Green Building

Contributed By:
Amitava Roy

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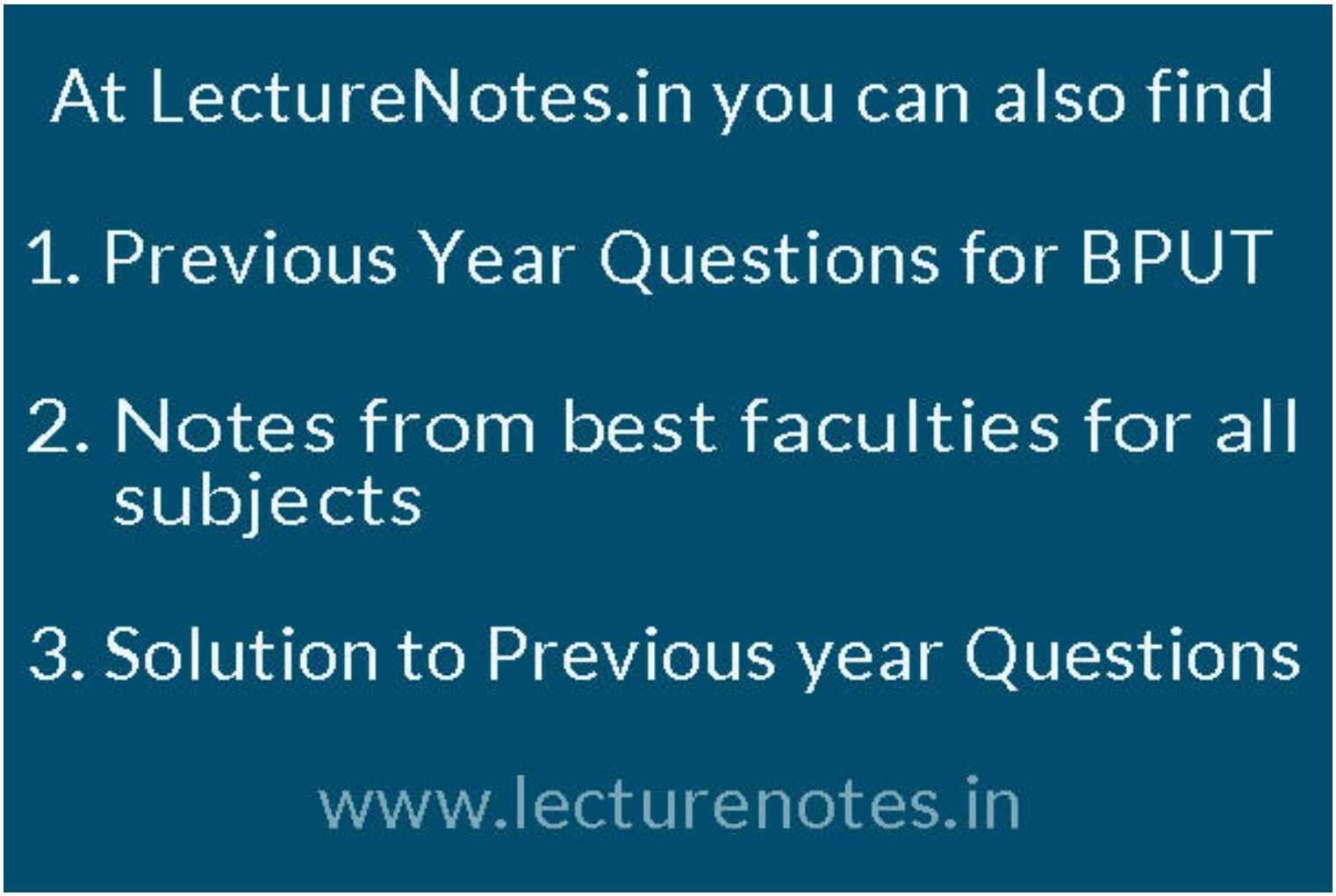

Green Building

Topic:

Indian Green Building Council

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Indian Green Building Council:
Introduction to IGBC green homes, Benefits of IGBC, IGBC green home rating system, introduction to USGBC, LEED rating system, procedure to get IGBC certification.

