VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELGAUM

GREEN BUILDINGS

(Subject Code: BETCK105B)

LECTURE NOTES

(MODULE-4)

I-SEMESTER

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Module -4

Green Building Rating Systems

BREEAM

BREEAM (Building Research Establishment Environmental Assessment Method) is a widely used environmental assessment method for buildings and communities. It evaluates the sustainability and environmental performance of a building and provides a rating based on its environmental impact, including energy efficiency, waste management, water use, materials, health and well-being, pollution, and transport. BREEAM is used in over 80 countries and is recognized as a leading tool for promoting sustainable building design and construction.

Environmental Assessment Method (BREEAM) of the Building Research Establishment (BRE) was originally established in the United Kingdom in 1990.

Design, specification, construction, and operation of buildings are governed by a set of best practise standards for environmental performance.

- Standard categories of development (offices, retail developments, education buildings, and healthcare buildings) are benchmarked by BREEAM, while non-standard buildings are assessed using a customised scheme.
- It can be used for new construction or renovation projects, and global programs are available for developments beyond UK.
- It gives clients, project team members, and facility management peace of mind that their project is following the needed standard of environmental professional standards.
- It can also be used to attract potential buyers or tenants as a marketing strategy. (BRE Group, 2021)

The BREEAM rating system is a globally renowned indicator of a building's sustainability.

A total of 594,011 buildings have been BREEAM certified, with another 2,313,475 on the waiting list.

While many of these are in the United Kingdom, there are currently more than 89 nations where they can be found. With variations for new structures, existing buildings, rehabilitation projects, and big developments, the BREEAM standard can be applied to a wide range of building types and regions. On a scale of 'Pass', 'Good', 'Very good', 'Excellent', and 'Outstanding', these projects are evaluated, scored, and certified. (BRE Group, 2016)

Ratings and Scoring

The total performance of a new building project evaluated using BREEAM is based on the number of factors.

- The BREEAM rating system establishes benchmarks.
- The BREEAM minimal requirements.
- The weightings for the environmental component
- Issues and awards in the BREEAM evaluate.

BREEAM Rating	Score (in %)
OUTSTANDING	≥85
EXCELLENT	≥ 70
VERY GOOD	≥ 55
GOOD	≥ 45
PASS	≥ 30
UNCLASSIFIED	<30

In this regard, each BREEAM rating level generally equates to the following results:

- **Outstanding:** Only 1% of new non-domestic buildings in the UK are in the top 1%.
- **Excellent:** Best 10% of new non-domestic buildings in the UK.
- **Very Good:** Top 25% of new non-domestic structures in the UK.
- **Good:** The top half of new non-domestic buildings in the UK.
- **Pass:** The topmost 75% of new non-domestic buildings in the UK.
- **Unclassified** BREEAM ratings indicate non-compliance with BREEAM in terms of meeting either the BREEAM minimum performance standards for major environmental concerns or the total minimum score essential for official BREEAM accreditation. (BREEAM, 2021)

The BREEAM assessment method is supported by a global network of over 2600 independent BREEAM Assessors who are all properly qualified and certified. This method adds to the belief that BREEAM-rated buildings are truly as sustainable as they promise to be- and that the highest-scoring structures are some of the outstanding models of sustainable innovation and construction in the UK and around the world. (BRE Group, 2016)

BREEAM Criteria:

Trained evaluators carry out BREEAM assessments, which are scored using a nine-criteria scoring system:

1. Energy
2. Land use and ecology
3. Water
4. Health and wellbeing
5. Pollution
6. Transport
7. Materials
8. Waste
9. Management

Conclusion

- Environmental weightings are an important part of any project environmental evaluation procedure since they allow you to define and rank the relative impact of various environmental issues.
- BREEAM employs a specific weighing method that is generated from a combination of consensus-based weightings and expert rating.
- The results of this activity are then used to calculate the respective importance of each of the BREEAM environmental components and their impact on overall BREEAM score. (BREEAM, 2021).

Environmental Section	Weighting
Management	12%
Health & wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%
Total	100%
Innovation (additional)	10%

The weightings for each of the nine environmental areas included in the BREEAM New Construction scheme are shown in the table above. Each criterion is given a score, which is then multiplied by a weighting.

There are minimal requirements to be met, with exception provided for special breakthroughs. Unclassified, pass, good, very good, excellent, or outstanding are the BREEAM grades that derive from the overall score.

