Energy efficient building structure

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***Abstract*— There are many factors which affect the heat load of the building. Factors such as solar heat gain in summer, heat loss in winter, and natural ventilation in transitional seasons must be considered when designing energy-efficient residential buildings for hot summer/cold winter zones In this paper we have discussed the various factors affecting the heat load of any buildings. The heat transfer process of building envelopes differs in summer and winter, and heat and mass (e.g., moisture) transfer must be considered when providing natural ventilation. It is impossible to design energy-efficient buildings using only one approach, such as lowering the heat transfer of exterior walls, roofs, and windows or increasing the thickness of thermal insulation. The coupling of thermal mass and natural ventilation is important to passive building design. In this paper we are going to discuss various option for energy efficient building design.**

I. INTRODUCTION

Heating, ventilating, and air-conditioning (HVAC systems) account for 39% of the energy used in commercial buildings in the india. Consequently, almost any business or government agency has the potential to realize significant savings by improving its control of HVAC operations and improving the efficiency of the system it uses.

The use of high performance HVAC equipment can result in considerable energy, emissions, and cost savings (10%-35%). Whole building design coupled with an "extended comfort zone" can produce much greater savings (45%-75%). Extended comfort includes employing concepts such as providing warmer, but drier air using desiccant dehumidification in summer, or cooler air with warmer windows and warmer walls in winter. In addition, high-performance HVAC can provide increased user thermal comfort and contribute to improved indoor environmental quality (IEQ).

Each HVAC discipline has specific design requirements and each has opportunities for energy savings. It must be understood, however, that energy savings in one area may augment or diminish savings in another. This applies to interactions between components of an HVAC system, as well as between the HVAC system and the lighting and envelope systems. Therefore, understanding how one system or subsystem affects another is essential to making the most of the available opportunities for energy savings.there are many factors which are responsible for the heat load of the buildings.

Manuscript received April 23, 2015

II. THERMAL MASS

Thermal mass elements in buildings assists in the reduction of energy consumed in heating and cooling in most climate zones, can significantly reduce the ecological impacts of burning fossil fuels due to energy production, as well as reduce costs, improve comfort and reduce or eliminate the need for air conditioning. Introducing thermal mass into light weight structures is the only way to cool a structure down once the external temperatures exceed comfort levels and ventilation fail to provide comfort. Likewise, using thermal mass in lightweight structures is the only way winter daytime temperatures can be stored to keep buildings warm in winter evenings without introducing external energy sources. This is sometimes known as 'Passive Solar Design'.

However, with the introduction of second generation National Home Energy Rating Scheme (NatHERS) software tools such as AccuRate, First Rate and BERS Pro, the sometimes seemingly rigid precepts of passive solar design become more like guiding principles to stimulate design to enable ideas to be tested, simulated more accurately optimised and finessed.

This Technical Guide seeks to explain thermal mass, its benefits and limitations to enhance an understanding of mass and its uses in common buildings and provide guidance in areas where even the sophisticated 2nd generation thermal modelling tools do not deal adequately with the thermodynamics of vegetated high mass and green roof structures.

III. INSULATING THE WALLS

If we replace the plywood-reinforced honeycomb sandwich panel for the conventional honeycomb sandwich panel as building materials then also the heat load can be reduced by fraction. The sandwich material consists of composite materials and is fabricated by attaching two thin but stiff faces to the top and bottom of the lightweight but thick core [1]-[2] as shown in Fig. 1. Three types of plywood were selected for study, i.e., Chinese plywood, rubber plywood, and teak plywood, and the finite element simulation was performed to investigate the heat transfer. The result of the simulation showed that inserting plywood into the sandwich material could reduce the heat transfer content, especially the sandwich material inserted with chinese plywood which result the most efficient insulation, followed respectively by with teak plywood and rubber plywood. The result conformed to the heat conduction and heat resistance of the ASTM C 518 standards; therefore, the Chinese plywood sandwich panels were used to construct the walls of a building so as to study the energy saving efficiency inside the building. The experimental result showed that the energy consumption content in the room with regular walls was 1.07 kw., whereas the room with the chinese plywood sandwich panel walls consumed energy merely 0.90 kw. The employment of chinese plywood sandwich panel walls thereby reduced the energy consumption by 0.17 kw. In other words, the room walled off with the sandwich panel walls could save more energy than that with regular walls.

IV. Building Design

Buildings consume a lot of energy all around the world and are responsible for high environmental pollution. However, nowadays the stress on energy efficiency and environmental protection is very evident in building sector.

