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ECONOMIC EVALUTION AND STABILITY ANALYSIS OF RESIDENTIAL BUILDING WITH CONVENTIONAL AND NON CONVENTIONAL BUILDING MATERIALS

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ABSTRACT

Buildings consume a vast amount of energy, cost and CO_2 emission to the atmosphere during the life cycle stages of construction, use and demolition. Total life cycle energy use in a building consists of two components: embodied and operational energy. Embodied energy is expended in the processes of building material production, on-site delivery, construction, maintenance, renovation and final demolition. Operational energy is consumed in operating the buildings. In this paper the review is given about energy consumption, cost and CO_2 emission of the residential building. Energy required for various materials is calculated and energy efficient alternatives are suggested. Studies have revealed the suggestion of energy efficient alternatives materials and comparison of energy consumed by using each material. Current interpretations of embodied energy are quite unclear and vary greatly as change in site source of raw materials and embodied energy databases suffer from the problems of variation and incomparability.

Keywords— Embodied, Energy, Lifecycle, Joule, Emitted.

I. INTRODUCTION

The concept of sustainable buildings and use of environmentally friendly construction materials like stones, timber, thatch, mud etc have been practiced since ancient times. But the perception of people about strong and durable buildings have changed with the advent and lavish use of the present modern materials like steel, cement, aluminum, glass etc. A large amount of fuel energy gets consumed in producing such materials. These materials being industrial products further need to be transported to large distances before getting consumed in the buildings thus making them energy intensive. An estimate of the energy consumed in buildings using different permutations of materials and techniques will facilitate their appropriate selection and reduce the embodied energy consumption.

Considerable amount of energy is spent in the manufacturing Processes and transportation of various building materials. Conservation of energy becomes important in the context of limiting of greenhouse gases emission into the atmosphere and reducing costs of materials. Non conventional or Green building thought in broader terms is a building which is planned, built, operated, maintained or reused with objectives to defend inhabitant health, improve employee efficiency, use wisely natural resources and reduce the environmental impact. Green construction or sustainable building which complements the building plan with concerns of economy, utility, durability and comfort. In other words, the green building procedure incorporates environmental considerations into every phase of the building structure. This process focuses on the design, construction, process and maintenance phases and takes into account the lot design and

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development effectiveness, energy and water effectiveness, resource efficiency, indoor environmental excellence, building-owner maintenance and the building's overall impact on the environment. A Green Building is one which utilizes less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier space for occupants as compared to conventional buildings.

The paper also includes a comparison between building materials with low embodied energy, as a result of which the material with the lowest embodied energy is timber. It also reflects on the great significance in the differentiation between renewable and non-renewable resources and their importance to the environment. [5] proposed a principle in which another NN yield input control law was created for an under incited quad rotor UAV which uses the regular limitations of the under incited framework to create virtual control contributions to ensure the UAV tracks a craved direction. Utilizing the versatile back venturing method, every one of the six DOF are effectively followed utilizing just four control inputs while within the sight of un demonstrated flow and limited unsettling influences. Elements and speed vectors were thought to be inaccessible, along these lines a NN eyewitness was intended to recoup the limitless states. At that point, a novel NN virtual control structure which permitted the craved translational speeds to be controlled utilizing the pitch and the move of the UAV. At long last, a NN was used in the figuring of the real control inputs for the UAV dynamic framework. Utilizing Lyapunov systems, it was demonstrated that the estimation blunders of each NN, the spectator, Virtual controller, and the position, introduction, and speed following mistakes were all SGUUB while unwinding the partition Principle.

II. PROBLEM STATEMENT

The environmental impact of a building depends on many factors, including energy (e.g. Embodied energy, energy used during the building operation, and energy used during Construction), materials, use of water and other resources. This research focuses on"Green" residential buildings, where special attention is paid to building energy Performance; in other words, the investigation focuses on low-energy residential Buildings, and particularly in the passive house standard, by taking care of cost, CO2 emission, Strength & durability ,reduction of wastes by utilizing for construction and water saving.

III. OBJECTIVES

The objective of the project is to develop buildings which utilize the natural resources to the minimal at the time of construction and operational stage. Non conventional buildings emphasize on the resource usage efficiency and also press upon the three R's - Reduce, Reuse and Recycle.

- Natural Resource Conservation, Energy Conservation, Materials Conservation & Water Conservation in construction of residential buildings.
- Cost reduction in the construction and use of residential buildings.
- Design for Human Adaptation

IV. METHODOLOGY

The total experimental approach involved in this work has been divided into four different phases. The details of the work in phase are narrated below.

Phase-I:-

1) Study of available literature on above concept.
2) Identifying different methods of calculating embodied energy ad CO_2 emission.
3) Collecting the working drawing of residential building and preparing estimate.