Green Building Design Site issues:
Site analysis and design, site development and layout, **Water issues**: watershed protection, drainage of concentrated Runoff, water efficiency and conservation, rain water harvesting, water reclamation, **Sustainable materials**: Reduce / Reuse / Recycle, Natural Sources, concrete, masonry, metals, wood and plastic, finishes.

Passive Solar Design:
Passive solar design, Day lighting, Building envelope, Renewable energy, **Construction Process And Maintenance Of Green Building**
Environmental construction guidelines, building operations and maintenance.

Indoor Environmental Quality:
Significance, design principle, ventilation control, occupant activity control, significance of acoustics.

Economics Of Green Homes:
Economics of green buildings, Selecting environmentally and economically balanced building materials, Project cost, Income and expenses.

Text Books:

1. Green homes by R.K .Gautham, BS publications.
2. Sustainable building technical manual- Green building design, constructions and operation; Produced by Public Technology Inc., US Green Building Council.
3. IGBC Green homes rating system Version 1.0 – A bridged reference guide

Reference Books:

1. Green Building A Basic Guide to Building and Remodeling Sustainably; Tree Hugger Consulting.
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison; E & FN Spon, an imprint of Thomson Science & Professional

CE 4073 FUNDAMENTALS OF RCC DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the different properties, types & test of cement.
CO2. know the different gradation of coarse aggregate, test of fine & coarse aggregate, types .
CO3. know the manufacturing process & different grades of steel.
CO4. know the different behavior of concrete.
CO5. know about the concept of stress and strain.
CO6. understand basic design concepts and to be able to design simple beams & columns.

Pre-requisite: Nil

Materials for Concrete: Cement:
Physical and chemical properties of cement, Types of cements and their use, Tests on cement.

Fine aggregates and coarse aggregates:
Gradation of fine aggregate, Tests on sand, Tests on coarse aggregates **Steel:** Steel manufacturing process, grades

resistances, Tractive power & Tractive resistances, Permanent way, Railway gauges, Sleepers, Ballast, Track design, Stations & yards, Station Equipments, Signalling, High speed Trains, Train Accidents- Causes & Prevention.

Airport Engineering:
Administration, Advantages & Disadvantages of Air transport, Aircraft Characteristics, Airport Obstructions, Typical layout of Airports – Component parts – Objectives of components – Runways – Taxiways – Aprons – Landing, Helicopters, Air traffic control, Airport Marking & Lightning.

Tunnel Engineering:
Introduction-Advantages, disadvantages, economics & selection, Classification of tunnels, Design of shape & size of tunnels, Components of Tunnel, Methods of tunneling, Pre cautions, Tunnel Lining & drainage.

Docks & Harbor Engineering:
Introduction, Classification & Requirements of ports, harbor, docks, Maintenance of ports & harbours, advantages of docks, Transit shed & warehouse, Tides, wind & waves, Different components of docks, Navigational aids, Breakwater.

Text Books:
1. "A Textbook of Transportation Engineering", by S.P. Chandola, 1st Edition, S.Chand (G/L) & Company Ltd.

Reference Books:
1. "Transportation Engineering Vol. I & II", by V. N. Vazirani & S. P. Chandola, 5th edition & 8th edition, Khanna Publishers, New Delhi.
2. "Roads, Railways, Bridges, Tunnels & Harbour Dock", by Amit Gupta&B.L.Gupta, 5th edition, Standard Publications.
3. "Highway Engineering", by K. S. Rangwala, 10th edition, Charotar Publishing House Pvt. Limited
4. "Airport Engineering" by S. C. Rangwala, K. S. Rangwala and P. S. Rangwala, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
5. "Railway Engineering", by Rangwala, 25th edition, Charotar Publishing House Pvt. Ltd.
6. "Harbour, Dock and Tunnel Engineering" by R. Srinivasan, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.

