A Study on Expenditure Variation Between Green Building and Conventional Building

Ms. M. Dharani[1], Mr. M. Sasi Kumar[2]

[1]Student M.E. (CE&M), Erode Builder Educational Trust's Group of Institutions, Kangayam-638108, India

[2]Associate.Prof, Dept. of Civil Engg, Erode Builder Educational Trust's Group of Institutions, Kangayam-638108, India

Abstract - **The blending of traditional wisdom with contemporary technology and practices seems to be current trend in construction field. The designed needs of human had made some imbalance in environmental conditions which could be rectified by introducing sustainable construction. Green building has developed as a holistic and practical answer to the environmental impact and health burdens of the built environment. This study aims at incorporating the features of green building in conventional building (commercial) and thereby comparing the expenditure variation between them.**

Keywords – blending, contemporary, expenditure variation, green building, imbalance, holistic, traditional.

I. INTRODUCTION

There is no debating that the human race is growing faster than the planet earth can sustain. This unsustainable growth is clearly causing certain environmental changes that need to be reversed, or at the very least, slowed down. People are now fully aware of the resource crunch the country is faced with and are increasingly demanding self sustaining efficient developments that cost less to operate. Now, there are many different things we can do to correct our ways and minimize environmental degradation. Buildings are responsible for a large portion of our emissions, especially in a country like India where the sector contributes significantly to GDP, is a huge employment generator, energy consumer, water consumer, wastewater and waste generator.

Yet green buildings are easy to design and build and do not cost much more to build than non-green buildings. However, green buildings seem to be the lowest hanging fruit in this quest to achieve reasonably sustainable growth. Hence, it's only common sense to insulate oneself from the resource crunch and strive toward self-sufficiency and smarter living. This realization has contributed immensely to the growth and promotion of green building.

A. Definition of Green Building

A Green Building is one which uses less energy, water and natural resources, creates less waste and is healthier for the people living inside compared to a standard building.

B. Why Green Building?

The building sector in India is growing at a rapid pace and contributing immensely to the growth of the economy. This augurs well for the country and now there is an imminent need to introduce green concepts and techniques in this sector, which can aid growth in a sustainable manner. The green concepts and techniques in the building sector can help address national issues like water efficiency, energy efficiency, and reduction in fossil fuel use for commuting, handling of consumer waste and conserving natural resources.

C. Scope of the Project

- When looking at the impacts of the built environment on the nature, it is clear that first, the best technologies currently available are not sufficient to eliminate negative impacts on the built environment, and second, given that green buildings only represent 2% of all buildings, technological improvements alone will not bring about needed change.
- This rise in green building is not just thanks to increased environmental awareness, and also to increased perception of the benefits of green building, including serious cost benefits.

D. Objective of the project

- To motivate the society to accept the green building concept.
- To practice the maximum energy efficiency in construction.
- To enhance the human safety, health, and productivity in the built environment.

II. LITERATURE REVIEW

In today's age of urbanization the environment is being ignored by human beings. Environmental imbalance is produced due to different activities made by us. Construction industry is doing s massive role in this. In normal constructions proper care is not taken to save energy and energy is not efficiently used even though water for construction, gardening and other domestic purposes proper care is not taken and water is wasted. [1].A green building design provides solutions to all above mentioned problems and contributes in keeping the environmental clean and green. The study shows that green buildings are only way to a sustainable future. Following are the points possess prime importance.

In design, construction and operation of a green building are Proper site planning, Efficient use of water, Sustainability criteria, Passive design of building, Use of non-conventional energy, Saving energy, Solid waste management, Waste water management.