Each category concentrates on the main important issues, such as carbon reduction, low-impact design, climate change mitigation, environmental value, and biodiversity preservation. (BRE Group, 2021) (NBS,2016)

LEED (Leadership in Energy and Environmental Design)

Introduction

The most extensively used green building rating system in the world is LEED.

- LEED is a framework for healthful, extremely efficient and cost-effective green buildings that is applicable to practically all building types.
- LEED certification is a worldwide recognised mark of excellence and leadership in the field of sustainability.
- LEED is applicable to all types of buildings and phases of construction, including new construction, interior fit, maintenance and repair, and core and shell. (USGBC, 2021).

The United States Green Building Council (USGBC) developed the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, which provides a set of standards for ecologically sustainable building design, construction, and management. LEED has expanded to include nearly 14,000 projects in the United States and 30 countries, comprising 1.062 billion square feet (99km^2) of construction space since its establishment in 1998. (Environment and Ecology, 2021)

LEED Certification

LEED's versatility allows any project or building type to pursue certification, from commercial buildings to residences to cathedrals to schools.

- The LEED grading system has been modified by the USGBC so that new development, interiors, residential structures, residences, localities, and even entire cities and communities can receive certification.

- Buildings are essentially about people, which is why LEED-certified structures indicate that public health and well-being were prioritised throughout construction. (USGBC, 2021).
- Platinum, Gold, Silver, and Certified are the four LEED certification Levels.
- All projects must meet statutory criteria and then choose from 100 available credit points to reach the targeted certification rank, regardless of certification level.
- The LEED Platinum level certification is the highest award, while the LEED Certified level certification is the most basic.
- Apart from 100 credit points it has 6 additional points for innovation and 4 additional points for regional priority which makes a total of 110 credit points. (Emerald Built Environments, 2021)

The above-mentioned figure shows certification points:

- Certified – 40-49 points
- Silver – 50-59 points
- Gold – 60-79 points
- Platinum – 80 points and above

LEED certification demonstrates that a building has gone above and beyond to guarantee that it is built and operated in the most environmentally friendly manner possible. To gain LEED certification, project team members must follow the requirements and credits across nine building excellence measurements, ranging from integrated operations to building materials to indoor air quality, in order to receive points indicated in the grading system. (USGBC, 2021)

Benefits of LEED Certified Building

- Spaces in LEED buildings have been demonstrated to have superior indoor air quality than other offices due to their unique green HVAC systems fitted with antimicrobial, allergy-friendly filters.
- It might reduce the amount of sick leave taken by the staff throughout the year, resulting in higher productivity level.
- Air quality-related illnesses can be decreased by up to 50% in spaces that have been modified to meet LEED requirements.
- LEED-certified buildings, according to studies, can help companies recruit and retain skilled people.
- Furthermore, LEED-certified offices have a high level of employee engagement, which reduces staff turnover. This is notably evident among Millennials, who have been found to value working for environmentally conscious companies.
- If the company is trying to go green, LEED office space can help company achieve those goals. The buildings are more eco-friendly, and they will fit nicely with the long-term sustainability strategy.
- Buildings that are LEED accredited use less water and power. The bottom line will benefit from decreased utility usage.
- Recycling and composting programmes are common in LEED buildings, allowing trash to be recycled and composted.
- This can help companies save a lot of money on garbage removal. Companies may even obtain refunds from the sale of recycled products in some situations.

Conclusion

- Energy saving and other resources conservation strategies reduce the building sector's environmental effect while lowering total cost of ownership.
- On the other hand, a green certification validates that the structure was constructed in a sustainable way.
- Property developers can certify their properties to draw clients, and organisations in general can certify their buildings to boost public reputation.
- The construction industry accounts for 40% of worldwide energy consumption and emissions, and green construction may significantly minimise its impact on the environment.

- Businesses benefit from green buildings as well: they have cheaper ownership costs and a better internal environment, which improves human performance and wellbeing.

GREEN STAR

Introduction

- Authentication of green development, construction, and operation of buildings and community developments is provided by the Green Star certification programme.
- The Green Building Council of Australia introduced Green Star in 2003, and it is Australia's only fully accredited and independent system of environmental sustainability grading.

Green Star is a programme that strives to improve the built environment by:

- Reducing climate change impact.
- Preserving and conserving our planet's natural environment.
- Creating sustainable solutions for buildings, fitouts, and societies.
- Contributing to market expansion and a sustainable economy increasing our health and quality of life.