CE 4072 GREEN BUILDING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand necessity and role of green buildings & regarding Indian green building council
CO2. design green buildings considering water, site and material parameters
CO3. understand passive solar design
CO4. handle construction and maintenance of green buildings

Pre-requisite: Nil

Introduction To Green Buildings:
Green Buildings, Global warming, requirement of Green Building, Benefits of Green Buildings, Requisites for Constructing a Green Building, sustainable construction focus point: site, water, energy, material, indoor air quality, construction procedures.

eacher's Sign / emarks

GREEN BUILDING:-

→ Green building is also known as a 'sustainable building' is a structure that is designed, built, renovated and operated, re-used in ecological and resources efficient manner.

→ The term green building is the 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

Green building Principles :-

→ Minimize natural resource consumption throughout the total building life cycle.

→ Minimize pollution and environmental releases throughout the total building life cycle.

→ protect the ecological environment

→ create a healthy, comfortable, non hazardous space.

→ Incorporate quality, function and performance consistent with the objective of the building

→ Balance environmental performance with cost and economic performance

Objectives of a green building :-

→ protecting occupant health.

→ Improving employee productivity

→ Using energy, water and other resources more efficiently.

→ reducing overall impact to the environment.

→ optimal environmental and economic performance

→ Satisfying and quality indoor spaces.

Materials for construction practice

→ Using sustainable building materials like recycled glass and steel, as well as renewable materials like bamboo and rubber.

→ Installing energy efficient windows and doors

→ Using lower - VOC (volatile organic compound) paint and stains.

→ Constructing green roof system (aka "plant on your roof") that offer many benifits including on site gardens, rainwater management

and protecting roof from harmful UV light.

→ Adding water harvesting and purification system that not only manage but also make the use of rainfall

→ Maximizing natural light, which not only save on lighting requirements but also keep building warm in winter.

→ Installing commercial solar panel system.

Considerations of a green building:-

→ Control erosion to reduce negative impacts on water and air quality.

→ Reduce pollution and land development impacts from automobile use

→ Limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration and managing storm water, run-off

→ Increased use of renewable technologies to reduce environmental impacts associated with the use of fossil fuel energy.

→ Provide a high level of individual occupant control of ventilation and lighting systems to support good health, better productivity and a comfortable atmosphere.

→ Provide a connection between indoor spaces and outdoor environment through the introduction of sunlight and views into the occupied areas of the building

Green buildings project in India

1. Suzlon Energy Limited - Pune
2. Biodiversity Conservation India - Bangalore
3. Olympia Technology Park - Chennai
4. ITC Green Centre - Gurgaon
5. The Druk White Lotus School - Ladakh
6. Doon School - Dehradun
7. Raintree hotels - Chennai
8. Nokia - Gurgaon
9. Rajiv Gandhi International Airport - Hyderabad
10. Hiranandani - BG house, Powai, Mumbai
11. ABN Amro Bank, Chennai
12. Palais Royale at Worli, Mumbai etc.

How traditional buildings affect us?

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

Benefits of Green Building:-

- Green building 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.
- Green buildings also attempt to work towards on-site energy generation through renewable energy utilization to cater its energy needs. Eg:- Solar thermal systems can help generate hot water and replace the conventional geyser. Solar PV panels can help generate electricity which can reduce the buildings' dependence on grid power.
- Green buildings consume 40% to 80% lesser water compared to conventional buildings. By utilizing ultra low-flow fixtures, dual plumbing systems, waste-water recycling system, rain water harvesting.
- Green buildings generate lesser waste by employing waste management strategies on site. They also employ waste (manure or compost) on site to minimize burden on municipal waste management facilities and Land fills.

→ They generate lesser pollution both during construction as well while in use (barricading of site, proper storage and disposal of waste etc).

→ GB ensure proper safety, health and sanitation facilities for the labourers and occupants.

→ GB restrict the use of high ODP (ozone depleting potential) substances in their systems as well in finishes.

→ GB offer higher image and marketability.

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

Requirement of Green Building:- / How to make a building gr

→ Sustainable site planning with bioclimatic architectural plan

→ Incorporate solar passive techniques in a building design t minimize load on conventional systems.

→ Design energy efficient lighting and HVAC (heating, ventilation and air conditioning) system,

→ Use low energy and renewable materials.

→ Choose construction materials and interior finishes produ with zero or low emissions to improve indoor air qualit

→ Use dimensional planning and other material efficienc strategies.

