Identification & Suggestion of Energy Efficient Alternative for Selected Building Materials

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Abstract— The total life cycle analysis can be divided as Operational Energy and Embodied Energy in case of the construction industry. The operational energy which is necessary for the whole life of the building starting from its genesis to ravage which includes energy required for heating and cooling are which is constructed already, processing of instruments, heat water and light rooms. The embodied energy can be explained as which enswathe and sustain the construction sites, for example, with a concrete panel, the energy need to manufacture cement, sand, aggregates, transport them to the site, mix them in a appropriate proportion, casing of them in a particular thickness. The energy required to ruin and recycle it can be taken in to account for best practice. Embodied energy is the addition of all the energy required to make a material from its manufacture to shipping. Embodied energy is comprises of the energy required for processing and manufacturing, transport, maintenance and demolition but it is very hard to calculate the energy required for the maintenance, demolition and transportation so because of this while calculating the embodied energy for the materials many researcher considered only processing and manufacturing energy.

Keywords- embodied; life cycle; operational; energy; specific

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I. INTRODUCTION

Embodied energy is considered at the basic stage of the construction. The pollution control has vital importance in the present scenario. The construction industry emits most of the pollutants in the environment. The statistics shows near about 40% gases are emitted by construction industry. So the immediate advertence is required for this trouble. By calculating embodied energy required for every material, pollution caused by construction industry can be calculated.

Today's most important issue is to save environment by minimizing the pollution. As per the various researchers, construction industry is responsible for emitting nearly 40% of global warming gases into atmosphere. So from this, the pollution caused by the construction industry is very high and needs immediate attention. While considering the pollution caused by the construction industry, embodied energy require for various materials must be considered. There are two types of embodied energy first is initial embodied energy and second is recurring embodied energy. The energy emitted during construction process is the initial while energy discharged during maintenance is the recurring energy. Energy used for dismantle of building can also be considered in some of the cases. By using low embodied energy material, expenditure required for construction can be minimized and also the emission of greenhouse gases into atmosphere can be minimized.

In the world, buildings consume 30% to 40% of the energy during it's formation of structure, operation and maintenance; also buildings are liable for creating 22% of the CO2 in environment annually. India is a big country with a population of about 1.2 billion. It is estimated that by the year 2020, the population will increase by 40% in urban areas, which will lead to increase in energy demands.

For construction, lot of material is used. These materials may have high embodied energy which will result in high cost of the material and will be responsible for the emission of greenhouse gases into the atmosphere. By using the materials which are having low embodied energy, the cost of construction can be minimized and it may result in environmental friendly material utilization.

Embodied energy is computed in various units like Joule, Calories, BTU (British Thermal Unit). The embodied energy is more which emits more the larger carbon during its life cycle. The life of the material doesn't matter in it. The material whose embodied energy is more has may be minimum life cycle. There are different formulae by which the embodied energy can be calculated. There are various types of energy like mass, thermal, electric etc. The specific energy of material should be calculated first by understanding its type. Then convert it into embodied energy.

II. OBJECTIVES

This report presents the energy required to the building in its life cycle. The total energy consumption that can be attributed to a building throughout its life will depend upon the energy consumed for the production of the building materials,

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construction, operation, maintenance and for demolition and disposal or recycling.

The total life cycle energy consumption of a building includes embodied energy as well as operational energy. Embodied energy is the combined energy required to extract the raw materials, transport and refine the raw materials and then to manufacture the components, deliver to site and assemble the product. Different materials have an effect on the amount of energy required to produce the buildings.

A.   Introduction to "Embodied energy" and its necessity in present scenario.

B.   Study various methods of calculation of embodied energy.

C.   Study the steps in calculating embodied energy for all building materials and construction.

D.   Calculation of specific energy of building materials and converting it into embodied energy.

E.   Calculation of embodied energy of selected building components.

F.   Identification of different energy efficient alternatives for selected building components.

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

H.   Recommendation of the energy efficient materials.

I.   Calculate the embodied energy for a building by taking case study.

J.   To comment on energy consumption for a building of case study.

K.   To suggest alternative building material and construction techniques to reduce energy consumption.

L.   Collection and study of literature pertaining to the dissertation work.

M.   Collecting the working drawing of residential building and preparing estimate.

N.   Identify the material requirement and the best resource of the material.

O.   Analyzing and calculating energy required for production of building material and energy required for execution.

P.   To prepare the energy audit of the building.

Q.   To comment on the suitability of the building material used for construction.

III.   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 embodied energy

   2) Identifying different methods of calculating embodied energy.
   3) Collecting the working drawing of residential building and preparing estimate.

Phase-II:-
   4) Calculating Specific Energy of general materials.
   5) Calculation of embodied energy of selected building components.

Phase-III:-
   6) 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.
   2) Recommendation of the energy efficient materials.
   3) Report writing.
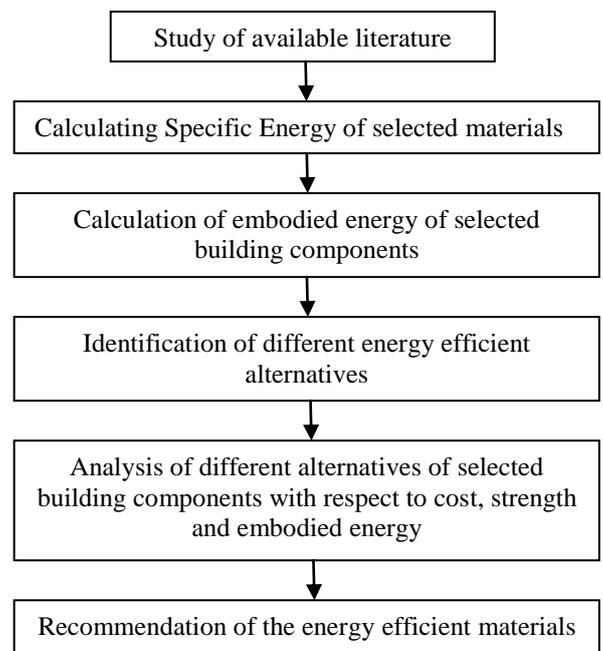
Fig. 1 Stages in Work

IV.   CALCULATION OF EMBODIED ENERGY

The three main embodied energy analysis methods are described:

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

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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:

- Measurement of the direct energy requirements of the process.
- Measurement of the output of the process.
- 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:

- *Direct input-output matrices:* 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.
- *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 represent 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 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.

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
- *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.

V. CONCLUSION

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

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to calculate exact energy calculation. Calculation of embodied energy estimates the embodied energy required, the life cycle energy and CO2 emissions. These calculated energy elements allow design and compare the energy efficient materials and thereby providing a valuable decision making tool for developers, contractors, architects, builders and consumers. Acceptance of embodied energy principals will allow us to use relatively easy, immediate and significant reductions in total greenhouse gases emissions and efficiency in construction.

VI. ACKNOWLEDGMENT

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