A. Proper site planning

The Woods Hole Research Center (WHRC) is an *independent*, non-profit, non-governmental organization focused on environmental science, interdisciplinary analysis, policy innovation, and public education on the connections between environment and human well-being. It focuses particularly on clarifying and communicating the impacts of human activities on the planet's vegetation, soils, water, and climate and on promoting practical approaches to their management in the human interest. The facility was designed with the express goal of being a zero net-energy building and has been instrumented with a whole-facility monitoring system that provides the basis for an on-line educational display system and long-term study of energy performance.[2]

B. Sustainability criteria

Sustainable construction can turn built assets into a profitable and competitive industry. This enhances life quality, offer customer satisfaction, and maximize the efficient use of resources. This paper develops a set of sustainability criteria for the local residential buildings. Spectral methods were introduced for the analysis of the data collected from the survey. It was found that the "gas boosted solar hot water system", "parking area for cycles", "degree of noise in operation", "quality of interior air" and "emission of greenhouse gas" are the top five sustainability criteria for improving sustainability performance of the local residential environments.[4] The "Green Building" is an interdisciplinary theme, where the green building concept includes a multitude of elements, components and procedures which diverge to several subtopics that intertwined to form the green building concept.

Generally, the green building is considered to be an environmental component, as the green building materials are manufactured from local eco-sources, i.e. environmentally friendly materials, which are then used to make an eco-construction subject to an eco-design that provides a healthy habitat built on the cultural and architectural heritage in construction while ensuring conservation of natural resources. This ensures disassembling the building components and materials, after a determined building lifetime, to environmentally friendly materials that can be either re-used or recycled. During their lifecycle, the green buildings minimize the use of resources (energy and water); reduce the harmful impact on the ecology, and provide better indoor environment. [6]

C. Efficient use of water

Methodology adopted in the study includes; Deciding shape, dimensions and orientation of building on the basis of passive solar design approach. Selection of appropriate green materials for reduction in embodied energy of building. Selection of energy efficient lighting and cooling methods. Estimation of rainwater harvesting system. Estimation and comparison of cost for conventional and green alternatives in building design. Validation of parameters by simulation for thermal performance.

Based on the design of green building and analysis of different construction material following important conclusions are drawn from the present work: Analysis shows that planning, design, and building materials have great impact on energy efficiency of building. With the appropriate use of green construction materials like fly ash brick, Pozzolana Portland cement and recycled steel the significant amount of cost and CO2 emission saving is achieved. The operational cost reduction as well as CO2 emission reduction for electro-mechanical appliances is achieved using low energy consuming appliances like CFL Lights, Evaporating coolers for lighting as well as cooling requirements respectively.

Conserving rainwater and reusing it reduces excess pressure on Ground Water and is recommended for the designed green building.

D. Passive design of building

This paper outlines the solutions for the energy efficient futuristic buildings. The implementation of latest technology in construction will lead to better building with green rating. Buildings are the greatest consumers of water, energy and materials. The idea of green buildings promotes use of renewable energy, recyclable & recycled products. Green building has to save water 36-40%, save energy 30-40% and save material 25-40% compared to conventional building. Green building is which one high thermal insulations, Rain water harvesting, terrace gardening, ventilation and energy efficient appliances [6].

Numerical investigations have been performed to study the cooling load reduction of office buildings by using different types of solar shades and find out the most efficient type of shade. In this paper simple indices were proposed to compare the thermal efficacy of different types of solar shadings in non-residential buildings. The building cooling load influenced by sunlight and outside weather. The design of low energy buildings in tropical climates and in warm climates normally focuses first on the quality of solar shading. Solar shading is the over-riding design feature needed to avoid overheating inside the building and thus decrease the cooling capacity of air conditioning. [3]

E. Saving energy

A green building is that which optimum energy and puts least impact on environment. Industrialization and technological development exerts excess load on the local environment in terms of increasing energy demand and pollution emissions. It is, therefore, essential to investigate the better design options in terms of whole building system. Since there are number of parameters as construction materials, lighting and cooling systems, water, etc., it is essential to apply an integrated approach toward green building design.

