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Evaluating interior surfaces including finishing materials, ceiling, and their contribution to solar energy in residential buildings in Famagusta, North-Cyprus, Turkey

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ABSTRACT

With the recent development of sustainable design trend, the major areas to consider are energy resources, construction techniques and materials, water usage and waste in architectural designs. There is no that doubts that controlling these elements through creative designs, innovation, specification, and every element have impact on the atmosphere. Materials have a tremendous effect on environmental issues, from climate alteration to alternative resources, biodiversity trouncing, waste amounts and types, and health issues. The embodied product's life cycle consume energy appends to climate change and carbon emissions, whilst the effect differentiates between types of materials. Therefore, optimizing passive solar design terminology is the simplest and most efficient approach to reduce energy required by construction. Passive design relies on active technologies and renewable energy sources. The simplicity of passive design principles allows designers to effortlessly integrate it in their projects. In this research, the study is oriented to examine the appliance of passive measures in residential buildings in Famagusta besides tasting the contortions of interior surfaces on the buildings' thermal behavior. Structured criteria used to select case studies to analyses day lighting, solar gain, energy consumption and prospective insolation energy. Both qualitative and quantitative methodologies adapted into comparison and problem solving methodology to achieve opportune results. Lack of considering passive parameters and material selection specifications affects directly the energy efficiency of the building, thus curtain strategies are recommended for effective energy management, constructing techniques and passive optimization concepts.

1. Introduction

Gradual growth on energy prices, increasing climate temperatures and emergent CO^2 emissions produced by air conditioning systems are the forceful factors to optimize passive and effective approaches measures in residential buildings around the world. It is crucial that new houses provide both comfort and energy efficiency all over its lifespan. Considering masonry and concrete thermal mass would consequence towards accomplish these goals. Annually, demand on air conditioning is by 10% around the world, which produces about six million tons of CO^2 emissions a year by 2020 [2]. Current reports related to the Part L of the building Regulations represent the imperative necessity to reduce carbon emissions produced by building heating and cooling systems, involving more restricted standards of insulations, air tightness and ways to decrease overheating in cooling season [15].

This paper highlights the miss-cointegration in dwelling's construction techniques, especially the interior surfaces, that is affecting the electrical consumption in North Cyprus. The island allocated in Mediterranean climate with mild winter and dry hot summer. Typically, this region has recorded the highest annual total technical potential of solar energy in compare to other regions of the world, not differentiated by conversion technology. Essentially, the Cypriot electricity production system is hooked on imported petroleum-fueled power plants by 95% of total energy produced in the island, rather the promising potentials on adopting the clean energy sources as solar, wind and biomass in such a region with high levels of solar radiation. Yet the plans for new power system plants are oriented toward the petroleum and liquid gas power plants, keeping the fuel-base system as main character of energy system in the island [16].

1.1. Problem and question

Since the island is located in a region with the highest Annual Total

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Technical Potential of Solar Energy without taking advantage of this rates of energy, this research attempts to investigate the potential contribution of interior surfaces to reduce energy consumption in residential buildings in Famagusta. This issue defines the impact of not implementing solar architecture principles to enhance building energy efficiency and how far the interior surfaces of the space can contribute to energy efficacy of residential envelopes?

1.2. Aim and objective

The aim of this work is to evaluate interior surfaces behavior in the case studies in order to distinguish the effects of incorporating passive solar measures to evaluate the potential of interior surfaces' contribution to envelope's energy consumption. The results would preface for further studies in search of the most suitable strategies to achieve the energy efficiency in residential buildings.

1.3. Methodology

In this research, six residential buildings are included into the study to achieve convenient results about residential in Famagusta, North Cyprus, Turkey. The samples are selected according to the residential types existing in the region, considering the occupant's number and economic status in a shape of; family house, social house and three deferent sizes of apartment buildings. Thus, qualitative and quantitative methodologies are combined in this research. As the first step, the case studies are observed and surveyed to define the problems, based on several parameters representing fundamental issues of energy efficiency and passive solar architecture as: site positioning, orientation, building form and compactness, A/V ratios, apertures and shading systems. Accordingly, the wide rand of data are abridged between two case studies that could contain all the cases varieties located between the two selected buildings. Then, the two buildings were simulated in computer to state the problems statically, testing the quality and the quantity of solar radiation effect in the building interiors. Finally, comparison methodology is adapted in this study in a way to analyse and evaluate the data obtained by mentioned above methods, resulting a sold evaluation of the interior surfaces contribution to energy efficiency of the residential building by utilizing the solar energy source.