Phase-II:-

1) Calculating Specific Energy and CO_2 emission of general materials.
2) Calculation of embodied energy and CO_2 emission of selected building components.

Phase-III:-

1) Identification of different energy efficient alternatives for selected building components.

Phase-IV:-

1) Analysis of different alternatives of selected building components with respect to cost, strength and embodied.

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3) Laboratory tests on Conventional and non conventional Building materials.
4) Tests on Prism and Slab constructed with Conventional and Non conventional building materials.
5) Recommendation of the energy efficient materials.
6) Report writing.

V. MATERIALS

- ORDINARY PORTLAND CEMENT
- COARSE AGGREGATES
- RIVER SAND
- BURNT BRICKS
- STELL
- WOOD
- PORTLAND POZZOLONA CEMENT
- M SAND
- STABILIZED MUD BLOCKS
- RECYCLED STEEL
- UPVC

VI.CALCULATION OF EMBODIED ENERGY

A. Process analysis

Process-based analysis is one of the most widely used methods of embodied energy analysis, as it delivers more accurate and reliable results. This method involves using the energy data from the factory manufacturing the material to determine the energy used in creating it. The total embodied energy comprises the energy required directly for the main manufacturing process and the indirect energy embodied in the material inputs to the process. For the construction of a building, for example, the direct energy may include that used on-site for the operation of power tools, while the indirect energy may include that used directly in the manufacture of material used in the building. The indirect energy of the steel would in turn comprise energy embodied directly in the extraction and transport of iron ore.

Process analysis, according to definitions, comprises four steps:

1. *Measurement* of the direct energy requirements of the process
2. Quantification of the products required directly by the process and the application of steps 1 and 3 to the products quantified in step.
3. The speed and relative simplicity of this method make it preferable to Input-Output analysis as these would relate to lower costs in an industry setting.

B. Input-output analysis

An input/output-based analysis could account for most direct and indirect energy inputs in the process of production of building materials and thus is considered relatively complete. This process makes use of economic data of money flow among various sectors of industry in the form of input/output tables made available by the national government, thereby transcribing economic flows into energy flows by applying average energy tariffs. Thus, in an input/output analysis, the embodied energy is calculated by multiplying the cost of the product by the energy intensity of that product expressed in MJ or GJ/$1000 and dividing it by $1000.

There are two types of input-output tables commonly used:

1) Elements of the direct input-output matrix represent the amount of the row sector (for example, cement) in dollars required directly to make each dollar of output of the column sector (for example, concrete). These values are called 'direct requirements coefficients.

2) Leontief inverse input-output matrices Elements of the Leontief inverse input-output matrix represent the amount of the row sector (for example, cement) in dollars required to directly and indirectly make each dollar of output of the column sector (for example, concrete). These values are called 'total requirements coefficients', and repre sent the direct plus the indirect requirements.

The main disadvantage of this method is that it is time consuming if the Leontief matrix is not supplied. There are also identifiable sources of error such as varying energy and materials prices, as well as

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methods of data collection as sources of error for Input-Output calculations. The age of the data is also a potential source of error.

C. Hybrid analysis

This combines elements of both the input-output analysis in an attempt to achieve a more accurate value of embodied energy than that obtained by either of the methods individually. The method uses data from input-output analysis of the sample building then modifies the values using process analysis to obtain a value containing 48% more embodied energy than the Input-Output analysis alone.

1) There are two possible options for the basis of a hybrid analysis

 Process-based hybrid analysis

Process-based hybrid analysis involves the derivation of product quantities for an individual product and the subsequent application of total energy intensities derived using input-output analysis. The essential premise of process-based hybrid analysis methods is that the errors in the input-output model for the sector which produces a particular product can be obviated by determining the quantities of inputs of goods and services into the main process.

b) Input-output-based hybrid analysis

This method incorporates identification and extraction of direct energy paths from input/output-based analysis in order to integrate the reliable and accurate process based data to avoid indirect effects. Where the direct energy intensity of a material is relatively small, compared to its total energy intensity, the material inventory of a process-based hybrid analysis is occasionally extended a further stage upstream so that more certainty can be attributed to these materials.

Input-output-based hybrid methods can be classified into three options:

 Substitution of process analysis data into the input-
 output model.
 Adding a column to the input-output model for the
 process analysis data.
 Modification of direct energy paths with process analysis data.

The selection of the most appropriate allocation method is not straight forward. Results may vary widely according to the method chosen.

VI. ESTIMATING CONSTRUCTION ENERGY FOR BUILDING BY CONVENTIONAL METHODS

Constructions consume a variety of building materials. Abundant raw materials are to be transported from far off distances to the industry which requires further processing thus consuming primary and commercial resources. The finished products from the industry further need to be distributed to the local areas and construction sites which increase the pressure on the commercial fuels like petrol/diesel etc. The most common building materials used in construction activity today is cement, steel, bricks, stones, glass, aluminum, timber, etc. The estimates of the energy consumed in the manufacture/extraction are calculated below.

