CHAPTER-1

INTRODUTION

1.1General

Nowadays, we all know that our Mother earth is not well because of excessive pollution caused by mankind. Globally, buildings are responsible for at least 40% of energy use. An estimated 42% of the global water consumption and 50% of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, and operational period of buildings. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its greenhouse gases, 50% of all water pollution, 48% of all solid wastes and 50% of all chlorofluorocarbons (CFCs) to the environment [1]. New technologies and protocols are introduced to save our Mother earth. Green building is one of them.

India too faces the environmental challenges of the construction sector. The gross built-up area added to commercial and residential spaces was about 40.8 million square metres in 2004-05, which is about 1% of annual average constructed floor area around the world and the trends show a sustained growth of 10% over the coming years. With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase, from a low 14% in the 1970s to nearly 33% in 2004-05[2]. Energy consumption would continue to rise unless suitable actions to improve energy efficiency are taken up immediately.

1.2 Defining Green Building

Green building means a high performance building property that considers and reduces its impact on the environment and human health. Green buildings are designed and constructed to maximize whole life-cycle performance, conserve resources, and enhance the comfort of their occupants. However, as a general concept, green building is simply a way of building that minimizes the environmental and human health impacts of the building both during construction and subsequent operation. Traditional buildings negatively impact the environment and human health and comfort in a number of ways.

a. Indoor climate control provided by mechanical heating and cooling, lighting and appliances uses energy resources
b. Plumbing fixtures, irrigation and potable water needs depletes water resources
c. Impervious materials on site limits infiltration of storm water and groundwater recharge
d. New materials used in construction deplete non-renewable or scarce natural resources
e. Chemical use in building materials and operations affects building occupants' comfort and contributes to outdoor and indoor air contaminants
f. Waste accumulation occurs during demolition and construction and during operation of the building

An additional and arguably synonymous component of this definition is the inclusion of an integrated design process. Integrated design is essentially a whole-building, systematic approach in making design decisions. This proves to be a critical piece of the green building process that is often overlooked, and has serious implications for the final product. According to Marian Keeler and Bill Burke's sustainable architecture textbook [3], "the integrated whole building approach, which considers life cycle at all levels, is essential to our contemporary definition of green building" [3]. An example of the virtues of an integrated design process is the collaboration between the mechanical engineer and the architect in designing the HVAC system.

If the architect is designing a super-insulated, high-performing building envelope that significantly lowers the amount of heat the building requires, the mechanical engineer should take this into account and design a much smaller heating and cooling system. If there was no cooperation and strategic thinking between the architect and the mechanical engineer, and each designed their particular piece of the building entirely separately from the other, the outcome would be much more inefficient and costly in both first costs and operations. While there is no officially accepted definition of green building, Keeler and Burke's book [3] provides a helpful framework for what elements any green building project strives to include in its design and construction.

a. Tackle site-demolition issues and construction-and-packing-waste issues, as well as waste generated by users of the building
b. Strive for efficiency in a broad area of resource use
c. Minimize the impact of mining and harvesting for materials production and provide measures for replenishing natural resources.
d. Reduce soil, water, and energy use during materials manufacture, building construction, and occupant use.
e. Plan for low embodied energy during shipment
f. Proceed logically, as the chain of materials production is traced.
g. Conserve and design for the efficiency of energy consumed by powering mechanical systems for heating and cooling, lighting, and plug loads.
h. Provide a "healthy" indoor environment

i. Avoid building and cleaning materials that emit volatile organic compounds (VOCs) and their synergistic interactions

j. Avoid equipment without controls or appropriate filters for particulate entry or production

k. Control entry of outdoor pollutants through proper air filtration, ventilation and walk-off mats, as well as occupant-born contaminants, such as personal care products.

l. Design a connection to the exterior providing natural ventilation, daylight, and views

Fig 1.1 Schematic Diagram Highlighting Green Building Features [1]

Several building processes and occupant functions generate large amounts of waste, which can be recycled for use or can be reused directly. Buildings are thus one of the major pollutants that affect urban air quality and contribute to climate change.

