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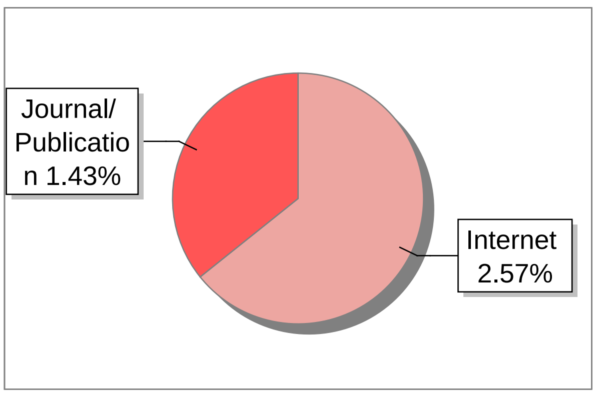

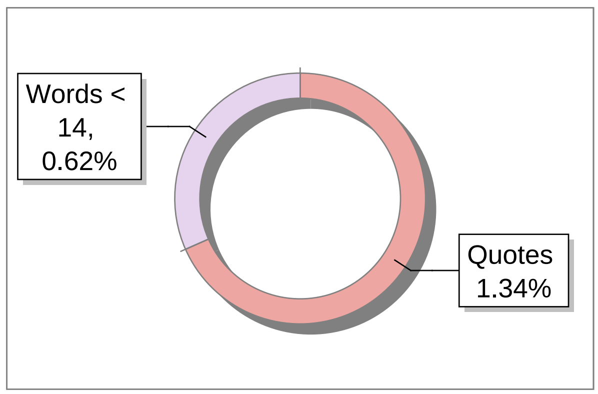

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SOLADEVANAHALLI, BENGALURU -560107

"Towards Sustainable Built Environments: Aligning G20 and UN 2030 Goals"
A case of a Aeropace Research Development center.

ARCHITECTURE DESIGN PROJECT (THESIS) – 2022-23

Submitted in partial fulfillment of the Requirements for the

“Bachelor of Architecture” Degree Course

Submitted by : Akshath Reddy.U
USN :1AA19AT004
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A project report submitted to

VISVESHWARAYA TECHNOLOGICAL UNIVERSITY

“Jnana Sangama”, Machhe, Belgaum – 590018

ವಶವ◌ೇಶವರಯಯ ತಾಂತರಕ ವಶವವದಯಾಲಯ, ಬಳಗಾವ - ೫೯೦೦೧೮

CERTIFICATE

This is to certify that this thesis report titled by “Towards Sustainable Built Environments: Aligning G20 and UN 2030 Goals"A case of Aerospace Research Development Center of by AKSHATH REDDY.U IX SEMESTER B. Arch, USN No. 1AA19AT004, has been submitted in partial fulfillment of the requirements for the award of under graduate degree **Bachelor of Architecture (B.Arch)** by Visveshwaraya Technological University VTU, Belgaum during the year 2023- 24.

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Principal

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DECLARATION

This thesis title "by "Towards Sustainable Built Environments: Aligning G20 and UN 2030 Goals"A case of Aerospace Research Development Center", submitted in partial fulfillment of the requirement for the award of the undergraduate of Bachelor of architecture is my original work to the best of my knowledge.

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ABSTRACT

This thesis explores the application of Sustainable Development Goals (SDGs) within an Aerospace Research Development Centre, focusing on mitigating greenhouse gases and addressing waste stemming from the architectural sector. Through the lenses of energy efficiency, circular economy, and digital twin technology, the study aims to create a more sustainable built environment.

The project delves into aligning SDGs to combat greenhouse gas emissions, emphasizing the implementation of energy-efficient practices within the aerospace centre to reduce its environmental footprint. Additionally, it investigates the adoption of circular economy principles to minimize waste and enhance resource reuse within the architectural sector. Furthermore, the study evaluates the integration of digital twin technology to optimize resource management and operational efficiency, reducing the environmental impact of these centres.

The research aims to illustrate the convergence of SDGs with specific methodologies in Aerospace Research Development Centres. It seeks to combat greenhouse gases and architectural waste, ultimately contributing to a more sustainable, environmentally conscious built environment.

Table of Contents

INTRODUCTION

AIM

AIM- To understand how important it is necessary to evaluate pre, during and post construction (life cycle assessment) in future. WE as architectural fraternity need to look beyond the demand , economic factor and apply these best practices in every day design for comacting Climate change.

Comprehensive Environmental Assessment:

- **Pre-Construction Evaluation:**
  - **Material Sourcing:** Assessing the environmental impact of materials. Opting for sustainable, locally sourced, and renewable materials reduces the carbon footprint.
  - **Design Optimization:** Incorporating sustainable design principles right from the conceptual stage ensures energy efficiency and reduces waste.
- **During Construction Assessment:**
  - **Construction Processes:** Monitoring construction methods to ensure minimal waste generation and energy efficiency. Adopting eco-friendly practices during the building phase is crucial.
- **Post-Construction Assessment:**
  - **Operational Efficiency:** Evaluating how the building functions post-construction is critical. Assessing energy usage, waste management, and the building's overall environmental impact in its operational phase is vital.
  - **Adaptability and Longevity:** Designing buildings for adaptability and longevity reduces the need for frequent reconstruction, ultimately minimizing environmental strain.

- **Prioritizing Sustainability:** Moving beyond mere economic factors to prioritize sustainability. Design choices based on long-term ecological impact rather than short-term cost savings are crucial.
- **Advocating Holistic Design:** Encouraging holistic design that incorporates energy efficiency, waste reduction, and renewable resources, considering the entire life cycle of the building.

Combating Climate Change:

- **Reducing Carbon Footprint:** Implementing life cycle assessments aids in reducing the carbon footprint of buildings, a significant contributor to climate change.
- **Mitigating Resource Depletion:** By considering the life cycle impact, architects can mitigate resource depletion and environmental degradation.

Future Necessity:

- **Regulatory and Societal Demand:** With increasing regulatory demands and societal consciousness about environmental impact, considering life cycle assessments in design is becoming imperative.
- **Long-Term Viability:** In the face of climate change, sustainable design practices become a marker of long-term viability for the architectural fraternity, ensuring future relevance and resilience.

OBJECTIVE

- Objective- to understand the core of sustainibality
- 1)To develope relationship between tchnology and architecture to achive sustainability
- 2) to define sustianability practices architectureal built spaces beyond green rating systems
- 3) built enviornment as well as material cycle , relooking ar design principles in architectural spatial development in terms
- The principles of sustainability in architectural design and the built environment. This involves delving into the core concepts and ideologies that define sustainability within the context of architecture.

Establishing the Relationship Between Technology and Architecture for Sustainability:

  - Investigate how technological advancements and innovations can be integrated into architectural practices to achieve sustainability goals. This involves examining the symbiotic relationship between technological solutions and architectural design for environmental preservation and efficiency.
- **Reimagining Sustainability Beyond Green Rating Systems in Architectural Practices:**
  - Define sustainability practices that transcend conventional green rating systems in architectural design. Explore and establish new metrics or paradigms for sustainability, moving beyond standardized assessments and delving into more comprehensive, holistic approaches to sustainable architecture.

