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Zero Energy Building with Natural Ventilation

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Abstract: *Worldwide buildings consume up to 40% of the total global energy and 36% of carbon dioxide emission. By the year 2030, the consumption is expected to increase up to 50%. In India buildingsector consume a total of 70% of the electricity generated in country. Studies indicate more than50% of energy is used in buildings for Occupants comfort like cooling and lighting. Energy consumption in the building sector will continue to increase until building can be designed to produce enough energy to compensate the growing energy demand of these buildings. Towardsthis end, many governments promote zero energy building. A zero energy building is a building with zero net energy consumption; it means the total amount of energy used by the building on an annual basis is equal to the amount of energy produced on the site or off the site. These buildings do not increase the amount of greenhouse gases and less impact on climate.*
Keywords: *Natural Ventilation, Zero Energy Building, Energy Saving, Solar Panels, Natural Air.*

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I. INTRODUCTION:

In India most of the energy used today is produced from fossil fuels like coal, oil, natural gas, and a direct consequence of using these fuels is that greenhouse gases are released into the atmosphere with one of the most significant being carbon dioxide (Co2). These gases emitting infrared radiations, contribute to global warming and climate change. In response to this threat, government across the world have committed to reducing greenhouse gas emission and increasing renewable energy production. India is the sixth largest Co2 emission country (6.6%)in the world and continued to increase by 7.8%. The increase in Co2 emission was mainly caused due to consumption of energy which is primary demand of building sector. Buildings have significant impact on energy use and the environmental impact. Buildings are almost 40% of the primary energy approximately 70% of the electricity. Natural ventilation uses the natural forces of wind and buoyancy to introduce fresh air and distribute it effectively in buildings for the benefit of the occupants. Fresh air is required to achieve a healthy, fresh, and comfortable indoorenvironment for people to work and live in. Natural ventilation can ensure or support the supply of adequate breathing air, adequate ventilation of contaminants, adequate thermal conditioning and moisture dissipation, and contribute to wellbeing through a connection to the dynamics of nature. For natural ventilation to be effective there has to be a close relationship between the architecture and the air circulation system. This includes the relationship between the built forms, the site environment in a particular location, and the layout within the building. There is a growing concern about the increase in energy use and its adverse effects on the environment. A warmer world even by a half-degree Celsius causes adverse risks to our agriculture, health, water supply and more. The world's 2nd most populated country India consumed about 30.48 quadrillion BTU of energy in 2017 out of which 91% were from non-renewable sources of energy and only 9% from renewable sources and nuclear energy. When energy is consumed at such a fast pace it is imperative that we save energy as much as possible.

II. LITERATURE REVIEW:

The reviewed literature has indicated that there is wide diversity among ZEB definitions. Thus the definitions are divided into a number of groups in order to spotlight the most important topics for the discussion before formulating a ZEB definition. In the report, written in 2006 by Torcellini et al., authors use the general definitions for ZEB given by the U.S. department of energy (DOE). Building Technology Program: "A net zero energy building (ZEB) is a residential or commercial building with greatly reduced energy need through efficiency gains such that the balance of energy needs can be supplied with renewable technology". However they also point out clearly undefined "Zero": "Despite the excitement over the phrase "Zero energy," we lack a common definition, or even a common understanding of what it means." Considering different definitions of Zero Energy Building Torcellini, et al. (2006) distinguish and point out four mostcommonly used definitions.

- Net Zero Site Energy:

A site ZEB produced at least as much energy as it uses in a year, when accounted for at the site.

- Net Zero Source Energy:

A source ZEB produces at least as much energy as it uses in year, when accounted for at the source. To calculate a building a building's total sources energy, imported and exported energyis multiplied by the appropriate site-to-source conversion multipliers.

- Net Zero Energy Costs:

In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.

- Net Zero Energy Emission:

A net-zero emission building produced at least as much emissions-free renewable energy as it uses from emission-producing energy source. Kilkis, (2007) in his work refers to Torcellini, et al. (2006) however, in the discussion on ZEB definitions, he takes slightly another direction.

Ford B, Schiano-Phan R, Francis E (2010) The architecture and engineering of downdraught cooling: a design source book.

The book deals with the theme of summer climate control of buildings obtained through a flow of fresh air descending naturally and/or with water supplementation to evaporate. The techniqueis explored in the light of results achieved, interviewing users, in interventions carried out in various parts of the world characterized by warm climates: spain, sicily, arizona, malta, bangalore etc. The introduction mentions the origins of the cooling technique with water contained by porous clay containers and other examples of cooling towers also ancient. Finally, a mention of the barriers that the market poses to the development and dissemination of the proposed techniques, the book is very interesting because it opens up a number of possibilities to bring back nature in buildings, reducing the power, and consumption, of the technical systemsto be installed. Affects all employees, designers, users, and all those who care about comfort in residential and working environments, without resorting to expensive mechanical systems and even harmful both to the health of people and for the nonchalant use of greenhouse gases and forthe consumption of non-renewable resources.