Hence the need to design a green building, the essence of which is to address all these issues in an integrated and scientific manner. It is a known fact that it costs more to design and construct a green building compared to other buildings. However, it is also a proven fact that it costs less to maintain a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in. Thus, the challenge of a green building is to achieve all its benefits at an affordable cost. A green building depletes the natural resources to a minimum during its construction and operation. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources when in use, and maximize the reuse, recycling, and utilization of renewable resources.

Fig 1.2 Cross section through a typical building highlighting select green features [1]

It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bioclimatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. It is evolved through a design process that requires input from all concerned the architect; landscape designer; and the air conditioning, electrical, plumbing, and energy consultants to work as a team to address all aspects of building and system planning, designing, construction, and operation. They critically evaluate the impacts of each design decision and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on the environment. In sum, the following aspects of a green building design are looked into in an integrated way.

a. Site planning
b. Building envelope design
c. Building system design (HVAC)
d. Integration of renewable energy sources to generate energy on-site
e. Water and waste management Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, and so on)
f. Indoor environmental quality (maintains indoor thermal and visual comfort and air quality).

1.3 Green Building Principles

Viewed from a life-cycle approach, the fundamental principles and objectives of green building are to:

a. Minimize natural resource consumption (materials and energy) throughout the total building life cycle.
b. Minimize pollution and environmental releases throughout the total building life cycle.
c. Protect the ecological (natural) environment.
d. Create a healthy, comfortable, nonhazardous space.
e. Incorporate quality, function, and performance consistent with the objective of the building and
f. Balance environmental performance with cost and economic performance.

1.4 Benefits of green building

A green building has lower resource consumption as compared to conventional buildings. The following is the percentage reduction of various resources in a building and their respective reasons.

a. Green buildings consume 40% to 60% (depending on the range of measures adopted) lesser electricity as compared to conventional buildings. This is primarily because they rely on passive architectural interventions in the building design, and high efficiency materials and technologies in the engineering design of the building.
b. Green Buildings also attempt to work towards on-site energy generation through renewable energy utilization to cater to its energy needs. For instance, solar thermal systems can help generate hot-water and replace the conventional electrical geyser in buildings. Solar PV panels can help generate electricity which can reduce the buildings dependence on grid power.
c. Green buildings consume 40% to 80% (depending on the range of measures adopted) lesser water as compared to conventional buildings. By utilizing ultra

low-flow fixtures, dual plumbing systems, waste-water recycling systems and rain-water harvesting, green buildings not only reduce their demand for water use but also look at on-site supply options to cater to its internal and external (landscape) water demands.

d. Green buildings generate lesser waste by employing waste management strategies on site. They may also employ waste to energy or waste to resource (like manure, or compost) strategies on site, to minimize their burden on municipal waste management facilities and landfills.
e. Green buildings generate lesser pollution both during construction as well as while in use. Through best-practices such as proper storage of construction materials, barricading of the site to prevent air and noise pollution during construction, proper storage and disposal of waste during construction and operation, and so on, ensures reduced impact on the surrounding environment.
f. Green buildings ensure proper safety, health and sanitation facilities for the labourers (during construction) and the occupants (while in use).
g. Green buildings restrict the use of high ODP (ozone depleting potential) substances in their systems as well as in finishes.
h. Green buildings offer higher image and marketability.

All of these can be achieved at a minimal incremental cost with an estimated payback period of about 3 – 5 years (excepting renewable energy for power generation).

1.5 Review of Literature

1.5.1 Background

One important aspect of the green building includes the market for this type of structure. The demand has increased in the last decade and is expected to continue to do so. LEED (Leadership in Energy and Environmental Design) registered public sector green buildings have increased 10 percent while commercial buildings have increased 5 percent of the annual construction market [4]. LEED registered buildings are only part of the green construction movement.

There are a number of building councils, associations and government sponsored initiatives that support the construction of green buildings. Together an improved understanding of the green building and construction requirements are being formed. The literature search has only uncovered a fraction of available information that will better define and support the design and construction of a green building. The focus of the literature review at this point is to uncover the accepted definition of a green building and the most prevalent criterion used in the design and construction.