Rethinking Architectural Design Principles for Sustainability in Built Environments and Material Cycles:

- Evaluate the existing design principles within architecture and spatial development through a sustainability lens. Explore how these principles can be adapted or redefined to address material cycles, energy consumption, waste management, and overall environmental impact. The objective is to reimagine architectural design in a way that fosters sustainability not just in the design phase but also throughout the entire life cycle of the built environment.

These objectives collectively aim to deepen the understanding of sustainability within architecture, emphasize the integration of technology to achieve sustainability goals, expand the scope of sustainability beyond traditional metrics, and reconsider design principles to create more environmentally responsible built environments.

SCOPE

The scope of the study encompasses an extensive exploration into sustainable architectural practices and their impact at various stages of the construction life cycle, aiming to address climate change and environmental concerns:

- **Evaluation Across Construction Life Cycle:**
    - Analysing the significance of assessing environmental impact and sustainability at the pre-construction, construction, and post-construction phases. This involves understanding how each phase contributes to the overall environmental footprint of a building.
- **Integration of Technology and Architecture for Sustainability:**
    - Investigating the intersection between technological advancements and architectural practices to achieve sustainable designs. This includes exploring innovative tools, materials, and design methods that reduce the ecological impact of architectural projects.
- **Redefining Sustainability Beyond Green Rating Systems:**
    - Expanding the definition of sustainability in architectural design beyond traditional green rating systems. This involves identifying and adopting alternative or complementary criteria for measuring sustainability, considering broader ecological and social impacts.
- **Revisiting Design Principles for Environmental Impact Mitigation:**
    - Reviewing existing architectural design principles in the context of sustainable development. This encompasses re-evaluating material cycles, energy efficiency, waste management, and other environmental considerations. The aim is to redefine design practices to ensure a more responsible and environmentally conscious built environment.

This scope emphasizesredefined sustainability parameters, and the adaptation of design principles for mitigating environmental impact throughout the architectural life cycle.

INTRODUTION

Sustainability is a word we read and hear about on a daily basis and it is a word that is very misunderstood. Acceptance of the sustainability concept has not been very satisfactory because people have been refusing to change and compromise the lifestyles they live.

Sustainable architecture has become aone of the major concerns in how buildings and cities are being .built because construction is a major global energy consumer.

What does sustainable architecture really mean?

Sustainable architecture is architecture that aims to minimize the negative environmental impact of buildings througimproving efficiency in the use of materials, energy, development space and the ecosystem

Sustainable architecture constant approach to energy and ecological conservation in the design of The built environment Sustainable architecture is generally shown through building materials, construction methods, resource Use and design in general. The design must also cosnist of sustainable operations during the building life cycle,

Including its ultimate demolotion stage also creating a negtive carbon foortprint . The space has to be constructed with the goal/aim of achieving long-term energy and resource efficiency above Being functional and aesthetically excellent .

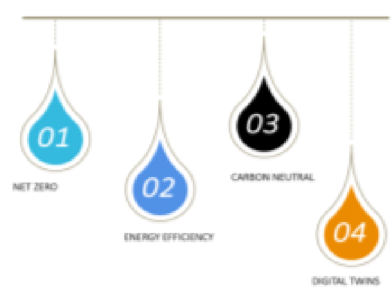


Fig : 1

Research question- to test the hypothesis of how susutinability can be much beyound a best practice of architecture

Rather than a theme-based approach.! In architecture the term sustainability is often tag or theme-based design of a building or space rather than .The default practice itself With the rising environmental concerns and the objective of sustainability flowing across in the field of Architecture .

Sustainability being the part of every design and should be embedded as the core of the building design in All given cases. Now, in recent times the term "sustainability" has more become a selling word /terminology rather than

Actually, looking at what actually is sustainability in the first place,.

"what defines sustainability ..? "

This major terminology has become popular and the hot topic's is because of the rising environmental Concerns in this era .The term sustainability is different and the definition can be different upon one's perspective

There is no such set of key points to consider in order to achieve sustainability as a whole for Sustainability rather is is a points based approach of the more number of points the more sustainable Is your built structure.The thesis would look in detail and precsely how sustinabiliyty can be achived at a much higher and

A superiror level possible .What amount and percentage sustinability canbe achived in the ground realityy , by integrating

Both architecture and technology at one place . To get the best possible outcome .

The thesis would majorly loook at considering two things as the basis to move forward

1) how we as archietcts can contribute to the world by making every space better to live , recide

2) how we as architects also giving back to the nature.

“what defines sustinability ..? ”

Plays a major role and key point where the thesis would be oriented to Taking example of 3 cases of what defines sustainability in terms of building cycle

1) Once the structure is built without giving a taught on the material aspect and the structure once Built becomes / fucntions a net zero building, green building ..etc but yet the building will not be producing Carbon emissions
2) during the whole process of a building construction attention to detail is gven and closely looked Upon considering right from the very initial stage to the end
3) the building actual carbon emsiions / carbon footprint which are emitted in the logn run of a building and

Trying minimize its performance of my building for its next 50- 100 years of ,life span . The thesis would focous on how this problems can be solved using design and technology at the frist place byIncluding best practices in architecture rather than this becoming a theme for architecture and a selling word .This would be an attempt or test the hypothesis of creating the most sutiale / feesible sustinable buiolt enviornment In the best possible way .Basically to re-interpret things by using design and technonology. So susutinability becomes very decisisve in terms where a architect, perosn or an orginization eg-igbc, griha , leed , Bream ..etc look at.
This can varey in prespectives of how sustinability can be best achived in a bets way .

This can be linked to -
The prliminary atage of selectiong the site
Site
Materials
Deisgn(passive and active)
Energy simulations

Net zero concepts

Green building conepts

Performative facades ..etc

The thesis would re-interpret in detail of each and every aspect of build strucute right from the start to the end

In the effort of making built environment a livng organism.

Defining sustinability factors in all tangents

The term sustainability is broadly used to indicate programs, initiatives and actions aimed at the preservation Of a particular resource

Human sustainability aims to maintain and improve the human capital in society. Investments in the health And education systems, access to services, nutrition, knowledge and skills are all programs under the umbrella Of human sustainability.

Social sustinability means to preserve future generations and to acknowledge that what we do can have an impact on others and on the World as it it briefely talks about the how our actions will define and derive the furture genertaions . Social sustainability focuses on Maintaining and improving social quality Social benefits of sustainable architecture:

- improvement of the living conditions, health and comfort of our population
- improvement of air and water quality
- minimization of demand on local utility infrastructure

Envornmental sustinability aims to improve human welbeing trough the protection of naturla elements (land , water , air , ..etc). Initiatives and programs are defined environmentally sustainable when they ensure that the needs of the population are met without the risk of compromising the needs of future generations

Environmental benefits of sustainable architecture:

- conservation and restoration of natural resources
- reduction in energy consumption and waste
- protection of ecosystems and environmental biodiversity
- improvement of air and water quality

SUSTAINABILITY DEVELOPMENT GOALS (SDG'S)

During ,2015, the united nations adopted a set of 17 sustainable development goals (sdgs) to promote prosperity and well-being for all while protecting The environment.