The present study briefs the analysis and design approach for green building. A case study for composite climate is considered for green building design. Various alternatives for design parameters in terms of cost and energy saving with reference to conventional and non-conventional energy system have been estimated. Design is validated through computer simulation. It is found that with the appropriate use of green construction materials, energy efficient lighting and cooling appliances, water conservation system significant amount of cost, energy and CO2 emission saving is achieved. Green buildings are designed to maintain indoor comfort conditions with respect to the local climate while minimizing the use of conventional energy, generation of greenhouse gases and the cost of operation. Common objective is to reduce overall impact of the built environment on human health and the natural environment efficiently. [5]

III. RESEARCH METHODOLOGY

The research initially starts with the findings that comprise the study of basics about the green building and its rating systems follows with its scope, objective and benefits. Subsequently a comprehensive study of conventional building and its features were attained based upon which green building concept was introduced. The concepts of green building were sketched up under the guidelines of IGBC Green New Buildings Rating System (Version 3.0) Abridged Reference Guide. In which the rating system is to facilitate a holistic approach to create environment friendly buildings, through architectural design, water efficiency, effective handling of waste, energy efficiency, sustainable buildings, and focus on occupant comfort and well-being.

The entire study involves the cost-benefit analysis and quantifying the benefits of green building with the analysis of financial tools such as life cycle cost and payback period with the comparison of normal building. The conventional building selected was TexValley, is an integrated wholesale textile trading center which supports the wholesale business activities in Erode. As per the client request, primarily the expenditure variation between the conventional weathering course and cool roof insulation tiles was done given as follows,

IV. APPROACH TO GREEN BUILDING IMPLEMENTATION

The Green Building movement was pioneered in Great Britain with the rating system called BREEAM, which was first launched in 1990. This system was later adopted in the United States when the U.S. Green Building Council was formed.

Leadership in Energy and Environmental Design (LEED) was loosely adopted from the BREEAM system and came into existence sometime in March 2000.

Indian Green Building Council (IGBC) has licensed the Leadership in Energy and Environmental Design (LEED) Green Building Standard from the U.S. Green Building Council and is responsible for certifying LEED-New Construction and LEED-Core and Shell buildings in India. There are many energy efficient buildings in India, situated in a variety of climatic zones. Indian Green Building Council, formed by Confederation of Indian Industry (CII) in 2001, is continuously striving towards wider adoption of eco-friendly and green building concepts in the Indian industry.

The Confederation of Indian Industry (CII) – Green Business Centre building in Hyderabad is one of the green buildings in India. There are three primary Rating systems in India.

- GRIHA
- IGBC
- BEE

A. Aspect of conventional building

The commercial buildings sector boasts the most explosive growth in green building. In 2010, a third of all new commercial construction was green, amounting to a Rs. 3240 billion market for commercial green buildings. By 2015, green buildings in the commercial sector are expected to triple, accounting for Rs. 7200 billion to Rs. 8700 billion in new construction and Rs. 840 billion to Rs. 1080 billion in major retrofit and renovation projects.

The implementation of green building on Texvalley benefits and encourages builders, developers, owners, architects, and consultants to design and construct green buildings, thereby enhancing the economic and environmental performance of buildings. Texvalley has two major textile markets - The Main Mall (Daily Market) and The Weekly Market. The third major world class complex in Texvalley is The International Convention Centre. Tex Valley – Daily Market -is a sprawling 11.5lakh square feet monolith of a building with 2 basements and 4 floors including a ground floor.

B. Scope of IGBC

India is witnessing tremendous growth in infrastructure and construction development. The construction industry in India is one of the largest economic activities. As the sector is growing rapidly, preserving the environment poses a host of challenges. To enable the construction industry environmentally sensitive, CII-Sohrabji Godrej Green Business Centre has established the Indian Green Building Council (IGBC). IGBC is a consensus driven not-for-profit Council, represents the building industry, consisting of more than 1,820 committed members.

As Texvalley comes under the category of new buildings and also tenant occupied building so the assessment is made on the guidelines of IGBC Green New Building Rating System (Version 3.0) – Abridged Reference Guide – July 2014. The Green Building Movement in India has been spearheaded by IGBC since 2001, by creating awareness amongst the stakeholders Thus far, the Council has been instrumental in enabling 2.14 Billion sq.ft of green buildings in the country. The Council's activities have enabled a market transformation with regard to green building materials and technologies. IGBC continuously works to provide tools that facilitate the adoption of green building practices in India. The development of IGBC Green New Buildings rating system is another important step in this direction.