1.5.2 Current Issues and Trends

An important concept in approaching this thesis is defining a green building. The Indian Green building council defines as "A green building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building", and The California Integrated Waste Management Board defines a green building as, "A green building, also known as a sustainable building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment" [4].The Green Building Revolution, describes a green building as, "a high-performance property that considers and reduces its impact on the environment and human health" [5]. The Massachusetts Technology Collaborative Renewable Trust, defines a green building as, "a building that has been constructed or renovated to incorporate design techniques, technologies, and materials that minimize its overall environmental impacts" [6].

The definitions of a green building will sometimes include a description of a high-performance building. A high-performance building while similar to a green building specifically aims to be energy efficient. High-performance buildings and there design are an all-inclusive philosophy taking into consideration the interaction of the whole building structure and systems [7].

"Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building."

"Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

For example, green buildings may incorporate sustainable materials in their construction (e.g., reused, recycled-content, or made from renewable resources); create healthy indoor environments with minimal pollutants (e.g., reduced product emissions); and/or feature landscaping that reduces water usage (e.g., by using native plants that survive without extra watering)" [9].

1.5.3 Green Building Rating Systems

A green building rating system is an evaluation tool that measures environmental performance of a building through its life cycle. It usually comprises of a set of criteria covering various parameters related to design, construction and operation of a green building. Each criterion has pre-assigned points and sets performance benchmarks and goals that are largely quantifiable. A project is awarded points once it fulfills the rating criteria. The points are added up and the final rating of a project is decided. Rating systems call for independent third party evaluation of a project and different processes are put in place to ensure a fair evaluation. Globally, green building rating systems are largely voluntary in nature and have been instrumental in raising awareness and popularizing green building designs

1.5.3.1 The Green Building Council and LEED

The United States Green Building Council (USGBC) was founded in 1993 for the main purpose of driving the change of sustainability in the construction of buildings. Originally USGBC was organized as a committee of like-minded people coming together to form a consensus on the creation of sustainable building. The committee recognized the need to educate members of their own profession on how to create a sustainable building. The ultimate goal of LEED's was to impact a market transformation. In 2000, LEED was launched. LEED encourages adoption of sustainable green building and development practices [10]. The LEED creators understood that for a green building to become viable, their clients would have to understand what advantages building green would have for them in terms of life-cycle costs, productivity increases and the ability to market the buildings [9].This is accomplished through implementation of tools and performance criteria. LEED is a certification program that has become nationally accepted as a way to prove a building is green.

The Indian Green Building Council has adapted LEED system and has launched LEED India version for rating of new construction. In addition, Indian Green Building Council (IGBC) has launched several other products for rating of different typologies of buildings including homes, factories, among others. To receive a LEED certification a building must meet the criteria for that particular type of structure in the appropriate program. This thesis will discuss the LEED programs for new construction. New construction program guidelines cover seven categories: LEED uses a point based-rating system. Points are given for each criterion that has been met. Each of the seven categories in the New-Construction program has sub-categories that are assigned points adding to a possible score of up to 80 points. LEED then adds the points and issues a rating level. The rating system for New Construction is:

- Certified – the project scored 40 to 49 points of the core points.
- Silver rating – the project scored 50 to 59 points.
- Gold rating – the project scored 60 to 79 points.
- Platinum rating - the project scored more than 80 points.

Earning points for any of the programs is accomplished by meeting the criterion established for the particular category within the given program [11].

1.5.3.2 BREEAM

Building Research Establishment's Environmental Assessment Method (BREEAM) was developed in the United Kingdom in 1990 and is one of the earliest building environmental assessment methods. BREEAM covers a range of building types including offices, homes, industrial units, retail units, and schools. When a building is assessed, points are awarded for each criterion and the points are added for a total score. The overall building performance is awarded a 'Pass', 'Good', 'Very Good' or 'Excellent' rating based on the score. BREEAM has separate criteria/checklist for evaluation of Design and Procurement and for Management and Operation of buildings. There is also a set of core credits that can be applied for, in case if the building wishes to go in for 'Core only' assessment for building performance [12].