These goals address various global challenges, including poverty, inequality, climate change, and resource depletion architects in architectural practices ,
Interior design, and construction industries should always try to align and understand ,align with these goals to promote a more sustainable future.

The sdg’s are interconnected and mutually reinforcing, meaning that progress in one area can positively impact other goals.
For instance, designing energy-efficient buildings (goal 7) can contribute to reducing greenhouse gas emissions (goal 13) and promoting sustainable
Cities (goal 11).By understanding the connections between the goals, you can create designs and projects with a broader, more significant impact on sustainability.
While the sgd’s were prepared there were closely looked at wwf was involved able to ensure that the sdgs include a lot of .The things that everyone cares about, including goals on:

1)Food and sustainable agriculture
2)Water
3)Energy
4)Sustainable consumption and production
5)Climate change
6)Oceans
7)Ecosystems
8)Forests and biodiversity

THESE ARE THE FOLLOWING SDG'S THAT ARE RELATED TO ARCHITECTURAL PRACTICES THAT CAN BE IMPLEMENTED INTO THE PRACTICE.

Why is sdg benificial for architects

The sdg's that are introduced by the g20 sumit . Deals with the 17 differnet sd"s that the g20 sumit is looking at Making changes in these areas for a more sustinable and a better living .These goals cover a wide range of social, economic and environmental issues that needs to resolve to achieve the 2030

Out of all the 17 sdg's for the development there are 6 sdg's which catrer to the sustinability factor with Relating to the architectural industry .They are
Sdg goal 7: ensure access to affordable, reliable, sustainable, and modern energy for all.
This goal emphasizes the importance of designing energy-efficient buildings and incorporating renewable energy sources, such as solar panels or
Wind turbines..etc
Sdg goal 9: build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
This goal highlights the need for innovative building materials and construction techniques that minimize environmental impacts and enhance resilience
To climate change and other shocks.
Sdg goal 11: make cities and human settlements inclusive, safe, resilient, and sustainable.
This goal focuses on the role of architects, interior designers, and construction companies in creating sustainable urban environments and built spaces

That promote well-being, and environmental quality.
Sdg goal 12: ensure sustainable consumption and production patterns.
This goal emphasizes the importance of selecting sustainable materials, reducing waste, and minimizing the environmental impact of construction processes.
Sdg goal 13: take urgent action to combat climate change and its impacts.
This goal underscores the urgent need for the design and construction industries to adopt climate-responsive strategies, such as energy efficiency, passive
Design, and low-carbon materials, to reduce greenhouse gas emissions and increase resilience to climate change impacts.
Sdg goal 15: protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse
Land degradation and biodiversity loss.
This goal highlights the importance of preserving and enhancing biodiversity and natural ecosystems in the built environment through a taught based site
Selection, landscape design, and the use of native plants and materials.
By focusing on these critical sdgs, architects, interior designers, and constructioncompanies can make a meaningful contribution to global sustainability efforts

Role of architects in creating sustinable built enviornment

When it comes to sustinability we as architects do have a very important role to play thats shapes and moulds the
Furture of the bulit enviornment.

We as archiitects inculcating these sustibanable pracites which can lead to the overall betterment if the humans
And in directly increase the potenial life on earth for the furture generations.

In the morden context of built spaces when we as architects design a partiicular build

spaces sustinabilty should be
Embibed into the design rather that it beoming a selling term or a trend thats comes up in the feild

It should be considered the part of the architectural built spaces because of the drastic evolution of human practeices
And the increasing pollution and the enviornmental concerns .

Sustinabilty should become the part and parcel of archietcts design rather than just a selling point.The sdgs consider cities as drivers of economic growth in which the urban development can generate sustinable practices by reducing the number of slum dwellers in Urban areas. This results in bringiing the whole idea of producing an inclusive, safe, resilient and sustainable city between the current architects and designers.

How do sdgs impact the design and construction industries?
Thers a urgent requirment for combacting the climate change . Which is declared as "code red " He design and construction industries play a significant role in achieving the sdgs. Buildings and infrastructure are responsible for approximately
40% of global energy consumption and 30% of greenhouse gas emissions.
The medium to large-scale disasters will increase by 40% from 2015-2030 due to rising global temperatures that lead to more extreme weather changes (united nations, 2020).

Inculcating plans to enhance climate adaptation and resilience, all the sdgs allow architects and designers to demonstrate commitment to sustainability,
Raising awareness and becoming part of the sustinable practices which can decrease the overll impact on climate and pollution The main concers in the present day scenario are all replated to climate and pollution And according to the data we as the construction industry contribute around 20-60%

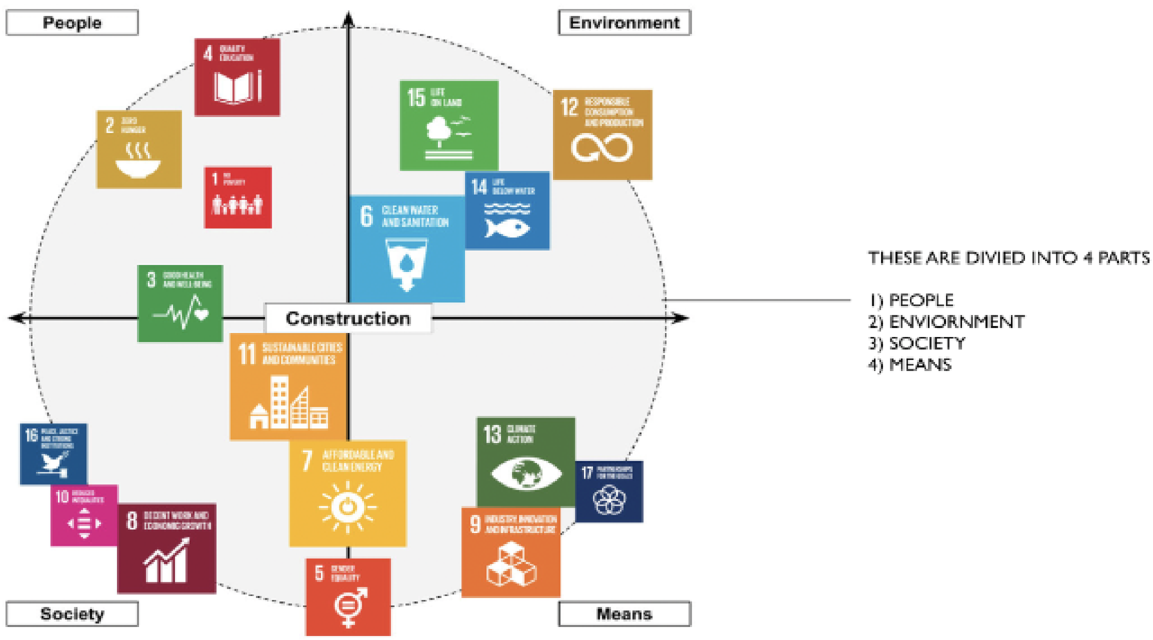
We are the industry on the top of the list which contribute to the highest amoiunt of waste genertaed and dumped

The building materials waste is difficult to recycle due to high levels of contamination and a large degree of heterogeneity". All the waste material is deposited in landfill in each country therfore creating more and more landfills which caused land degeradation.