Mumovic D, Santamouris M (eds) (2009) A handbook of sustainable building design & engineering**.**

The second edition of this authoritative textbook equips with the tools needed to tackle the challenges of sustainable building design and engineering. The book looks at how to design, engineer and monitor energy efficient buildings, how to adapt buildings to climate change, and how to make buildings healthy, comfortable and secure. New material for this edition includes sections on environmental master planning, renewable technologies, retrofitting, passive house design, thermal comfort and indoor air quality. With chapters and case studies from a range of international, interdisciplinary authors, the book is essential reading for students and professionals in building engineering, environmental design, construction and architecture. The combined challenges of health, comfort, climate change and energy security cross the boundaries of traditional building disciplines. This authoritative collection, focusing mostly on energy and ventilation, provides the current and next generation of building engineering professionals withwhat they need to work closely with many disciplines to meet these challenges. A Handbook ofSustainable Building Engineering covers: how to design, engineer and monitor a building in a manner that minimizes the emissions of greenhouse gases; how to adapt the environment, fabric and services of existing and new buildings to climate change; how to improve the environment in and around buildings to provide better health, comfort, security and productivity; and provides crucial expertise on monitoring the performance of buildings once they are occupied. The authorsexplain the principles behind built environment engineering, and offer practical guidancethrough international case studies.

Designing Spaces for Natural Ventilation:

An Architect's Guide UlrikePasse, Francine Battaglia. Buildings can breathe naturally, without the use of mechanical systems, if you design the spacesproperly. This accessible and thorough guide shows you how in more than 260 color diagrams and photographs illustrating case studies and CFD simulations. You can achieve truly natural ventilation, by considering the building's structure, envelope, energy use, and form, as well as giving the occupants thermal comfort and healthy indoor air. By using scientific and architectural visualization tools included here, you can develop ventilation strategies without an engineering background. Handy sections that summarize the science, explain rules of thumb, and detail the latest research in thermal and fluid dynamics will keep your designs sustainable, energy efficient,and up-to-date.

Natural Ventilation in Buildings: A Design Handbook, Servando Alvarez.

The benefits - environmental, economic and health - of ventilating buildings naturally, rather than mechanically, are becoming increasingly recognized. Approaches can be high- or low-techbut need to be a part of an integrated design approach. A range of technical barriers, such as building codes, fire regulations and acoustics, also need to be taken into account. This handbookdescribes the potential of natural ventilation, its appropriate use, the design and dimensioning methodologies, the need for an integrated design approach.

Natural Ventilation in the Urban Environment: Assessment and Design Francis Allard, Cristian Ghiaus

Throughout the world, there is an increasing interest in ecological design of buildings, and natural ventilation has proved to be the most efficient low-energy cooling technique. Its practicalapplication, however, is hindered by the lack of information on the complex relationship betweenthe building and its urban environment. In this book, a team of experts provide first-hand information and tools on the efficient use of natural ventilation in urban buildings. Key design principles are explained, enabling readers to decide on the best solution for natural ventilation ofbuildings, taking into account climate and urban context. In the initial sketches, architects need answers to open problems such as 'what kind of solution to adopt' and 'how to modify existing strategies to exploit the potential of the site'. This book formalizes the multi-criteria analysis of candidate solutions based on quantitative and qualitative estimation of the driving forces (wind and buoyancy), as well as of the barriers induced by the urban environment (wind speed reduction, noise and pollution) and gives a methodology for optimal design of openings.