BREEAM major categories of criteria for Design and Procurement include the following:

a. Management (commissioning period and process adopted, monitoring of commissioning, energy use in site activities, waste management, pollution minimization).
b. Health and comfort (adequate ventilation, humidification, presence of controllable blinds, energy efficient lighting, thermal and visual comfort, low noise levels).
c. Energy (sub-metering).
d. Transport (modes of transport to and from site, alternative transport facilities)
e. Water (consumption reduction, metering, leak detection).
f. Materials (asbestos mitigation, storage facilities, reuse of structures, specifications of envelope, use of crushed aggregate and sustainable timber).
g. Land use (previously used land, use of re mediated contaminated land).
h. Ecology (land with low ecological value or minimal change in value, maintaining major ecological systems on the land, minimization of biodiversity impacts).

i. Pollution (leak detection systems, on-site treatment, local or renewable energy sources, light pollution design, avoid use of ozone depleting and global warming substances) [12].

Further details on the system can be obtained from Building Research Establishment Ltd, UK.

1.5.3.3 CASBEE

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was developed in Japan, in 2001. The family of assessment tools is based on the building's life cycle: pre-design, new construction, existing buildings, and renovation. CASBEE presents a new concept for assessment that distinguishes environmental load from environmental quality and building performance. Under CASBEE there are two spaces, internal and external, divided by the hypothetical boundary, which is defined by the site boundary and other elements, with two factors related to the two spaces, in which the 'negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)' and 'improving living amenity for the building users' are considered side by side. Under CASBEE, these two factors are defined below as Q and L, the main assessment categories, and evaluated separately [13].

Q (Quality): Building Environmental Quality and Performance

Evaluates 'improvement in living amenity for the building users, within the hypothetical enclosed space (the private property)'.

L (Loadings): Building Environmental Loadings

Evaluates 'negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)'.

By relating these two, factors, CASBEE results are presented as a measure of eco-efficiency **or**

BEE (Building Environmental Efficiency). Results are plotted on a graph, with environmental load on one axis and quality on the other – the best buildings will fall in the section representing lowest environmental load and highest quality. Each criterion is scored from level 1 to level 5, with level 1 defined as meeting minimum requirements, level 3 defined as meeting typical technical and social levels at the time of the assessment, and level 5 representing a high level of achievement.

CASBEE major categories of criteria include

Building Environmental Quality and Performance

a. Indoor environment (noise and acoustics, thermal and visual comfort, and indoor air quality)
b. Quality of services (functionality and usability, amenities, durability and reliability, flexibility and adaptability)
c. Outdoor environment on site (preservation and creation of biotope, townscape and landscape, local characteristic and outdoor amenities)

Building Environmental Loadings

a. Energy (Building thermal load, utilization of natural energy, efficiency in building service systems, and efficient operations)
b. Resources and materials (water conservation, materials of low environmental loads)
c. Off-site environment (air pollution, noise and vibration, odour, sunlight obstruction, light pollution, heat island effect, and load on local infrastructure) [13].

1.5.3.4 GBTool

GBTool was developed by the International Framework Committee for the Green Building Challenge, an international project that has involved more than 25 countries since 1998. GBTool is designed to be adapted by sponsors to reflect regional conditions and context. It includes criteria in categories such as Site Selection, Project Planning and Development; Environmental Loadings; Energy and Resource Consumption; Indoor Environmental Quality; Functionality; Long-Term Performance; and Social and Economic Aspects. Criteria are assessed using scales that are based on local benchmarks of 'typical' practice; buildings can score –1 if below typical practice or from +1 to +5, representing good to very high performance. All criteria must be attempted. The benchmarks of typical practice and weightings of criteria are set by the sponsoring organization to represent national, regional, or local codes, practice, context, conditions, and priorities [14].

GBTool major categories of criteria include the following.

a. Energy consumption is assessed through total use of non-renewable energy (embodied and operational), electrical demand, usage of renewable energy, and commissioning.
b. Resource consumption is assessed through materials use (salvaged, recycled, bio-based and sustainably harvested, locally produced, designed for disassembly, re-use, or recycling) and water use for irrigation, building systems, and occupant use.
c. Environmental loadings include GHG emissions, other atmospheric emissions, solid wastes, storm water, waste water, site impacts, and other local and regional impacts.

d. Indoor environmental quality is assessed through indoor air quality, ventilation, temperature and relative humidity, daylight and illumination, and noise and acoustics.

e. Other criteria include selection of appropriate site (in terms of land use, brown fields, access to transportation and amenities), project planning, urban design (density, mixed uses, compatibility, native species, and wildlife corridors), building controls, flexibility and adaptability, maintenance of operating performance, and a few social and economic measures [14].