By thebsharing a common language for sustainability, the sdgs helps architects and designers to convey their ideas to one and other showcase their knowledge in Practice and shape the future of the built environment, hence contributing to a more sustainable world. And prolonging the overall life on earth on a efficient and susutinable manner .The sdgs offer a clear and and detailed ramework for making sustainable design choices. Hence, this allows architects and designers to collaborate and engage with stakeholders, to educate the public and the new age architects about the importance of sustainability, and encourage more people to achieve a sustainable future ahead .

Incorporating sustainable design principles into your projects, we as an industry can contribute to reducing these environmental impacts while conserving natural resources and Promoting healthier living environments.
This, in return , benefits not only our clients but also our business by placing us as a forward-thinking, environmentally responsible professionals.
Therefore the demand for sustainable buildings is rising day in and out , this is by a growing awareness of climate change, environmental degradation, and the need for healthier living spaces.
this presents an opportunity forus architects, interior designers, and construction

companies to differentiate themselves from our competitors by offering innovative, sustainable solutions that meets
 the needs of our clients.



These sustinable practices are a smaller part of the sustainability term What defines a builidng is sustinable ..?Is it the rating system that gives a tag to a build space as sustinable building .?Susutinability in a built space should do more with the deatil of the built spaces rather That having aspect of sustinability in a design for the rating syatems .The sustinable factors or solutions , design considerations that cater to the sustibale Practices should be togother and work in one order to gother as a single unit To increase the effenciy of a bilt enviornment.

The sustinable practices are much more than just acheving the rating systems
Eg- a building that has platinum rating of igbc, griha ..leed ..etc
Does/ neeed not necessaraly be completely sustainable in nature .

Sustinability becomes very subjective and very definative wehn it comes to a bult space
It dpends on a individual how he/she defines sustinability at first place . Upon whivh the
Solutions / stratergies are built upon
fall in practices Raitng sysetms do have a some/many short falls in the first place
The raitng systes often look at them at the ground level(site work level) or at the design Level So these systems show how the built architectural spaces will lead to sustinability only once The structure is built.
Generally these ratiing systems are looked on the process which generally gets approved as With the green ratings
But the pre and post analysis of weather the building is still has the same energy effenciy is a Queation mark ..?

In the recent times the green rating systems are rather bound to become jsut a vertical rather than They being the fundemental aspect of a practice
This approach would be fetching money and income to the indivuduals right now this would crete caourse In the furture.
When we talk about the best practices in architecture we need to follow the sustinability practices where They just become the part of a bulit structure because of the tag thats comes along with them .

When the term effenciy comes into picture anything that is in the market in the present day scenarion always has Effenciy to it by default .
Because it plays a important role in determinig weather a product ..etc anything in that mtter is feesible or not ..!
Eg- buying a car (we look at the effenciy of the car the milage it gives per a liter of pertrol .) Buying a apartment(we look a the floor effeenciy of how the spaecs are organised for Maximum utilization and minimal disturabnce)

Byuing any good / item (always we check for the effenciy or feesability of the particular product)

We do we only see for the effenciy of the floor per sq.feet / foot)
Why do we least look at and the buildings effenciy is given the least importance ..?
The same level of deatiling should be looked at the buildings effenciy alos which does not happen .!
In the other way one of the benifits would be that the building or the structure would be having more prolonged
Life which would decrase the necissity of rebulidng the entire structure till an extent .
Where the life now of the concrete built structures is around 50-100 years

This can be pushed or scaled upto alteats (10- 20%)in the least case scenario. Which would make a difference .We can have movable and collapsable structures which could raie a point in the furture but right now in the present
Abrupt scenarios where there is red alert

Any structure thats is being built around(96-97%) of the the structure around the

world are built without taken envornmenatl Feesibility into consideration leaving aside the urban planing , urban design prinviples , governemnt protocols ..etc
Its become a very easy task to build a built structure around the world without knowing the upcoming hazardous issue and problrms
That can arise due to this. This problem gets worsen when we as the cosntruction and design industry contributr to(30- 50%) of the total waste and emissions
Without considering the enviornmental factors and it become a simple task to build any structure in the recent times.

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 Cfcs (chlorofluorocarbons) to the environment.

The fundamentals of the course talks a lot on the .lines of ethics and morla values but when it comes to the actual practice in architecture
On the ground the reality is differnent . We do not follow this part in our day- to - day lifes .

This practice has to be rectified . Eg- if a architect is practising architecture he/she should be well aware of all the following materilas being used , where do they come from what are they made up up of .? , what’s the carbon emissions of the particular material being used in the building .

At the initial stages of the implementation the cost of them would be on a higher note
But according to a researc paper published the cost of the green buildings using sustinable practices at initial stages the incremental cost has been experienced
Between 12-18 percent and now we can observe that the incremental cost has been reduced to 5-8 per cent. Further, we are aiming at green buildings becoming less costly

than conventional Buildings thus making them affordable for the common.

Mass production - the industrilization has led to the mass production and in india the trend has started late and also contiuing in the same fashion
Without giving a second taught about the enviornmental concerns
Furture of sustinable practice
Circular economy
Circular economy is described described it as “a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing down and closing, and narrowing material
and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.”
This is a continious process of how it is worked on creating a efficient bulit structures.
With the construction industry we as a industry are responsible for around 60% of total waste in the world , the need for a more sustainable, ‘circular economy’ approach is clear and urgent in the prsent day context .
But what does it mean to practice to design a building on circular economy principles?

We must move on from the take, make and dispose economic model that has underpinned development and gdp growth since the industrial revolution. Within this model, the construction, maintenance, modification
And replacement of buildings and infrastructure is a huge consumer of material and a significant producer of waste.

(Reference)Sunand prasad – founder penoyre & prasad and trustee of ukgbc

The uk green building council (ukgcb) report circular economy guidance for construction clients includes a methodology for architects and clients to adopt from the very outset of a new project, covering design, materials, And construction. For many architects, these methods will represent a significant change in the way of designing – they effectively banish the tradition of demolishing and starting from scratch with a design created On a blank page in a studio.

Furture of sustinable practice

Energy effeincy in the buildings

Active -

Comfort temp- 18-24 degreees celcuis (generally)

Energy transfers in the building

3 types

1)conduction - solids

2)convection - air - solid (openings)

3)radiation - electromagnetic waves.