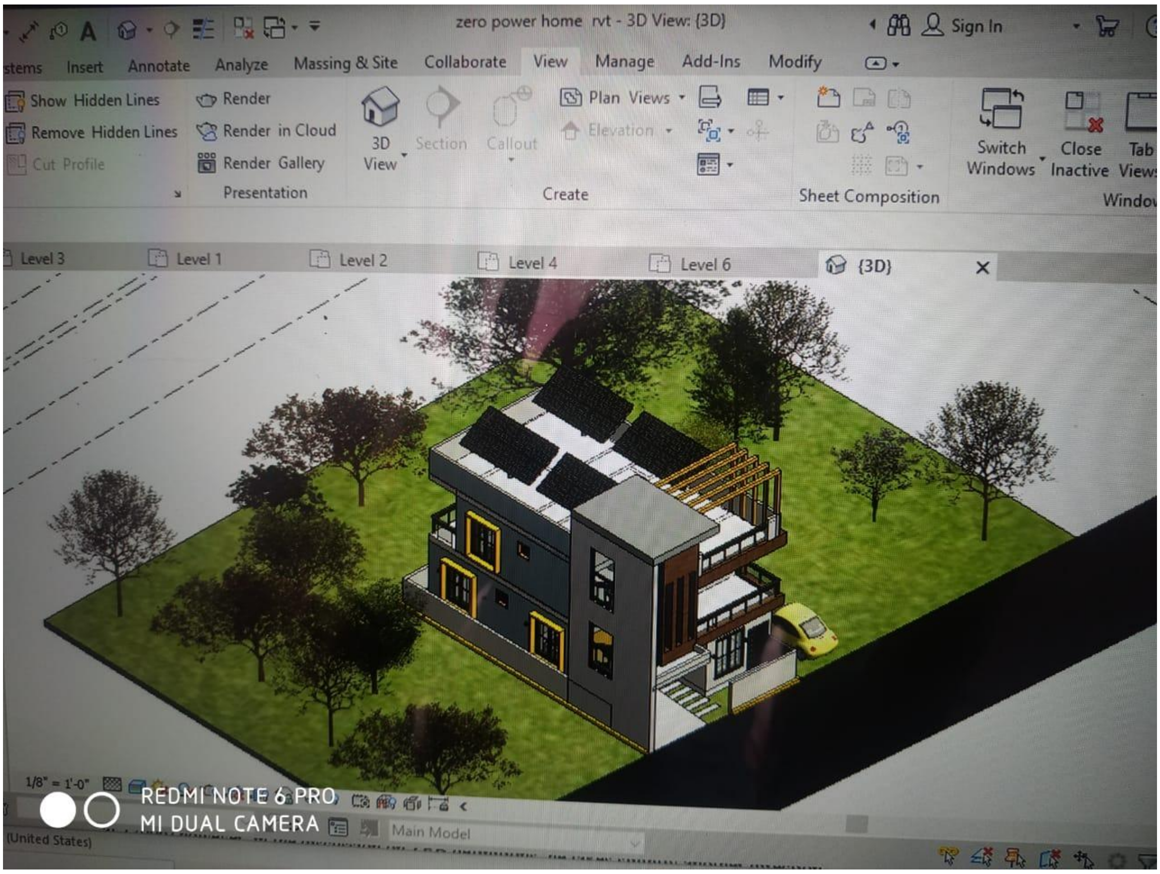
- Development of a computer simulation

Autodesk Revit is a building information modelling software which allows users to design a building and structure and its components in 3D, as well as annotate the model with 2D drafting elements. Revit includes categories of objects called families. They are mainly divided into System Families, (such as walls, floors, roofs, and ceilings, built inside a project), Loadable families/components, (which are built with separately from the project and loaded into a project for use) and In-Place Families, (which are built in-situ within a project with the same toolset as loadable components). This enables users to create realistic and accurate families ranging from furniture to lighting fixtures, as well as import existing models from other programs. The plans of the building in CAD format were obtained from Anna University’s Estate office. These drawings were linked into AUTODESK REVIT software. The ground and first floor plans were similar and the second and third floor plans were similar and thus loaded as a single plan. Various detailing needed for the ZEB like the building orientation, double glazed windows, LEDs, solar panels, Grey water and Rain water harvesting structures are added.

1. Concept:

1.1. Introduction:

A zero energy building (ZEB) produces enough renewable energy to meet its own annual energy consumption requirements, thereby reducing the use of non-renewable energy in the building sector. ZEBs use all cost-effective measures to reduce energy usage through energy efficiency and include renewable energy systems that produce enough energy to meet remaining energy needs. Notable advantages to implementing ZEBs are lower environmental impacts, lower operating and maintenance costs, better resiliency to power outages and natural disasters, and improved energy security. ZEBs combine energy efficiency and renewable energy generation to consume only as much energy as can be produced onsite through renewable resources over a specified time period. ZEBs have a tremendous potential to transform the way buildings use energy. We can further delve into the prospect of using construction materials reclaimed from industrial sludge for constructing ZEBs.



2. Advantages and Disadvantages:

Advantages:

- Isolation for buildings owners from future energy price increases.
- Increased comfort due to more uniform interior temperature.
- Reduced requirement foe energy austerity.
- Reduced total cost of ownership due to improved energy efficiency.
- Beautiful architecture.
- Reduce energy consumption.
- Minimum maintenance.
- Reduce carbon emission.
- Fast refurbishment.

Disadvantages:

- Initial cost can be higher.
- Effort required to understand, apply and qualify for zero energy building subsides, if they exist.
- While the individual house may use an average of net zero energy over a year, it may demand energy at the time when peak demand for the grid occurs.
- Less effective in warmer climate.
- Cool air in winter as with warmer climates natural ventilation system can also be less effective for operations in winter climates if below freezing temperature are common.

III. CONCLUSION:

- Providing architectural and planning solutions to improve the energy efficiency of the designed building.
- Thermal mass flooring can be used for zero-heat load on the building.
- LED light usage has advantage in energy conservation compared to conventional lighting.
- Ventilation systems to maintain better indoor air quality.
- More attention has been paid for planting greenery to provide necessary absorption of pollutants and to

support healthy ecologically sustainable environment.

- Sustainable design requires a long term durable approach and passive environmental control offers this.
- Substantial reduction in environmental issues.

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