C. Overview and process of IGBC

IGBC Green New Buildings rating system addresses *green* features under the following categories:

- Sustainable Architecture and Design
- Site Selection and Planning
- Water Conservation
- Energy Efficiency
- Building Materials and Resources
- Indoor Environmental Quality
- Innovation and Development

The guidelines detailed under each mandatory requirement & credit enables the design and construction of new buildings of all sizes and types (as defined in scope). Different levels of green building certification are awarded based on the total credits earned. However, every green new building should meet certain mandatory requirements, which are non-negotiable.

D. Rating level of IGBC

The various levels of rating awarded are:

TABLE I. THRESHOLD CRITERIA FOR CERTIFICATION LEVELS

Certification Level	Owner–occupied Buildings	Tenant–occupied Buildings	Recognition
Certified	50 – 59	50 – 59	Good Practices
Silver	60 – 69	60 – 69	Best Practices
Gold	70 – 79	70 – 79	Outstanding Performance
Platinum	80 – 89	80 – 89	National Excellence
Super Platinum	90 - 100	90 - 100	Global Leadership

E. Certification process

To achieve the IGBC Green New Buildings rating, the project must satisfy all the mandatory requirements and the minimum number of credit points. The project team is expected to provide supporting documents at preliminary and final stage of submission, for all the mandatory requirements and the credits attempted. The project needs to submit the following:

1. General information about project, including
   a. Project brief stating project type, different type of spaces, occupancy, number of floors, area statement, etc.,

   b. General drawings (in PDF format only):
      i. Master/ Site plan
      ii. Parking plans
      iii. Floor plans
      iv. Elevations
      v. Sections

   c. Photographs / Rendered images

2. Filled-in Master Template

3. Narratives and supporting documentation such as drawings, calculations (in excel sheets), declarations/ contract documents, purchase invoices, manufacturer cut-sheets/ letters/ material test reports, etc., for each mandatory requirement and credit.

The project documentation is submitted in two phases

- Preliminary submittal and
- Final submittal

Preliminary phase involves submission of all documents, which shall include mandatory requirements and the minimum number of credits. After the preliminary submission, review is done by third party assessors and review comments would be provided within 30 days. The next phase involves submission of clarifications to preliminary review queries and final submittal. This review will also be provided within 30 days, after which the rating is awarded.

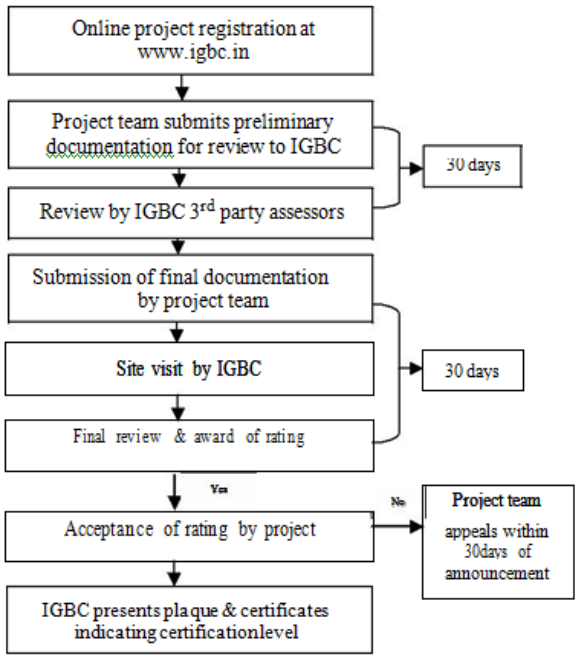

fig 1. Certification Process

It is important to note that the mandatory requirements and credits earned at the preliminary review are only considered as expected. These mandatory requirements and credits are not awarded until the final documents are submitted, along with additional documents showing implementation of design features.