Properties -

1) heat always transfers from warm to cold

2) increase temperature difference - result either heating or cooling is faster .

3) heat vs temperature

Factors affecting energy effenciy in the buildings are -

1)geographical factor -

Macro, micro climate is important

Winds, sunpath , intensity, radiation , rainfall

Data from meterogolical depeartment file
Epw format

2)energy efficient -

From , shape , design is important factor to consider

Small changes can contribute to a big difference .

Aim - compact simple design results in more efficiney

3)less heat excahnge -

Main objective - minimixe surfacxe area

Ratio= a/v = building area of contact with outside air (meter square)building volume
Helps us understand weather it is feesible or not .Simple form better design

4) building orentation

Direction most sutiable

Using north as major facade or oreinting big face to north

Climate and geograhical

Main aim is to (understand we need more sun light or less acording to the climatic zone)

5) window -wall ratio :

Important factor

Eg-

Glass- absorbs the heat

U value - weaker than the wall3-4 times than the wall

Windows are one of the most vunnnerable parts of the builing which have to be taken care of .

Double galzing windows can reduce the heat gain in warmer regions

Orentation

Sun shading devices

Ratio- =net galzing area (meter sq)/ gross wall area

West

North

South

East -

7) building envlope -

Building envlope is importanat

Material used in the building envelope is most important .

Desnisty of the material

U value -always good u- value is better for the structure

Insulating materials - fiber glass .etc

Mearured in u - value

8) conductuon heat loss

Factors affecting it are -

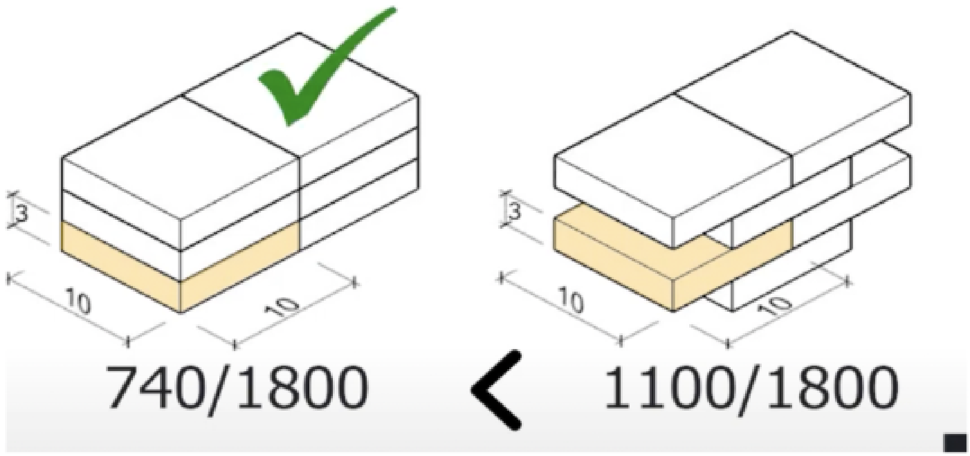
Two factors

Thermal conductivity of material

Thiickness of the material

Q=kxax delta(t)/ d

9) energy performance

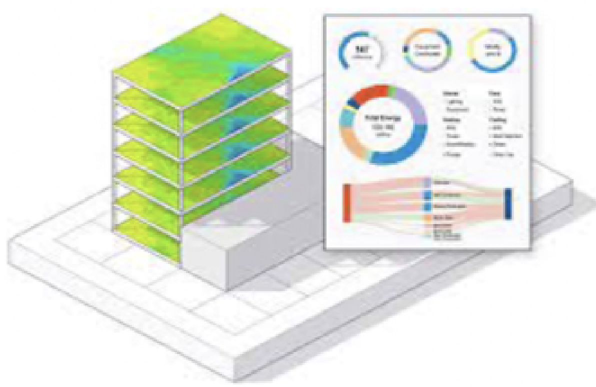


Total energy consumption in a particular yaer per sq.km

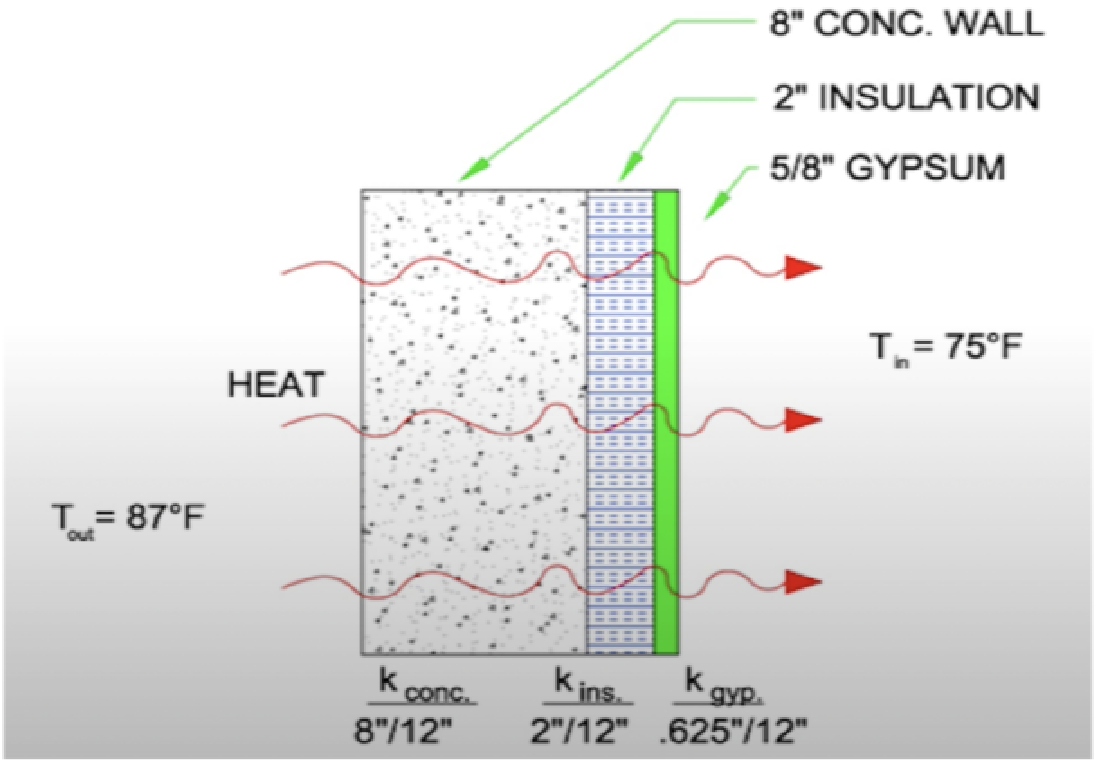
10) hvac -

Size and capicity

Components (arand op)



Placement Managment and se rvices



Pasive

Form design

Building orientation

Opening directions

Openeing sizes and ratio

Using isolation materilas

Double glazing windows

Active

High efficient hvac

Led lighting

Renealble energy

Energy managment sys

Digital twins (smart monitering)

Circular economy

Hvac

Interiro heat source

1) occupuant

2) activity

3) machines and devices ...etc

Typer of building

Hospital

Office spaces ..etc

concrete wall;

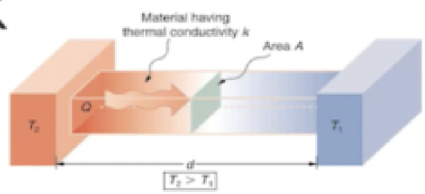
k= 1.5 W/m-K

A= 20 m2

ΔT= 10 kelvin

d = 0.2 m

Q = 150 watts/h



Bream , Leed

BREEAM

BREEAM is a sustainability rating system developed by the Building Research E stablishment (BRE) in the United Kingdom in 1990.