→ Design for a greay water system that recovers rai water for site irrigation and a dual plumbing syst for use of recycled water for toilet flushing.

→ Use re-circulating systems for centralized hot wa distribution.

Sick Building Syndrome:- A condition affecting building workers, typically marked by headaches and respiratory problems, attributed to unhealthy or stressful factors in the working environment such as poor ventilation. OR

→ It is a medical condition where people in a building suffer from symptoms of illness or feel unwell for no apparent reason. They will disappear when they go awa

Green Building

Topic:

Sustainable Construction Focus Point

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SUSTAINABLE CONSTRUCTION FOCUS POINT

A. SITE SELECTION AND PLANNING

→ The main purpose of suitable site planning is to integrate design and construction strategies by modifying both site and building to achieve greater human comfort and efficiencies

→ 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 is the one in which the arrangement of roads, buildings and associated uses is developed using site data.

Firstly selection begins with the calculation & requirements of:-

① degree of resource use
② degree of disturbance of existing natural systems
③ Requires connections to mass transit, vehicular infrastructure and utility and telecommunication networks.
④ proper drainage systems, circulation patterns, landscape design and other site-development features can be determined.
⑤ Selection of an appropriate project location can reduce the need for private automobile use and reduce urban sprawl

→ Practices for site selection and planning

(A) → Site analyses and assessment - so that it can be broke into basic parts, to isolate areas and systems requiring protection & to identify both off-site and on-site factors that may require mitigation

(B) Site characteristics for green building design

(a) Geographical latitude (solar altitude) and microclimate factors such as wind loads affecting 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) Air movement patterns, both annual and diurnal (active during daytime) 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 exterior 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 type of footing required. (soil potential for erosion by wind, water & machine disturbance)

(g) Zoning setbacks and easements can also affect development potential.

(h) Perform soil and groundwater testing to identify the presence of chemical residues from past agricultural activities (arsenic, pesticides and lead), industrial activities (clumps, heavy metal, carcinogenic compounds and minerals

(c) Site's Existing Air Quality

1) Assessment of the existing air quality of the site to determine the presence of noxious chemicals and suspended particulates
2) Projection of the negative consequences (if any) of the proposed development on existing air quality.

3) P

→ Cultural and historical data

Architectural style that is historically predominant in an area can be reflected in the building and landscape design, enhancing community integration.

→ Infrastructure data

- Topographical and hydrological impacts of proposed design and building use which measure cut and fill potential and asses potential for erosion, siltation and ground water pollution
- Identify alternative site design concepts to reduce resource costs and other alteratives to explore optimal pattern e.g. grading and tree-clearing consequences and resulting infrastructure costs

→ Site development and lay out

- Design the site plan by minimizing road length, building foot prints and the actual ground area required for intended improvements thus the planning decreases the length of utility connections.
- Use gravity sewer systems wherever possible (power consumption)

→ Transportation :-

- Support reduction of vehicle miles travelled (VMT) to the site where applicable existing mass-transit infrastructure and shuttle buses, new line, carpooling, use of bicycles should be considered.
- To minimize pavement costs, improve efficiency and centralize runoff, the pattern of roads, walkways and parking should be compact

→ Building and site ~~Orientation~~ Requirements :-

i). Building and site Orientation :-

- Should be oriented to take advantage of shade and airflows for cooling in summer and passive solar energy for heating and wind protection in winter.
- Calculating total site shadow can prevent the creation solar voids and cold air drainage dams. This is helpful in cold and temperate climates.
- provide entrances with airlocks and limit glass to prevent heat loss in human occupied areas.

ii) Landscaping and Use of Natural Resources

- Existing water sources and landforms can be used to create winter heat sinks in cold climates and temperature differentials for cooling air movement in hot climates.
- Use existing vegetation to moderate weather conditions and provide protection for native wildlife; they can provide shade and transpiration in summer and wind protection in winter.

iii) Public Amenities

- Considering seasonal weather patterns and climate variable designer should introduce structures and plantings that provide shelter from harsh elements and highlight desirable features.
- Modulation of tree-canopy heights and inclusion of water fountains and other built structures can fine tune an exterior site.

iv) Construction Methods

- It should ensure that each step of the building is focused on eliminating unnecessary site disruption (grading, blasting, clearing) resource degradation (stream siltation, ground water contamination, air quality loss)
- Involve a qualified site-design professional on the team early in the project.