1.5.3.5 HK–Beam

The Hong Kong Building Environmental Assessment Method (HK-BEAM) is a voluntary scheme first launched in December 1996 HK–BEAM is a performance based system that takes holistic view of building performance with emphasis on life cycle impacts. In HK–BEAM, the assessment is not finalized until a building is completed ensuring that 'Green and Sustainable' practices are implemented through the entire project cycle and the project meets the desired goals and performance. The 'New Building' certification system of HK–Beam is also well synchronized with its 'Existing Building' certification, for example, a new building certified under the HK–BEAM 4/04 and suitably operated and maintained would attain a similar grade under HK–BEAM 5/04 some years later [15].

HK–BEAM integrates the assessment of many key aspects of building performance embracing

a. Hygiene, health, comfort amenity

b. Land use, site impacts and transport

c. Use of materials, recycling and waste management

d. Water quality, conservation and recycling

e. Energy efficiency, conservation and management

HK–BEAM also exempt building from attempting certain criteria when an issue or past of an assessment is not applicable to particular circumstance or building type. The overall assessment grade is based on percentage (%) of applicable credits. Given the importance of indoor environment quality, it is necessary to obtain a minimum percentage (%) of credits for IEQ in order to qualify for the overall grade [15].

1.5.3.6 GRIHA

Most of the internationally devised rating systems have been tailored to suit the building industry of the country was developed by TERI (The Energy and Resources Institute), New Delhi, being deeply committed to every aspect of sustainable development, took upon itself the responsibility of acting as a driving force to popularize green buildings by developing a tool for measuring and rating a building's environmental performance in the context of India's varied climate and building practices. This tool, by its qualitative and quantitative assessment criteria, would be able to 'rate' a building on the degree of its 'greenness'. The rating shall evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system, based on accepted energy and environmental principles, seeks to strike a balance between the established practices and emerging concepts, both national and international. The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period. On a broader scale, this system, along with the activities and processes that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, improving energy security, and reducing the stress on natural resources [1].

The rating applies to new building stock commercial, institutional, and residential of varied functions. Endorsed by the Ministry of New and Renewable Energy, Government of India as of November 1 2007, GRIHA is a five star rating system for green buildings which emphasises on passive solar techniques for optimizing indoor visual and thermal comfort. In order to address energy efficiency, GRIHA encourages optimization of building design to reduce conventional energy demand and further optimize energy performance of the building within specified comfort limits.

A building is assessed on its predicted performance over its entire life cycle from inception through operation. GRIHA was developed as an indigenous building rating system, particularly to address and assess non-air conditioned or partially air conditioned buildings. GRIHA has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions.

GRIHA stresses passive solar techniques for optimizing visual and thermal comfort indoors, and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort. GRIHA integrates all relevant Indian codes and standards for buildings and acts as a tool to facilitate implementation of the same [1].

1.6 Sustainability and the Construction Industry

Sustainability is becoming a central concern for us all. It is a concern that has grown out of wider recognition that rising populations and economic development are threatening a progressive degradation of the earth's resources. The construction, maintenance and use of buildings impacts substantially on our environment and is currently contributing significantly to irreversible changes in the world's climate, atmosphere and ecosystem. Buildings are by far the greatest producers of harmful gases such as CO_2 and this eco-footprint can only increase with the large population growth predicted to occur by 2050. What sustainability means is adapting the ways we all live and work towards meeting needs, while minimizing the impacts of consumption, providing for people of today and not endangering the generations of tomorrow...

For all these reasons the construction industry will come under the particular scrutiny of government, the consumer and environmentalists. This will affect every stage of the construction process, from planning and design to assembly, operation and disposal, and it will affect all members of the industry, from small building firms to large construction companies. Until recently, the challenge of sustainability has not been fully understood nor taken up by the industry. A lack of long-term perspective, resistance from the public to the idea of buildings having a different appearance and function, and ambiguities in the very idea of sustainable development have all caused suspicion. There has been a lack of transparency and co-operation within the industry, not to mention a failure to realize the potential benefits at stake, which has led to the view of sustainability as another policy-driven burden.