(Certified Energy, 2021) (Green Building Council of Australia, 2020)

Green Star is a trademark for a certification programme:

- Green Star employs a rigorous, transparent, and impartial assessment procedure, and projects that achieve certification can display the Green Star Certification Trademark openly.
- Only projects that have been certified by Green Star are eligible for a Green Star rating.
- Projects that pretend to satisfy Green Star standards but are not certified may be accused of "greenwashing", which is a trademark violation.

How does it work?

Green Star evaluates a project's sustainability features using evaluation metrics. Each category contains several issues relating to a certain sustainable impact, which are referred to as "credits".

- Each of these activities is a criterion, and each credit addresses an initiative that improves or has the potential to improve a project's sustainability performance.

- By altering the number of points offered, credits are evaluated in respect to one another.
- Each credit specifies a specific result that a project must achieve.
- A project will be rewarded with the appropriate points available if the outcome is verified to have been fulfilled.
- After all credits have been evaluated, the overall number of points earned is evaluated to the number of points available in the rating system, and a verified rating is given.
- The term "certification" refers to projects that have shown that they have met a certain level of sustainability.
- The rating expresses the project's sustainability characteristics in ways that are widely recognised and accepted.

Green Star Rating System is based on six-star rating system. (Green Building Council of Australia, 2020)

Conclusion

- About 26 percent less energy is used in these buildings than in typical commercial ones.
- Emissions are reduced by 33 percent, according to the Environmental Protection Agency (EPA).
- Improving the respiratory health of building occupants with improved ventilation systems.

- Creating a healthier and safer living environment through the use of non-toxic materials.
- Making the space more inviting and hospitable by allowing abundant sources of daylight into the space.
- Producing 62 percent fewer greenhouse gas emissions than the national average for commercial buildings in Australia.
- In comparison, the average Australian construction project recycles only 58 percent of its waste.
- Reducing the consumption of potable water by 51 percent.

GRIHA (Green Rating for Integrated Habitat Assessment)

Introduction

The Sanskrit term GRIHA means 'Abode'. Human dwellings (buildings) have a variety of interactions with nature.

They use resources in the form of energy, water, resources, and other elements throughout their life spans, from development to operation to deconstruction, and generate wastes either typically in the form of waste materials or indirectly as emissions from energy generation.

- GRIHA aims to keep a structure's energy usage, waste output, and general environmental effect to a minimum, based on nationally accepted norms and standards. (GRIHA Council, 2021)
- The Green Rating for Integrated Habitat Assessment (GRIHA) Council is a non-profit organisation established by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE) of the Government of India to encourage and administrate green buildings in India.
- GRIHA was approved as the National Rating System for Green Buildings in India by the Ministry of New and Renewable Energy (MNRE) in 2007.
- GRIHA measures a building's environmental performance across its lifespan using statistical and qualitative criteria, resulting in a clear standard for green buildings and green environments. (Globalabc, 2021)

Rating Structure of GRIHA

- The below mentioned table shows the rating structure of GRIHA, this structure is followed while rating a building.
- It has 10 sections and an additional section (Innovation), all these sections have different criterion as mentioned in the table below and the maximum points are allotted to each section.
- If a building receives a score of 25-40, it will be given one star, 41-55 two stars, 56-70 three stars, 71-85 four stars, and above 86 five stars, as illustrated below.

GRIHA V 2019 Rating Thresholds	GRIHA Rating
25-40	★
41-55	★★
56-70	★★★
71-85	★★★★
86 or more	★★★★★