- protect soil and leave undisturbed. Humus can be used
- minimize heavy equipment on soil
- where grading is unavoidable, carefully remove and stockpile existing top soil.
- Remediate by tillage (cultivation). if compaction is unavoidable
- Orderly construction from beginning to end.

→ Plant materials and management :-

- Avoid sprawl (to spread in a disorderly fashion)
- Use greenbelts and protected wetlands to create a continuous web of native habitats
- Decrease parking, paving and lawns
- Avoid "replacing" healthy mature trees with small nursery stock.
- Use of deciduos, evergreen plant can provide an all round year protection
- Planting contract should be given to a effective and reputative contractor
- Employ integrated pest management (IPM) against insects and weeds. IPM uses biological controls which include parasitic insects, which destroy pests, pheromone (sex-scent) traps, natural pesticides like pyrethrum, companion-planting.
- Use mulching (Latter material used to cover top layer of soil), alternative mowing and composting to maintain plant health

—x—

Basic needs

1. Bank
2. Place of worship
3. Grocery
4. Hardware
5. Laundry
6. Medical
7. pharmacy
8. Restaurant
9. Post office
10. Open air theater
11. Fitness Center

Green Building

Topic:

Water Efficiency

Contributed By:

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WATER EFFICIENCY

In India fresh water withdrawal is about 500 Billion cu.m Of this water for agriculture constitutes 90%, industry 8% and domestic 2%

→ On a typical 100,000-square foot office building, low-flow fixtures coupled with sensors and automatic controls can save minimum 1 million gallons of water per year based on 650 building occupants using an average of 65 litres per day

1 gallon = 3.78 litre

1) WATER HARVESTING

→ Utilizing gravity flow to collect run off into harvesting areas such as storage tanks, open ponds or detention basins

→ Direct rainfall from roofs and water from cooling towers into runoff harvesting areas.

Suggested Practices and Checklist

(1) Preservation of soils and Drainage ways

- Emphasize preservation of mature vegetated soils and lowland areas — because they make watershed work by allowing rainwater and runoff to infiltrate the soil. On lowland areas groundwater discharges into surface drainage ways, streams and wetlands.
- Minimize pavement area—
  - → concentrate and cluster development to reduce road paving
  - → Double-load parking lots to share travelling and turning lanes.
  - → Minimize width of road pavements.
- Install silt fences to hold sediment on-site during construction
- Minimize use of landscape irrigation, herbicides, pesticides and fertilizers

② Porous paving materials

- Consider use of permeable paving material – (subject to existing codes) – eg. porous asphalt, porous cement concrete as they allow water infiltration.
- Use permeable vegetatted surfaces for occasionally used vehicular surfaces such as overflow parking and emergency access lanes – reinforced turf and open-celled pavers, concrete or plastic grids with voids that are filled with topsoil or aggregate.
- Build pedestrian surfaces such as walkways and patios, with loose aggregate, wooden decks or well-spaced paving stones

③ Drainage of Concentrated Runoff

- Consider disconnecting pre-existing downspouts and storm sewers from sanitary sewers.
- Moderate and treat runoff from roofs and unavoidable impervious pavements, and to the degree possible, return it to its natural path in soil.
  - → design every conveyance, pool and drainage basin.
  - → disperse runoff from impervious surfaces over adjacent vegetative soils with level spreaders.
  - → Convey concentrated runoff in vegetated swales, not structural gutters or pipes.
  - → Stabilize soil and reduce scouring velocity.
  - → Moderate discharge through use of constructed pools and wetlands along drainage courses.
  - → Use caution when constructing water bodies at lowest elevations of a site.
  - → Use vegetative buffer areas around parking lots

④ Construct infiltration basins.

(Infiltration basins are closed depressions in the earth from which water can escape only into the soil; so it filters pollutants through the soil, eliminates downstream floods and erosion and restores natural flows to groundwater and downstream).