BREEAM measures a building's environmental impact across ten categories, including energy, water, waste, pollution, transport, and ecology

Energy Consumption: Building analytics can monitor energy usage and identify areas where energy is being wasted. This information can be used to optimise building systems and reduce energy consumption, which can improve the BREEAM rating.

The categories are weighted based on their environmental impact, and a building must achieve a minimum score in each category to achieve certification.

building FACTORS THAN CAN improve a BREEAM rating

Energy Consumption: Building analytics can monitor energy usage and identify areas where energy is being wasted. This information can be used to optimise building systems and reduce energy consumption, which can improve the BREEAM rating.

Indoor Air Quality: Building analytics can track indoor air quality parameters such as temperature, humidity, and carbon dioxide levels. This information can be used to optimise ventilation systems and maintain healthy indoor air quality, which can contribute to a higher BREEAM rating.

Water Management: Building analytics can monitor water usage and detect leaks, which can help reduce water consumption and improve the BREEAM rating.

Waste Management: Building analytics can track waste generation and identify opportunities to reduce waste through recycling and reuse. Effective waste management can help improve the BREEAM rating.

Occupant Comfort: Building analytics can monitor factors that impact occupant comfort, such as temperature, lighting, and noise levels. This information can be used to optimise building systems and enhance occupant comfort, which can contribute to a higher BREEAM rating.

Renewable Energy: Building analytics can assess the potential for renewable energy generation, such as solar or wind power, and help identify opportunities to incorporate these technologies into the building design. This can help reduce carbon emissions and improve the BREEAM rating.

The BREEAM In-Use certification is valid for a 3-year period after the certification date. BREEAM enables continual monitoring, reporting and improvement of sustainability performance over time.

BREEAM In-Use Ratings

ASSESSMENT SCORE (%)	ASSESSMENT RATING	STAR RATING
< 10%	Unclassified	–
10%–25%	Acceptable	*
25%–40%	Pass	* *
40%–55%	Good	* * *
55%–70%	Very Good	* * * *
70%–85%	Excellent	* * * * *
≥85%	Outstanding	* * * * * *

Source: BREEAM USA

What are the levels of BREEAM certification?

- Pass: The building has achieved the minimum required score in each category.
- Good: The building has achieved a score of at least 55%.
- Very Good: The building has achieved a score of at least 70%.
- Excellent: The building has achieved a score of at least 85%.
- Outstanding: The building has achieved a score of at least 90%.

LEED

Leadership in Energy and Environmental Design (LEED) is a green building rating system developed by the United States Green Building Council (USGBC).
LEED is another major system used in India to certify buildings. This system focuses on the energy consumption and the impact the building has on the environment.

The requisites and criteria for LEED certification are management of:

35% of the credits in LEED are related to climate change.
20% of the credits are for how the building impacts human health.
15% of the credits are for its impact on the water resources.
10% of the credits for its effect on the biodiversity around.
10% of the credits relate to the green economy.
5% of the credits are for how it impacts the community.
5% of the credits are for how it impacts the natural resources.

he system ensures your business adheres to the LEED certification requirements and means that your buildings are dynamic, clean and cost effective, thereby attaining the status of being LEED certified.

LEED CERTIFICATION REQUIREMENTS

LEED uses a 100-point scale for rating and awards credits based on potential environmental impacts. Compliance with the LEED rating system for targeting the LEED Building Design and Construction Guide:

New Construction scheme requires objective evidence that specific requirements have been met in the following areas of site sustainability:

ADVANTAGES OF OBTAINING LEED CERTIFICATIONS ;

Carbon emission levels are less.
Energy consumption levels are lesser, reducing bills.
Efficient water and waste management.
Transportation costs are greatly reduced.
Materials selection and usage are done in a way to minimise impact on environment and economy.
Indoor environmental quality and safety is assured.
Health of workers and users are prioritised.

CERTIFICATIONS

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Griha , IGBC

GRIHA	IGBC

GRIHA

Green Rating for Integrated Habitat Assessment (GRIHA) is the national rating system of India for any completed construction, endorsed by the Ministry of New & Renewable Energy (MNRE), Government of India and TERI. It is an assessment tool to measure and rate a building's environmental performance.

The basic features of GRIHA:

Created to assist in 'designing and evaluating' new buildings (structures that are still at the starting phases). A building is evaluated based on its expected results over its full life. The stages of the life cycle identified for evaluation are:

Pre-construction stage: Intra and inter-site problems such as access to public transport, type of soil, kind of land, location of the property, flora, and wildlife on the ground before construction activity starts, the natural landscape and land features.

Building planning and construction stages: Resource conservation and resource allocation problems, energy effectiveness, energy regeneration, and reuse, and occupant safety and wellness regulations. The prime resources considered in this section are land, water, energy, air, and green cover.

Building operation and maintenance stage: Issues relating to the operation and maintenance of building systems and procedures, tracking and recording of energy consumption and occupant safety and well-being, as well as problems affecting the global and local environment

GRIHA Rating Criteria:

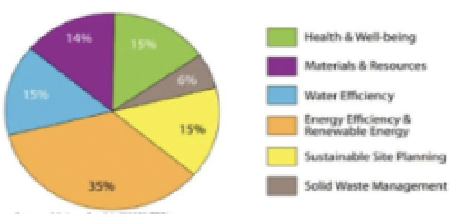
GRIHA provides a rating of up to five stars for green buildings and dispenses points based on criteria's met by any builder. It comprises a set of 34 criteria, few of them are:

> Preserving the existing landscape and protecting it from degradation during the process of construction can fetch 5 points.

> Enhancing energy efficiency of outdoor lighting and promoting usage of renewable forms of energy to reduce the use of conventional/fossil-fuel-based energy resources can gain 3 points.

> Preventing or minimization of air pollution from construction activities is also a GRIHA point.

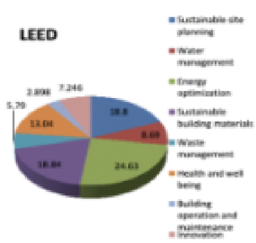
> Reducing volume, weight and time of construction by adopting efficient technology (such as pre-cast systems, ready-mix concrete) can fetch 4 GRIHA points.