2. Literature review

2.1. Energy efficiency

Recently, in order to achieve the energy consuming in buildings up to the maximum quantity, the energy efficiency and the building performances presents a vital role. The buildings in the European Union have saving energy about 40% of total consumption. Consequently, plenty of energy efficiency solutions have been discovered because of the global consciousness of energy saving requirements. One of the most common examples with positive results is the Passive House in Europe. The energy efficiency issue in buildings is the combination of renewable energy technologies, energy efficient equipment and energy efficiency measurements. In order to save global resources and prevent the environment from pollution, the energy efficiency has been demanded in various levels. Construction part of the building has the highest percentage of influence in energy consumption and energy efficiency [4].

By considering energy efficiency and passive building design, windows, windows size, and orientation of them are playing a core role in commercial and even in residential buildings. Surplus, placement, and various types of glazing area have impact on energy consumption and heating load of the building by mentioning the façade and orientation. Furthermore, the other significant factor in order to release solar energy especially for high passive solar gains is loads of zone. In order to placing the thermal mass, an accurate calculation of indoor sunlit surfaces should be considered [6].

2.1.1. Solar energy

Sun wave crossways from the sky, locations moving and geometry changing should be considered through modeling and dynamics. According to this methodology, solar energy absorption for indoor spaces can be performed by using the radiosity– irradiation method (RIM) which prepares solving factors in order to absorb energy for surfaces and the radiosity, irradiation [6].

Fundamentally, the term of passive solar is describing the system that collect, preserve and regenerate the energy deprived of utilizing any mechanical assessments as fans or other supportive systems. This property could be activated by integrating this method to the building design, adapting the envelop elements as apertures and walls to maximise benefits to the building energy efficiency. For instance, walling systems, rather than carrying loads, it has the capacity to store, transmit and radiate heat between indoor and outdoor. Therefore, most of the building elements have acting sever role in architecture simultaneously. Passively, the solar heating system contains minimum two elements: the collector that consists the openings faces the sun especially the southern façade, and the storage with a thermal mass features as rick, rocks and water. Hence the passive solar energy could be categorised in three main concepts; direct gain, indirect gain (trombe wall) and sunspace (isolated gains) [7]. Thus, direct solar radiation is considered as one of the prospective sources of energy and this can be effectively utilized in the large-scale by proper storage of it [13].

2.1.2. Thermal mass in houses

Through over the gradual improvements of insulation technologies and control of indoor air conditions to achieve energy efficiency in houses, this also can cause possibility of higher rates of overheating in summer season. Noticeable reduction in heat loss and thermal conductivity in dwellings is produced by effective insulation. Considering heat gain controlling techniques would help to avoid overheating caused by higher heat gain rates over loss. Other major factors influenced the thermal comfort are natural ventilation and Thermal mass (Fig. 1) [5].

Innate ability of gain and loss heat through day and night defines the level of thermal mass of houses. In summer time, heat absorbance rates during the daytime should prevent overheating and keep comfort temperature inside the dwellings (Fig. 2). Whilst natural ventilation merges low temperature air into the spaces, this would allow to stabilize internal thermal conditions at night time [17].

At winter season, warming the houses can be provided by thermal mass to reduce heating energy consumption. Heat gain from sunlight is

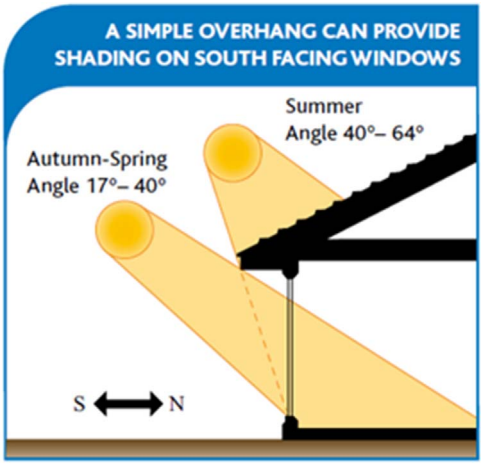

Fig. 1. The effects of shading systems on south windows facing with overhang.