The total amount of embodied energy associated with the building construction is calculated y using following equation.

EE= E mat + E trans + E site EE = Embodied energy.

E mat = Energy from material / product manufacturing. E trans = Energy from material / product transport.

E site = Energy from site works.

A. ESTIMATING CONSTRUCTION ENERGY FOR BUILDING

Material quantity required to construct the building is first estimated from the drawing. The quantity calculated is shown in table below.

TABLE I: QUANTITY OF MATERIAL REQUIRED

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Sr. No.	Material	Quantity	Unit
1	Bricks	320	Numbers
2	Cement	4	Bags
3	Steel	47.72	Kg
4	Aggregates	0.6	m^3
5	Sand	0.3	m^3

VI. LABORATORY TESTS ON MATERIALS

SL. NO	Tests	Material	Results	Material	Results
1	Specific gravity	OPC 43	2.95	PPC	2.80
2	Fineness cement		6 %		8 %
3	Compressive strength		50 N/mm^2		53 N/mm^2
4	Initial setting time		65 min		145mn
5	Normal Consistency		32 %		34 %

SL. NO	Tests	Material	Results	Material	Results
1	Bulk density	River Sand	1.64 gm /cc	M sand	1.73 gm /cc
3	Specific gravity		2.62		2.22
4	Bulking of sand		39.76 %		42.5 %
5	Fineness modulus		3.23 %		4.20 %

SL. NO	Tests	Material	Results	Material	Results
1	Water absorption	Burnt Bricks	12.02 %	Stabilized Mud Blocks	6.2 %
3	Compressive strength		3.86 N/mm^2		6.5 N/mm^2

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COST COMPARISION

Materials	Quantity	Cost	Total Cost	Materials	Quantity	Cost	Total Cost
OPC	2 bags	800/-		PPC	2 bags	760/-	
River Sand	0.15 m^3	200/-		M sand	0.15 m^3	300/-	
Burnt bricks	260 No's	4160/-	6540/-	Stabilized mud blocks	60 No's	1740/-	3640/-
Coarse aggregates	0.3 m^3	300/-		Coarse aggregates	0.3 m^3	300/-	
Steel	23.86 kg	1080/-		Recycled steel	23.86 kg	540/-	

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EMBODIED ENERGY COMPARISON

Materials	Quantity	EE	Total EE	Materials	Quantity	EE	Total EE
OPC	2 bags	360MJ	2273.357MJ	PPC	2 bags	252MJ	
River Sand	0.15 m^3	4.437MJ		M sand	0.15 m^3	1.109MJ	564.303 MJ
Burnt bricks	250 No's	937.5MJ		Stabilized mud blocks	110 No's	34.1MJ	
Coarse aggregates	0.3 m^3	64.74MJ		Coarse aggregates	0.3 m^3	64.74MJ	
Steel	23.86 kg	906.68MJ		Recycled steel	23.86 kg	212.354 MJ	

CO_2 EMISSION COMPARISON

Materials	Quantity	CO_2	Total CO_2 Emission	Materials	Quantity	CO_2	Total CO_2 Emission
OPC	2 bags	82 Kg	150.61 Kg	PPC	2 bags	1.148Kg	11.85 Kg
River Sand	0.15 m^3	1.419 Kg		M sand	0.15 m^3	0.355Kg	
Burnt bricks	260 No's	0.3 Kg		Stabilized mud blocks	60 No's	0	
Coarse aggregates	0.3 m^3	0.09 Kg		Coarse aggregates	0.3 m^3	0.09 Kg	
Steel	23.86 kg	66.80 Kg		Recycled steel	23.86 kg	10.260 Kg	

VII. EXPEXTED OUTCOMES

This research paper deals with the overall energy calculations of construction materials like bricks, cement, sand steel, aluminum, and construction of various structural elements. This paper gives idea about conservation of energy and an Attempt was made to find Out the conservation also will be Require for modifications with some Software's will be used To calculate exact energy calculation.

The current environmental practices such as environmental Selection of building materials, eco-labeling, and green building assessment, in the construction industry, depend mainly embodied energy analysis of the Building. From the dissertation work, it can be expected that Sustainable building is considered as a way for the Building industry to move towards protecting the environment. The promotion of Sustainable building practices is to pursue a balance among economic, Social and environmental performance in implementing construction projects.

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VII. PENDING WORKS

As we have conducted the tests on conventional and non conventional building materials, we have observed CO2 emission, embodied energy and cost parameters between conventional and non conventional building materials.

Further we have to carry out a prism test on burnt brick masonry and stabilized mud block masonry and test on slab constructed by steel and recycled steel to analyze the stability against loading. This present investigation is very important for present scenario to provide sustainable and economical housing in residential sectors.

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