In fact, sustainable development is not just another social or environmental policy; it is a business opportunity too. Reviewing their activities with a more sustainable perspective, construction businesses could go beyond reducing detrimental environmental impacts. In many cases they will also benefit from improved and more profitable operation, as well as an enhanced reputation both in the community and with customers.

An enduring long-term regard for sustainability as a way of business is essential to the future of the construction industry and could benefit individuals as well as contributing to global solutions. Disregarding social and environmental issues is not only damaging to the planet, but will ultimately inhibit the healthy progression of business. As the Sustainable Construction Task Force have asserted, Sustainability issues are of critical and strategic importance to business Ignore sustainability and your reputation is on the line [16].

1.7 Role of Structural Engineers

The role of a Structural Engineer in sustainable design is difficult to define. Many of the aspects of accreditation are determined by other contributors of the design such as architectural, civil, mechanical and electrical engineering. However, it is important for the Structural Engineer to choose the most appropriate material and load resisting system, including considering the possibility of reuse or recycling of materials throughout the design and planning phase.

Working with the rest of the design team, they can influence long life or deconstructability and respond to integrated sustainability design solutions. Also, often times the engineers must be able to come up with creative solutions to support sustainable design practices while at the same time maintaining public safety.

The minimisation of embodied impacts and maximising longevity or durability is an opportunity. However, availability of comparable data and the fact that the weighting of different environmental impacts is subjective makes consideration of embodied impacts difficult. Durability is a more familiar concept and more easily quantified. Efficiency of structural design is part of a structural engineer's reason for existence, but this takes nothing away from its importance in terms of sustainability after all it results in minimising material usage. Efficiency is also achieved when the structure serves other functions such as fire compartmentation, noise separation or provision of thermal mass.

Often times, the Structural Engineer may choose the material for a new project. Ease of production, availability, ease of transportation, and ease of construction, efficiency, and lifespan of a material are all considered when choosing a project material such as concrete, masonry, steel and wood or combinations of these materials.

1.8 Case study of K L U Library building

KL University is a 30-year old institution, is modernizing its sylvan campus on the banks of Krishna River in Vijayawada. The total area of the university is 45 acres. In the development of the university they are constructing G + 7 library building with an area on 1.7 lakh sft. The library is surrounded by EEE Department on right side, CSE Department on backside with FED on the left side to facilitate the students. The library consists of 1,600 intentional journals and the estimated construction cost of library is 40 crores and the university is going for green building certification.

1.9 Objectives of The Present Study

i. To rationalized the vision of green buildings to Civil Engineers.

ii. To know about different types of rating systems present in the world.

iii. To design conceptually for material selection, site selection, water efficiency, natural ventilation and natural day lighting to the building structures.

iv. To investigate the influence of construction material on reducing virgin materials consumption.

v. To investigate the maximum possible points to get LEED certification to the K L U Library building.

1.10 Organization of the Report

This report is divided in nine chapters.

In chapter 2, focuses on green site-planning strategies and practices that relate to assessing and selecting a site for uses such as office buildings and parks, institutional structures and libraries. The purpose of sustainable site planning is to integrate design and construction strategies by modifying both site and building to achieve greater human comfort and operational efficiencies. In this detailed LEED NC table for site selection and planning is given.

In Chapter 3, focuses on water efficiency and briefly discuss about measures to take to get maximum efficiency, harvesting techniques, landscaping, Indoor Water Conservation, grey water systems and black water systems. At last LEED NC table for water efficiency is given.

In Chapter 4, Building commissioning, renewable energy and types of renewable energy was explained and Heating, Ventilating, and Air-Conditioning with explained with LEED certification credit system.

Utilization of waste materials and by-products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete, and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment form possible pollution effects. Further, their utilization may improve the microstructure, mechanical and durability properties of mortar and concrete and the resources is presented and LEED certification table for materials and resources are given in Chapter 5.