GRIHA V.2019			
SECTION	CRITERION NO.	CRITERION NAME	MAXIMUM POINTS
1. SUSTAINABLE SITE PLANNING	1	GREEN INFRASTRUCTURE	5
	2	LOW IMPACT DESIGN	5
	3	DESIGN TO MITIGATE UHIE	2
2. CONSTRUCTION MANAGEMENT	4	AIR AND SOIL POLLUTION CONTROL	1
	5	TOP SOIL PRESERVATION	1
	6	CONSTRUCTION MANAGEMENT PRACTICES	2
3. ENERGY EFFICIENCY	7	ENERGY OPTIMIZATION	12
	8	RENEWABLE ENERGY UTILIZATION	5
	9	LOW ODP AND GWP MATERIALS	1
4. OCCUPANT COMFORT	10	VISUAL COMFORT	4
	11	THERMAL AND ACOUSTIC COMFORT	2
	12	MAINTAINING GOOD IAQ	6
5. WATER MANAGEMENT	13	WATER DEMAND REDUCTION	3
	14	WASTEWATER TREATMENT	3
	15	RAINWATER MANAGEMENT	5
	16	WATER QUALITY AND SELF-SUFFICIENCY	5
6. SOLID WASTE MANAGEMENT	17	WASTE MANAGEMENT-POST OCCUPANCY	4
	18	ORGANIC WASTE TREATMENT ON-SITE	2
7. SUSTAINABLE BUILDING MATERIALS	19	UTILIZATION OF ALTERNATIVE MATERIALS IN BUILDING	5
	20	REDUCTION IN GWP THROUGH LIFE CYCLE ASSESSMENT	5
	21	ALTERNATIVE MATERIALS FOR EXTERNAL SITE DEVELOPMENT	2
8. LIFE CYCLE COSTING	22	LIFE CYCLE COST ANALYSIS	5
9. SOCIO-ECONOMIC STRATEGIES	23	SAFETY AND SANITATION FOR CONSTRUCTION WORKERS	1
	24	UNIVERSAL ACCESSIBILITY	2
	25	DEDICATED FACILITIES FOR SERVICE STAFF	2
	26	POSITIVE SOCIAL IMPACT	3
10. PERFORMANCE METERING AND MONITORING	27	COMMISSIONING FOR FINAL RATING	7
	28	SMART METERING AND MONITORING	0
	29	OPERATION AND MAINTENANCE PROTOCOL	0
TOTAL POINTS			100
11. INNOVATION	30	INNOVATION	5
GRAND TOTAL POINTS			100 + 5

Conclusion

These systems will benefit the entire community by reducing GHG (greenhouse gas) emissions, limiting energy usage and relieving stress on environmental assets.

The following are some of the advantages of a green design to a building owner, user, and society as a whole:

- Lower energy usage while maintaining the same degree of comfort.

- Reduced deforestation, habitat damage, and biodiversity loss, as well as soil erosion.
- Pollution of the air and water is reduced (with direct health benefits)
- Water use is reduced.
- Due to recycling and reuse, waste generation is kept to a minimum.
- Pollution loads are reduced.
- User productivity has increased.
- Illustration and marketability of Green Buildings have improved.

Green Design

Definition

Green design, also known as sustainable design or environmentally responsible design, is a philosophy and approach to design that considers the environmental impact of a product or structure throughout its entire lifecycle, from raw material extraction and production to disposal or recycling. The goal of green design is to create products, buildings, and spaces that are efficient, healthy, and respectful to the environment while also being aesthetically pleasing and functional. This approach considers factors such as energy efficiency, water conservation, waste reduction, the use of sustainable materials, and the reduction of environmental pollutants. The ultimate goal is to create a harmonious balance between human needs and the natural world, while minimizing negative impact on the environment.

Principles of sustainable development in Building Design

Sustainable development in building design involves incorporating environmentally responsible and resource-efficient principles into the design and construction of buildings. The following are some of the key principles of sustainable development in building design:

1. Energy Efficiency: Incorporating energy-efficient systems and technologies such as insulation, efficient heating and cooling systems, and renewable energy sources to reduce the building's energy consumption and dependence on fossil fuels.
2. Water Conservation: Implementing water-saving measures such as low-flow toilets, showerheads, and faucets, rainwater harvesting, and greywater reuse to reduce water usage and protect precious water resources.
3. Material Selection: Choosing materials that are environmentally friendly, sustainably sourced, and have low embodied energy and embodied water. This includes materials such as bamboo, recycled steel, and sustainable timber.

4. Indoor Environmental Quality: Providing a healthy indoor environment by using materials that do not emit toxic fumes, ensuring adequate ventilation, and incorporating natural light and thermal comfort measures.
5. Site and Landscape Design: Protecting and preserving the natural environment by minimizing site disturbance, preserving existing vegetation, and incorporating green spaces into the design.
6. Waste Management: Minimizing waste by designing for deconstruction and recycling, using recycled materials, and implementing a comprehensive waste management plan.
7. Life Cycle Assessment: Conducting a life cycle assessment to evaluate the environmental impact of a building over its entire lifecycle, from construction to demolition and beyond.