Source: Majumdar, M. (2008), TERI

Points Awarded	Rating
50-60	One Star
61-70	Two Stars
71-80	Three Stars
81-90	Four Stars
91-100	Five Stars

LEED



IGBC

GRIHA is a National Rating System that was developed keeping in mind the different climatic zones in the country.

It is suitable for rating all kinds of buildings.

GRIHA stands for Green Rating for Integrated Habitat Assessment. The rating system takes into account the National Building Code of India, Energy Conservation Building Code, and local standards and laws.

The GRIHA rating system evaluates the environmental performance of a building over its entire life cycle and provides a standard for what is represented as a 'green building'.

The standard criteria are revised every three years to maintain a balance between established practices and technology that is emerging in the field

GRIHA's rating system has 100 points where certain requirements are mandatory to receive a minimum score of 50. There are also innovation points that can be awarded over the 100 point system. A project can hypothetically apply for a maximum score of 104 points, however, the final scoring is awarded out of 100 points.

Indian Green Building Council (IGBC) has developed green building rating programmes to cover commercial, factory buildings etc. and not only residential ones. IGBC rating system addresses green features under the following categories:

Site Preservation & Restoration
Site Planning & Design
Water Efficiency
Energy Efficiency
Materials & Resources
Innovation & Design Process

Advantages of an IGBC certified building:

Reduced energy consumption and bills without sacrificing the comfort levels of user
Reduced destruction of natural habitats, soil and biodiversity.
Reduced air and water pollution.
Reduced water consumption and efficient recycling and reuse.
Limited waste generation due to efficient recycling and reuse.
Increased user productivity and safety levels.

IGBC has developed the following green building rating systems for different types of building in line and conformity with US Green Building Council. Till date, following Green Building rating systems are available under IGBC.

LEED India for New Construction
LEED India for Core and Shell
IGBC Green Homes
IGBC Green Factory Building
IGBC Green SEZ
IGBC Green Townships

Level Of Certification	Recognition
Certified	Good Practice
Silver	Best Practice
Gold	Outstanding Performance
Platinum	National Excellence
Super Platinum	Global Leadership

NET ZERO ENERGY	GREEN BUILDING CONCEPT
Net-zero building concepts aim to create buildings that produce as much energy as they consume over the course of a year. These buildings are designed to be highly energy-efficient and typically incorporate renewable energy sources to achieve a balance between energy consumption and production.	Green building, also known as sustainable or eco-friendly building, is an approach to designing, constructing, and operating buildings that aims to minimize their negative impact on the environment while maximizing resource efficiency and occupant well-being.
THESE ARE THE FOLLOWING THINGS NETZERO BUILDINGS CONSIDER IN THE FIRST PLACE TO ACHIVE NETZERO BUILDINGS . Energy Efficiency:	The concept of green building encompasses a wide range of principles and practices aimed at reducing energy consumption, conserving water, using sustainable materials, improving indoor air quality, and promoting overall sustainability.
Insulation: Net-zero buildings are well-insulated to minimize heat loss in winter and heat gain in summer.	Energy Efficiency: Building Envelope: Lighting RENEWABLE ENERGY
High-performance windows and doors: Energy-efficient windows and doors with low U-values and proper seals reduce heat transfer.	WATER EFFICIENY:
Energy-efficient appliances and lighting: Energy Star-rated appliances and LED ighting fixtures are commonly used to minimize electricity consumption.	LOW-FLOW FIXTURES- RAINWATER HARVESTING - GREY WATER SYSTEMS
HVAC systems: Heating, ventilation, and air conditioning systems are designed for efficiency.	SUSTAINABLE MATERIALS -
Passive design: Buildings may be oriented to maximize natural daylight and passive solar heating, reducing the need for artificial lighting and heating.	Recycled and Recyclable Materials: Sustainable Wood: Non-Toxic Materials:
Renewable Energy Sources: Solar panels: Photovoltaic (PV) solar panels are the most common renewable energy source in net-zero buildings.	Site Selection and Design: Location: Choosing a site that is close to public transportation, amenities, and reduces the need for long commutes can minimize environmental impact. Site Planning: Designing landscapes that promote biodiversity and minimize disturbance to natural ecosystems.
Wind turbines: In some cases, wind turbines can also be integrated into the design to harness wind energy Geothermal systems: Ground-source heat pumps can provide efficient heating and cooling by utilizing the stable temperatures found beneath the Earth's surface.	INDOOR AIR QUALITY VENTILATION - LOW EMITTING MATERIAL - CONTROLLING MOISTURE -
Energy Monitoring and Management: Building automation systems (BAS) Energy management software: Smart meters	WASTE REDUCTION - SUSTINABLE OPENRATIONS AND MAINTAINENCE-
Passive Strategies: Passive solar design: Buildings are oriented and designed to maximize the use of natural sunlight and passive heating Daylighting-	Building Management Systems: Implementing smart technology for efficient operations, including lighting, HVAC, and security. Regular Maintenance: A well-maintained building is more efficient and durable, reducing the need for repairs and replacements.
Energy Storage: Battery systems: Grid Interaction ustainable Materials and Practices: Sustainable construction materials: Green construction practices: Behavior and Education: Occupant behavior	Green Certifications: LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), and other certification programs provide frameworks for evaluating and benchmarking the sustainability of a building. Life Cycle Assessment: Analyzing the environmental impact of a building throughout its entire life cycle, from construction to operation and demolition, helps make informed decisions.
Achieving net-zero energy in a building requires a holistic approach that combines energy-efficient design, renewable energy generation, effective energy management, and sustainable practices. It's an evolving concept that continues to gain importance as the world seeks to reduce its carbon footprint and combat climate change.	Green building concepts aim to create structures that are not only environmentally responsible but also economically viable and provide a healthy and comfortable living and working environment

HOW THE FOLLOWING GREEN RATING SYSTEMS ARE LINKED TO SUSTAINABILITY

Enhances the design process

Green rating systems offer guidelines and metrics that improve collaboration and provide a framework that defines "sustainability" and links project issues and solutions within the context of sustainability.

Provides economic benefits

A green rating system often results in a more efficient, durable and resilient project. Utilizing a sustainability framework helps to reduce waste and energy costs and provides opportunities for tax incentives and long-term operational cost savings.

Reduces risk

Green rating systems focus attention on project goals, means and methods. Green projects are better prepared to mitigate the severe impacts of natural disasters. These projects are also better designed to prevent losses from fire and plumbing damage and withstand unpredictable energy prices.

Increases accountability

Green rating systems link sustainability policy to planning and design so that the overall project vision is used throughout the process. These rating systems also promote stakeholder participation and provide milestones That help to monitor progress and keep the project team on track.

Improves quality of life

Projects designed within the sustainable framework of a green rating system create more livable and resilient Communities with reduced waste, more opportunities to conserve and protect natural ecosystems, and Residents who enjoy improved air and water quality.

Gives rise to use of efficent materials

The use of building materials to achive any certification gives rise to the usage of Carbon neutral/ efficient materials therofre reducing the overall carbon foot print In the built space .