In Chapter 6, a tool for green building material selection, BEES is used to identify the material which is economic and environmental performance of the material. The tool gives about 230 materials used in the construction based on the processing, distance from manufacturer and site, locally available materials etc...

In Chapter 7, briefly discuss about day lighting, indoor environment quality, lighting and passive solar energy is explained and LEED credit points is given.

In Chapter 8, in this Innovation & Design Process of K L U Library building construction is given and also explains about sustainable construction management of a building is explained.

In Chapter 9, brief summary of the works carried out, and final conclusions drawn from this study, are presented. Future works that can be done in continuation with the present study on green buildings are also suggested.

CHAPTER-2

SITE SELECTION AND PLANNING

2.1 Introduction

This chapter focuses on green site-planning strategies and practices that relate to assessing and selecting a site for uses such as office buildings and parks, institutional structures and libraries. The purpose of sustainable site planning is to integrate design and construction strategies by modifying both site and building to achieve greater human comfort and operational efficiencies [17].

Site planning assesses a particular landscape to determine its appropriate use, and then maps the area's most suitable for accommodating specific activities associated with that use. The process is based upon the premise that any landscape setting can be analyzed and studied as a series of interconnected geological, hydrological, topographic, ecological, climatological, and cultural features and systems. An ideal site plan is one in which the arrangement of roads, buildings, and associated uses is developed using site data and information from the larger macro-environment, including existing historical and cultural patterns of the community.

Selecting a building site begins the process of calculating the degree of resource use and the degree of disturbance of existing natural systems that will be required to support a building's development. The most environmentally sound development is one that disturbs as little of the existing site as possible. Therefore, sites suitable for commercial building should ideally be located within or adjacent to existing commercial environments. Building projects also require connections to mass transit, vehicular infrastructure, and utility and telecommunication networks. Sound site planning and building design should consider locating building-support services in common corridors, or siting a building to take advantage of existing service networks. This consolidation can minimize site disruption and facilitate building repair and inspection [17].

The use, scale, and structural systems of a building affect its particular site requirements and associated environmental impacts. Building characteristics, orientation, and placement should be considered in relation to the site so that proper drainage systems, circulation patterns, landscape design, and other site-development features can be determined. Development and construction processes are often destructive to local ecology. These activities also encroach on productive agricultural land areas and open space. Stormwater runoff from developed areas can impact water quality in receiving waters, hinder navigation and recreation, and disrupt aquatic life. Fortunately, steps can be taken to reduce impacts on previously undeveloped lands and to improve previously contaminated sites [18].

Selection of an appropriate project location can reduce the need for private automobile use and reduce urban sprawl. Locating developments on existing brownfield sites, in existing urban infill areas and on other non-Greenfield locations may have economic benefits. For example, the infrastructure to service the development may already be in place. When considering site alternatives, it is important to consider environmental criteria throughout the site selection process.
The major ecological features of the site should be identified, including the site geology, hydrology, vegetation, wildlife and prior site history. Communication with project stakeholders, including building occupants, the general public and site neighbors can be facilitated through public meetings, design charrettes and organized comment processes. It is also important to minimize project impacts on surrounding

areas after construction is complete and the building is occupied. By addressing heat island effects and reducing light pollution on the site, the site can become integrated into its surroundings and serve as a considerate and beneficial neighbor for the lifetime of the building [18].

2.2 Practices for Site Selection and Planning

The first thing to do for site selection is Site Analysis and Assessment. The purpose of a site analysis is to break down the site into basic parts, to isolate areas and systems requiring protection, and to identify both off-site and on-site factors that may require mitigation. Site assessment is a process that examines the data gathered and identified in the site analysis, assigns specific site factors to hierarchies of importance, and identifies, where possible, interactive relationships. For example, an analysis may identify specific soils and their properties, vegetation types and their distribution, or various slope and slope-orientation conditions to name a few site factors. An assessment applies evaluation criteria that allow the comparison of various sites' suitability for a specific use.

Sustainable design practices assess both site and building program to determine the site's capacity to support the program without degrading vital systems, or requiring extraordinary development expenditures. The result of analysis and assessment is a blueprint for the most appropriate ecological and physical fit between site, building, and the resulting cultural landscape [17].

