

5- Exploring design maps and design systems to be integrated in a comprehensive design methodology.

Research Hypnosis

In order to implement a Sustainable roof design in an existing building or implement it in the design phase of a building from the beginning , certain features have to exist in the building , other features have to be modified & some features have to be put in consideration in the design phase to accept the requirements of the future green efficient various building types.

Research methodology

To reach the previously mentioned objectives, the following methodologies will be adopted:

Analytical methodology comprises three main aspects:

1. Reviewing different types of literature and data collection.
2. Analyzing and processing collected data.
3. Reaching results and gaining knowledge concerning the research issues.

By exploring the latest literature through books, published papers, projects frameworks and up-to date web sites

Deductive methodology involves reaching and developing a methodology for the sustainable-roof design.

By studying design maps and deducing a comprehensive design methodology.

Research scope and limitation

- The research focuses on the design of a sustainable-roof of either low rise or medium rise with either residential, commercial or office building use, which will have its effect on the building envelope design elements concerning the height of floors, the area and the spaces requirements and activities to achieve indoor comfort for space users.
- The location is considered to be generic, where the methodology can be applied anywhere, taking into consideration climatic and parameters concerning the specific location.
- The design phase is limited to schematic stage, which would focus on the criteria for selection of the techniques and materials. This phase of design is essentially the proof of concept phase. The project directions outlined in conceptual design are verified as being technically feasible, within budget, and able to deliver on design intents.

Research content

The research comprises of 4 chapters presenting the following:

Chapter one: Sustainable Development &Sustainable-roof

This chapter is concerned with the analytical preview of the elements, definitions and historical background for the thesis subject.

It starts with identifying the global problems and methods of solution through sustainability concepts and the method of applying these concepts in building roof design.

Then it continues with the study of the building and its elements, and the study of historical development of the sustainable cities. The chapter focuses on types of buildings roofs, and studies comprehensive definition of Sustainable-roof and accompanying theories and systems.

This chapter also studies the concepts and strategies affecting the sustainable-roof design concerning the comfort and well-being of the occupants through the following aspects:

1-Thermal comfort. 2- Visual comfort. 3- Acoustical comfort.

The study of each aspect is addressed through four components:

1- Concept.

2- Values and units.

3- Parameters.

4- Techniques.

Chapter Two: Sustainable roofing techniques & Standards

This chapter addresses the techniques that aim at reducing the environmental impacts through two aspects: energy and resources.

Energy consumption impact on environment is based on two goals,

a) Reducing the need for energy of heating/cooling,

b) Using renewable energy sources.

As for resources, the environment suffers from depletion of resources as material, water and air; the depletion is through quantity decrease and pollution of these resources. This chapter addresses the techniques that would reach high performance from these resources, the chapter ends with a case study illustrating the combination of techniques in an integrated way.

Chapter Three: Environmental Design method of sustainable roofing

This chapter addresses the method of Sustainable design. First, it studies maps of design methods and their progress and evaluation. Then the chapter goes through a design method based on the structure of the environmental briefing (EB) method developed by Richard Hyde, the chapter supports EB stages by work of other theorists to reach a comprehensive design method to be a guide for designers of sustainable-roofs, in which they can apply the environmental techniques addressed earlier through the thesis.

Conclusions and recommendations

The research reached several conclusions from the theoretical and analytical approaches along the pathway to reach the main goal

Sustainable roofs are a proven technology that provides building owners with opportunities to utilize often wasted roof spaces for energy efficiency, storm water management, sound insulation, and aesthetic improvements.

Accessible sustainable roof systems can confer significant added value to a building's occupants or to the general public with benefits ranging from enhanced educational opportunities in schools, private "roof parks" for condominium owners, public parkland, horticultural therapy and even food production.

Each sustainable roof system should be tailored to the specific needs of the client, with the variables determining costs.

It also generated recommendations for the governmental sectors and Educational institutes.

As more governments come to recognize the wide range of public benefits of sustainable roofs and how they can help to address many of the challenges facing cities, they will increasingly look to providing incentives for private building owners to undertake the additional capital costs associated with these systems.

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