By incorporating these principles into the design process, sustainable development in building design aims to create buildings that are environmentally responsible, resource-efficient, and provide a healthy indoor environment for their occupants.

Characteristics of Sustainable Buildings

Sustainable buildings are designed and constructed to minimize their environmental impact, promote human health and well-being, and use resources efficiently. The following are some of the key characteristics of sustainable buildings:

1. Energy Efficiency: Sustainable buildings are designed to minimize energy consumption through efficient insulation, glazing, heating and cooling systems, and the use of renewable energy sources.
2. Water Conservation: Sustainable buildings feature water-saving measures such as low-flow fixtures, rainwater harvesting, and greywater reuse to conserve water resources.
3. Material Selection: Sustainable buildings use environmentally friendly, sustainably sourced, and low-embodied energy and water materials in their construction.
4. Indoor Environmental Quality: Sustainable buildings promote healthy indoor air quality and thermal comfort through the use of non-toxic materials, adequate ventilation, and natural light.
5. Site and Landscape Design: Sustainable buildings are designed to minimize site disturbance, protect and preserve existing vegetation, and incorporate green spaces.
6. Waste Management: Sustainable buildings implement waste reduction, reuse, and recycling strategies to minimize waste and conserve resources.

7. Life Cycle Assessment: Sustainable buildings are designed and constructed with the full lifecycle of the building in mind, including the use of life cycle assessment to evaluate the environmental impact of the building.
8. Flexibility and Adaptability: Sustainable buildings are designed to be flexible and adaptable to accommodate changing needs and uses over time, reducing the need for frequent renovations and building replacement.

By incorporating these characteristics, sustainable buildings provide a healthy and comfortable living and working environment while reducing their impact on the environment and conserving resources.

Sustainably managed Materials

Sustainably managed materials are materials that are produced, used, and disposed of in a manner that minimizes their environmental impact and promotes sustainable development. This includes materials that are:

1. Renewable: Materials that can be replenished over time, such as wood, bamboo, and cork, rather than finite resources like fossil fuels.
2. Recyclable: Materials that can be recovered and reused at the end of their useful life, reducing waste and conserving resources.
3. Environmentally friendly: Materials that are free from toxic chemicals and emit low levels of pollutants during production, use, and disposal.
4. Sustainably sourced: Materials that are harvested or extracted in a manner that minimizes harm to the environment and wildlife, and supports local communities.
5. Efficiently produced: Materials that are produced using energy-efficient processes, reducing their embodied energy and carbon footprint.

By using sustainably managed materials, we can reduce the environmental impact of the materials we use and promote sustainable development. This helps to conserve resources, reduce waste, and support the transition to a more sustainable future.

Integrated Lifecycle design of Materials and Structures

Integrated lifecycle design of materials and structures is a design approach that considers the entire lifecycle of a building or structure, from the extraction of raw materials to the end of its useful life, when it is decommissioned or recycled. This approach takes into account the environmental impact of a building or structure throughout its entire lifecycle, and seeks to minimize that impact by making informed choices about materials and construction practices.

Some of the key elements of integrated lifecycle design of materials and structures include:

1. Material selection: Choosing materials that are environmentally friendly, sustainably sourced, and have low embodied energy and embodied water.
2. Life cycle assessment: Evaluating the environmental impact of a building or structure over its entire lifecycle, from construction to demolition and beyond, to determine areas where improvements can be made.
3. Design for deconstruction and recycling: Incorporating design elements that facilitate the deconstruction and recycling of a building or structure at the end of its useful life.
4. Durability and maintainability: Designing structures and materials to last, reducing the need for frequent repairs and replacements, and incorporating elements that are easy to maintain.
5. Energy efficiency: Incorporating energy-efficient systems and technologies such as insulation, efficient heating and cooling systems, and renewable energy sources to reduce the building's energy consumption and dependence on fossil fuels.

By integrating these elements into the design process, integrated lifecycle design of materials and structures aims to create buildings and structures that are environmentally responsible, resource-efficient, and have a minimal impact on the environment throughout their entire lifecycle.

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REVIEW QUESTIONS

1. Explain the green rating systems:
   a. BREEAM
   b. LEED
   c. GREENSTAR
   d. GRIHA
2. What is green design? Explain the Principles of sustainable development in Building Design.
3. Briefly explain the characteristics of sustainable buildings.
4. Explain Sustainably managed Materials.
5. Briefly explain Integrated Lifecycle design of Materials and Structures.

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