If there are changes in any 'expected credits' aspect after preliminary review, these changes need to be documented and resubmitted during the final review.

F. Modules

TABLE II. IGBC MODULES

IGBC Green New Buildings Rating System
Modules
Sustainable Architecture and Design
Integrated Design Approach
Site Preservation
Passive Architecture
Site Selection and Planning
Local Building Regulations
Soil Erosion Control
Basic Amenities
Proximity to Public Transport
Low-emitting Vehicles
Natural Topography or Vegetation
Preservation or Transplantation of Trees
Heat Island Reduction, Non-roof
Heat Island Reduction, Roof
Outdoor Light Pollution Reduction
Universal Design
Basic Facilities for Construction Workforce
Green Building Guidelines
Water Conservation
Rainwater Harvesting, Roof & Non-roof
Water Efficient Plumbing Fixtures
Landscape Design
Management of Irrigation Systems
Rainwater Harvesting, Roof & Non-roof
Water Efficient Plumbing Fixtures
Wastewater Treatment and Reuse
Water Metering
Energy Efficiency
Ozone Depleting Substances
Minimum Energy Efficiency
Commissioning Plan for Building Equipments & System
Eco-friendly Refrigerants
Enhanced Energy Efficiency
On-site Renewable Energy
Off-site Renewable Energy
Commissioning, Post-installation of Equipment & Systems
Energy Metering and Management
Building Materials and Resources
Segregation of Waste, Post-occupancy
Sustainable Building Materials
Organic Waste Management, Post-occupancy
Handling of Waste Materials, During Construction
Use of Certified Green Building Materials, Products&
Equipment
Indoor Environmental Quality
Minimum Fresh Air Ventilation
Tobacco Smoke Control
CO2 Monitoring
Day lighting
Outdoor Views
Minimize Indoor and Outdoor Pollutants
Low-emitting Materials
Occupant Well-being Facilities
Air Quality Testing, After Construction and Before Occupancy
Indoor Air Quality Management, During Construction

G. Priority modules

IGBC green new buildings rating system modules are broadly classified into seven main categories under which 52 sub categories are present in which 5 categories were recommended by the IGBC professionals. The five categories namely,

- Landscaping
- Rainwater harvesting
- Energy modeling
- Building materials
- Day lighting

And in this paper based on that among those 5 categories Building Materials and Resources were concentrated more.

V. EXPENDITURE VARIATION

The expenditure variation between the conventional weathering course (Brick Bat Coba) and Cool roof insulation tiles were designed for the area of 13071 Sq.m.

A. Brick Bat Coba

Generally buildings are prone to leakages from terrace and walls, ultimately the Freezing and thawing conditions leads to peeling of paints and ruining the interiors but also growth of fungus. Such unhygienic conditions can be detrimental to the health of occupants living inside the building. While constructing RCC roof slab, it should be borne in mind that the practice of using concrete which is not watertight and placing too much reliance on the waterproofing measures is not desirable. The brick bat coba is used particularly for waterproofing of flat roofs, primarily RCC with some thermal insulation (mud phuska) in the all region. It consists of putting brick bats on roofs, to give a slope and then grouting the same with mortar admixed with various proprietary chemicals most in the nature of waterproofing compounds. In the new construction, it provides an excellent slope in a moderate cost, so that the water drains away.

B. Estimation

TABLE III. ESTIMATION FOR BRICK BAT COBA

Item of Work	Unit	Total Qty	Cost / Unit	Total Cost (lakhs)
Brick bat coba	**Sqm**			
Brick batt with cement mortar 1:5 packing				
Thickness of Brick batt Assumed 75 mm				
Cost of Brick Bats	Cft	34600	30	1038000
Cement handling	Kg	324864	325	2111616
Sand for packing mortar	Cft	39835	35	1394196
Sub Data CM flooring with 20 mm thickness top layer of cm 1:5				
Cost of cement	Kg	86688	325	563472
Cost of sand	Cft	10630	35	372033
Admixture	Sqm	13072	32	418304
L/C for Laying	Sqm	13072	27	352944
Sundries	Sqm	13072		20000
Total	**Sqm**	**13072**	**480**	**5336365**