2.2.1 Site Characteristics for Green Building Design

The following site characteristics influence building design elements, including form, shape, bulk, materials, skin-to-volume ratio, structural systems, mechanical systems, access and service, solar orientation, and finished floor elevation:

a. Geographical latitude (solar altitude) and microclimate factors, such as wind loads Affect building layout, including solar orientation and location of entrances, windows, and loading docks.
b. Topography and adjacent landform Influence building proportions, wind loads, drainage strategies, floor elevations, and key gravity-fed sewer-line corridors
c. Groundwater and surface runoff characteristics— determine building locations as well as natural channels for diverting storm runoff and locations of runoff detention ponds.
d. Solar access Determines position of building to take maximum advantage of natural solar resources for passive solar heating, daylighting, and photovoltaics.
e. Airmovement patterns, both annual and diurnal particularly influence siting of multiple structures to avoid damming cold moisture-laden air, or blocking favorable cooling breezes during periods of overheating. Properly measured wind loads and pressure differentials are essential for designing interior air-handling systems or use of passive solar cooling strategies.
f. Soil texture and its load-bearing capacity Determine building location on the site and the type of footing required. Identify site-grading processes by the soil's potential for erosion by wind, water, and machine disturbance.
g. Parcel shape and access affect a site's capacity to accommodate a proposed development, even if its size and environmental factors are favorable. Potential access points should not burden lower-density or less compatible adjacent land use. Zoning setbacks and easements can also affect development potential.

h. Neighboring developments and proposed future developments Affect proposed project and may lead to requisite design changes.

Analyze specific characteristics of climate zones. Climate zones like hot-humid, hot-arid, temperate, and cold have specific characteristics requiring mitigation, augmentation, and exploitation. Each climate zone suggests historically amenable siting and building practices [17].

2.2.2 Site's Existing Air Quality

Most state and federal projects require an environmental impact statement (EIS) outlining the potential negative impacts of a proposed development and how they might be alleviated. Site planning requires two kinds of air-quality analysis regarding:

1. Assessment of the existing air quality of the site to determine the presence of noxious chemicals and suspended particulates, and
2. Projection of the negative consequences (if any) of the proposed development on existing air quality. In primarily commercial or industrial areas, poor air quality should be a key factor in determining site suitability and use, especially for such facilities as schools, parks, or housing for seniors. Testing should anticipate seasonal or diurnal wind patterns to make certain that the worst possible case is tested. Certified labs should perform testing to determine both chemical and particulate pollution.

Perform soil and groundwater testing to identify the presence of chemical residues from past agricultural activities (arsenic, pesticides, and lead); past industrial activities (dumps, heavy metals, carcinogenic compounds and minerals, and hydrocarbons); and any other possible contamination both on and in the vicinity of the subject site. Also, the possibility of water contamination, in areas where the native rock and substrata are radon-bearing deserves specific attention. These tests are crucial to determine both site feasibility and/or the construction methods required to either mitigate or remove contaminants.

Test soil suitability for backfills, slope structures, infiltration**.** The native soil should be tested to determine bearing, compactability, and infiltration rates, and, in turn, structural suitability and the best method for mechanical compaction (i.e., clay soils require non-vibrating compaction and non-erosive angles of repose for cut-and-fill slopes).

In addition to wetland regulations governing vegetative-cover removal, grading, drainage alterations, building siting, and stormwater runoff mitigation, there are endangered species regulations designed to preserve specific plant and animal species. Preservation and restoration strategies require thorough economic analysis, specialized expertise, and sound baseline data gathered through both remote and on-site sensing methods.Examine existing vegetation to inventory significant plant populations. This will enable the developer or owner to later specify vegetation that is susceptible to damage during construction, so that protective measures can be developed and implemented.

Map all natural hazard potentials (such as winds, floods, and mudslid**es)** Historic flood data, wind-damage data, and subsidence data should be mapped along with current annual wind and precipitation data. It is important to indicate if the proposed development is within a statistically significant probability of sustaining impacts within the near future. Often, evidence of past occurrences is not visible. Subsurface investigation may yield data on surficial rock strata or uncharted previous