In many countries at the beginning, when energy efficiency policy was introduced in a building sector, most of the energy efficiency measures were focused on energy conservation in heat supply and end-use side. It was the best way (relatively quick and cheap) to get a reduction in energy consumption in a short time in buildings.

To improve the energy efficiency in buildings in residential sector the following methods have been usually employed:

a.Improvement of thermal characteristics of building envelopes (including basement), to reduce heat demand for space heating;

b. Modernization of heat distribution systems and heat exchange stations (centres): introduction of automatic control system, applying of heat metering, to reduce heat supplied to buildings and heat distributed inside buildings;

c. Modernization of heat source systems (including thermal power plants), local thermal systems and boilers, and individual heat sources (as often is done by switching from highly polluting fuel e.g. coal to low polluting ones, e.g. gas), to reduce fuel consumption for heat production.

V. Upgrade the Building Envelope

Cooling buildings in summer is one of the main environmental problems for architects and builders in many countries. The weather during that period reaches peaks of more than 50◦C in some. Compressor air conditioners can solve the problem but they put a heavy strain on the electricity load. Evaporative coolers consume far less but sometimes do not lower the temperature enough for comfortable living. A procedure was tested for this research to combine the best of both by employing evaporative systems to cool only the structural envelope. A test building was modified in Baghdad, Iraq to test the system. The roof was cooled using a pool in a tunnel like compartment. The latter was ventilated by a small fan. The walls enclosed a 10 cm cavity. Cooled air from a small evaporative cooler was pumped into it. The test results showed a drop in interior temperature of more than 10◦C to an average of 31.76◦C. This system allows a compressor air conditioner to be used to further cool the interior. Calculations revealed that after using it to reduce temperatures to comfortable levels, the cooling load was less by up to 88% compared to untreated rooms.

VI. Zero Energy Building

A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. Despite the excitement over the phrase “zero energy,” we lack a common definition, or even a common understanding, of what it means.The way the zero energy goal is defined affects the choices designers make to achieve this goal and whether they can claim success. The ZEB definition can emphasize demand-side or supply strategies and whether fuel switching and conversion accounting are appropriate to meet a ZEB goal. Four well-documented definitions—net-zero site energy, net-zero source energy, net-zero energy costs, and net-zero energy emissions—are studied; pluses and minuses of each are discussed. These definitions are applied to a set of low-energy buildings for which extensive energy data are available. This study shows the design impacts of the definition used for ZEB and the large difference between definitions. It also looks at sampleutility rate structures and their impact on the zero energy scenarios

VII. Thermal Storage System

Thermal storage systems play an important role in many energy systems as in solar heating systems, in cooling or heating in dwellings and commercial buildings and in systems of waste heat application, etc. They are able to balance out the discrepancies between energy demand and energy supply, which are time-wise out of phase. There are three kinds of thermal storage: sensible heat storage, latent heat storage and reversible chemical reaction heat storage. For many cases, latent heat storage demonstrates some preferable characteristics: (1) phase change process is nearly an isothermal process; (2) compared with sensible heat storage system, it has, in general, larger heat storage intensity; (3) it is easier to control than a chemical reaction system.

However, for traditional PCM, in order to store and to release the latent heat of the PCM, special latent storage device or containers to encapsulate the PCM are necessary. This increases not only the thermal resistance between PCM and the heat transfer fluid but also the first cost of the system. And the latter is exacerbated for salt hydrated because the container must be hermetically sealed. For example, though the bulk cost of CaCl26H2O is only $90 US per ton, storage modules based on this material cost more than $2900 US per ton at the retail level in Canada. In recent years, a kind of novel compound PCM, the so-called shape-stabilized PCM has attracted the interests of the researchers [3–8]. It consists of paraffin as dispersed PCM and (high density polyethylene) HDPE or other material as supporting material. Since the mass percentage of paraffin can be as much as 80% or so, the total stored energy is comparable with that of traditional PCMs.

Conclusion

So by introducing the thermal mass system the load on the building can be reduced and by using this cost can also be reduced by reducing the cost of the fossile fuels. Introducing thermal mass into light weight structures is the only way to cool a structure down once the external temperatures exceed comfort levels and ventilation fail to provide comfort. the plywood-reinforced honeycomb sandwich panel for the conventional honeycomb sandwich panel as building materials then also the heat load can be reduced by fraction. Building design also play an important role for reducing the heat load on the building structure. if the the thermal characteristics of the building is change than it will help in controlling the thermal structure. A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. Thermal storage systems play an important role in many energy systems as in solar heating systems, in cooling or heating in dwellings and commercial buildings and in systems of waste heat application, etc. They are able to balance out the discrepancies between energy demand and energy supply, which are time-wise out of phase.

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