C. Roof Insulation Tiles

"When conventional weathering course fails to reflect and emit the suns heat instead of absorbing it! A cool roof insulation tile does it!"When a roof can deliver high solar *reflectance*, and high thermal emittance, it is considered a cool roof. Reflective roofing technologies are increasingly included in federal, state and local energy codes. Many opportunities exist in both new construction and re-roofing to install cool roofs and other energy-improvement options. Cool roofs are highly reflective and emissive materials that stay 50 to 60 degrees F cooler in the summer.

A cool roof reflects and emits the sun's heat back to the sky instead of transferring it to the building below. "Coolness" is measured by two properties, solar reflectance and thermal emittance. Both properties are measured from 0 to 1 and the higher the value, the "cooler" the roof. ... A cool roof is one that will both reflect the light and UV rays from the sun while also retaining very little heat. A cool roof is highly reflective and highly emissive and will retain these physical properties for the life of its installation.

D. Estimation

TABLE IV. ESTIMATION FOR ROOF INSULATION TILES

Item of work	**Total cost**
Roof tile installation	
1 Box (Covers 5.62 Sq Ft)	
Requirement - 140647 sq ft (taken as 150000 Sq.ft)	
Total no. of boxes required - 26690 Boxes	
Tile Basic Cost	Rs.290.00(Per Box)
Rs.290.00(Per Box)+(12.36% Exercise Duty +14.5% VAT)	
Item of work	**Total cost**
Net Cost	Rs.373.00 (Per Box)
Transport Cost	Rs 25.00(Per Box Approx)
Roof insulation tile	***Rs. 760 / Sq.m***

E. Comparative study

TABLE V. COMPARATIVE STUDY BETWEEN BRICK BAT COBA AND ROOF INSULATION TILES

Properties	**Brick batcoba**	**Roof insulation tiles**
Solar reflective index(SRI)	55	96
Reflectance	0.05	0.77
Emittance	0.90	0.94
Composition	Non – degradable	Non – degradable
Abrasion resistant	0.6mm to 0.9mm	0.2mm to 0.4mm
Flatness	< 5mm	< 1mm
Water absorption	> 9 %	< 7%
Appearance	Grey	White
Polishing	Not required	Not required
Surface	Non – skid	Non – skid

Though this conventional way of terrace waterproofing is prevalent, it is not a correct way of terrace waterproofing method, it just gives slope to terrace to drains away the water accumulated on terrace. This claim can't be quantified as it is not measurable. Moreover, it has been observed that the coba surface attains the same temperature as the bare cement slab during the peak hours in summer. This conventional method has severe following limitations; hence it can't be called as a waterproofing method.

- Imposes unnecessary load
- Cracks reappeared due to
- Temperature variations
- Damages mother slab
- Bricks acts as water reservoir
- Creates noise, debris
- Lack of skilled manpower

A cool roof is one that reflects the sun's heat and emits absorbed radiation back into the atmosphere. The roof literally stays cooler and reduces the amount of heat transferred to the building below, keeping the building a cooler and more constant temperature. Thereby it

- Reduces energy cost
- Improving occupant comfort
- Cutting maintenance costs
- Increasing the life cycle of the roof

Contributing to the reduction of urban heat islands and associated smog. By comparing the above properties roof insulation tiles stands tall among the two. Hence roof insulation tiles are highly recommended.

VI. CONCLUSION

Thus, the study about the green building and comprehensive study of conventional building is done, with procedures for attaining green building certification. As per the client request, expenditure variation between the weathering course (Brick Bat Coba) with the comparison of roof insulation tile was compiled and it was found that roof tile is 1.5 times more expensive than Brick Bat Coba. Instead it reduces the maintenance charge which invariably coupes up with the expensive surcharge for using brick Bat Coba. So this study concludes that roof insulation tiles are best preferred for terrace roofing.

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