CASE STUDIES

THE NEW ENERGY ACADEMY BUILDING , EUROPE.

Location: groningen, netherlands,europe

Site area: 44.350 m2 in hectars

Built-up area: 12676 m²

Architect: ar. Karan grover

Building type: commercial office building

Architects: broekbakema, de unie architecten

Year: 2016

Lead architects: aldo vos, paul van bussel

The energy academy europe (eae) is the most sustainable education building of the netherlands.

In this particular architectural built space the natural elements are used they are-

Earth

Water

Air

Sunlight

Are used innovatively in a solar chimney, winter garden, atrium and air labyrinth

Certification -

This type of designing results in both a breeam outstanding score and an energy-positive structure that will completely offset its Carbon footprint within 40 years.89,62% of points.

This pge is extracted due to viral text or high resolution image or graph.

Aerospace research development center, hyderabad

Introduction-

Location: hyderabad

Site area: 5 acres

Built-up area: 30,000 sq. Ft

Architect: ar. Khanna asscociates

Building type: research development center

The following three qualities are the essential characters of the research development Center

Environment friendly – efficiently using the natural resources, pollution reduction in its surroundings, and minimal generation of wastage comparatively.

Economical – using local materials which cut downs the transportation rate also affordable

Energy-saving – using more daylight into the building and utilizing electricity efficiently.

Tacres (total site area)

2200m2 (total built up area)

1,115 m2 (total air-conditioned area)

Size-

Tacres (total site area)

2200m2 (total built up area)

1,115 m2 (total air-conditioned area)

Main research and development area:

Cleanrooms for assembly and testing of aerospace components.

Laboratories for materials research, propulsion systems, and avionics.

Aircraft hangar and maintenance facilities:

Hangar space for the assembly and maintenance of aircraft and drones.

Space for the testing and evaluation facilities:

Wind tunnels for aerodynamic testing.
Environmental testing chambers for simulating extreme conditions.
Structural testing labs.
Flight simulators for pilot training and aircraft testing.

Office and administrative areas:
Administrative offices for project management and coordination.
Researcher and scientist offices.
Conference rooms for meetings and collaboration.
Break rooms and lounges for staff.

Training and education facilities:
Lecture halls and classrooms for educational programs.
Training simulators for aerospace engineers and pilots.
Research library and resource center.

Support spaces:

Cafeteria and dining facilities.
Fitness and wellness center for employees.
Restrooms and locker rooms.

Parking and vehicle storage.

Security and access control:

Secure access points with biometric and card-based authentication.
Surveillance and security systems for sensitive areas.
Control center for monitoring and responding to security threats.

Green spaces and environmental considerations:

Landscaped areas and outdoor spaces for relaxation and inspiration.
Sustainable design features such as solar panels, rainwater harvesting, and energy-efficient systems.

Infrastructure and utilities:
Adequate power supply for research equipment and facilities.
Advanced hvac systems for climate control.
Robust data and communication networks.
Backup power and emergency systems.

Accessibility and mobility:

Accessibility ramps and elevators for individuals with disabilities.
Bicycle racks and pedestrian pathways for eco-friendly commuting.

Future expansion considerations:

Allow for future expansion as research projects and programs grow.
Land and infrastructure planning for new facilities.

Safety and emergency response:

Fire suppression systems.

Emergency exits and evacuation plans.

First-aid stations and medical facilities.

Environmental impact assessment:

Conduct an environmental impact assessment to ensure compliance with environmental regulations and minimize ecological impact.

Aesthetic considerations:

Design the center with an aesthetic that reflects the cutting-edge nature of aerospace research.

Community outreach and engagement:

Consider facilities for public outreach and educational programs to engage with the local community.

Cii sohrabji godrej green buisness centre, hyderabad

Introduction-

Location: hyderabad

Site area: 4.5 acres

Built-up area: 20,000 sq. Ft

Architect: ar. Karan grover

Building type: commercial office building

The following three qualities are the essential characters of green building.

Environment friendly – efficiently using the natural resources, pollution reduction in its surroundings, and minimal generation of wastage comparatively.

Economical – using local materials which cut downs the transportation rate also affordable

Energy-saving – using more daylight into the building and utilizing electricity efficiently.

ENERGY SAVINGS

55% reduction, with ASHRAE 90.1 as the baseline

120,000 kWh / year

REDUCTION OF co_2 EMISSIONS;

~ 100 tons / year (building is functional since January 2004)

WATER SAVINGS-

35% reduction in potable water consumption

ENVELOPE THERMAL TRANSFER VALUE(U-VALUE)

U-value of double glazing: 1.70 Watt/m2 °K
U-value of solid wall: 0.57 Watt/m2 °K
U-value of roof: 0.294 Watt/m2 °K

AIR CONDITIONING SYSTEM EFFICIENCY -
0.8 kW/ton (water- cooled scroll chiller system with CoP: 4.23 at ARI condition)
Installed two 25 TR chillers

ENERGY EFFICIENCY INDEX (eei)-

84 kWh/m2/year

This was the first green building in the country. Hence, the incremental cost was 18% higher. However, green buildings coming up now are being
delivered at an incremental cost of 6-8%. The initial incremental cost gets paid back in 3 to 4 years.
Benefits achieved so far:

Over 120,000 kWh of energy savings per
year as compared to an ASHRAE 90.1
base case

Potable water savings to tune of 20-30%
vis-à-vis conventional building

Excellent indoor air quality
100% day lighting (Artificial lights are

switched on just before dusk)

Higher productivity of occupants

GMR AERO TOWERS & AIRPORT, HYDERABAD (AERO CITY)

Location: Hyderabad

Site area: 94,574.6 square meter

Built-up Area: The passenger terminal of RGIA,
has a built up area of 12,00,000 square feet.

floor area of 51,154 square meter

Architect: gmr associates

Building type: Commercial office building

Ownership- GMR Hyderabad International Airport Limited (GHIAL) is a company promoted as a joint venture comprising the GMR Group (63%)
in partnership with Airports Authority of India (AAI) (13%), Government of Telangana (13%) and Malaysia Airports Holdings Berhad (11%).

1)Incorporating green building designs

2)Adopting eco-friendly refrigerants in accordance with the latest technological advancements.

3)Implementing progressive generation and utilization of renewable energy sources to power airport operations.

4)Practising energy management techniques to optimize energy usage and vpromote conservation.

5)Encouraging behavioural changes to foster energy-saving habits.

6)Procuring energy-efficient equipment.

Cooling Tower Efficiency enhanced by Upgradation
They are replaced same with efficient cooling towers in terms of motors and thermal efficiency. Total 5 Nos of the Cooling Towers replaced.

water reserviour is made in order to store the rain water in and around the airport area for the water to seep in or can be furthur used to use as secondary water source.

Spread over an area of 45 acres, more than 30 thousand solar panels have been installed to produce 10 MW power. poly crystalline PV panels, which are far more efficient than mono crystalline solar PV panels