→ Design infiltration basins as open or closed systems.
→ Place infiltration basin near source of runoff to be most economical and effective.
→ Avoid placing basin near building foundations and on steep unstable slopes

WATER CONSERVATION

① Water harvesting

- Collect and use harvested water - harvested water may include stormwater and irrigation runoff, water from cooling towers and heating, ventilating and air-conditioning (HVAC)
  → Utilize gravity flow to collect runoff into harvesting areas such as storage tanks, open ponds or detention basins
  → Direct rainfall from roofs and water from cooling towers into runoff harvesting areas.

② Rainwater harvesting

- Collect and use rainwater ~~in~~ a roof or catchment area
- Consider quality of rain water - (can be acidic, can have colors etc explain)
- Design an appropriate harvesting and storage system
  → Use appropriate roofing materials - metal clay, concrete based (tile or fiber cement). Asbestos roof materials are not suitable as grit can enter.
  → Install gutters and downspouts size for the roof size and rainfall intensity - Install screening, roof washers
  → Construct cistern storage - prefabricated cisterns in steel or fiberglass are available. or from concrete, ferro-cement, stone or compressed earth. It must be watertight. To prevent algae growth use opague as it has exposure to sunlight
- Filter and treat rainwater to use it as an irrigation source

Green Building

Topic:

Gray & Blackwater System

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③ Landscaping

- Plant native or well-adapted species - as they are naturally adapted to conditions of an area and other problems related to area.
- Preserve native plant populations through careful site planning and protection of existing vegetation. - protect by avoiding cut- and fill in root zones
- Restore the native landscape - by reintroducing same species.
- Minimize use of high maintenance lawns.
- Minimize use of annual plants - (as they require more irrigation, high labor, capital inputs etc).
- Establish high and low maintenance zones.

GRAY AND BLACKWATER SYSTEMS

- Graywater is the wastewater generated from indoor uses such as laundries, showers and sinks and can be re-used in toilet flushing or irrigation
- Blackwater is used to describe wastewater from toilets which likely contains pathogens. It contain feces, urine, water and toilet paper from flush toilets.

(A) Graywater Systems

- Separate and use graywater generated from indoor uses such as laundries, showers and sinks.
- Check with the local health-code department to learn about regulations governing the use of graywater
- Install dual plumbing lines in building interiors - dual plumbing separates graywater from blackwater. Dual plumbing is not difficult to install, but it most-cost effective if done during initial construction.
- Utilize graywater for nonpotable purposes.
  - → Recycle gray water via dual distribution system
  - → Use of graywater for irrigation of areas such as golf courses, ornamental landscapes and turf areas

Types of irrigation systems that can utilize gray water include :-

1) drip irrigation with pressure dosing, which uses a pump system to "dose" irrigation water at regulated intervals
2) more traditional evapotranspiration systems.
3) shallow trench (hole) ditch systems, which utilize distribution pipes placed close enough to the surface to allow for irrigation of plant roots.

(B) Blackwater systems

- When possible treat blackwater from toilet-flushing with on-site systems.
  - → Utilize innovations such as low-pressure dosing systems in conjunction with septic tanks to overcome limitations of soil, geology or topography.
  - → ~~Constructed~~ Consider biological systems such as constructed wetlands. Constructed wetlands are artificial wetlands used for waste treatment (As wastewater flows, plants and naturally occurring microbes remove waste).
    - Surface flow wetlands or wastewater lagoons, use a tiered system of ponds with wetland plants to treat waste
    - Subsurface flow wetlands or microbial rock plant filters are soil-less and utilize a gravel medium to anchor p
  - → Consider sand filter and aerobic tank treatment.
  - → Consider composting toilets - composting toilets are waterless technology for dealing human waste to combine waste with organic material such as lawn clipping, to be used as soil amendment. This is also called "sludge composting".
- Check with the local health-code department to learn about regulations governing blackwater systems

A wetland is a land area that is saturated with water, either permanently or seasonally such that it takes on the characteristics of a distinct ecosystem

Wate...

- Use reclaimed water for purposes such as toilet-flushing if dual distribution lines are in place.
- check local regulations on use of reclaimed water.
- Apply reclaimed effluent to land
- Establish site-specific monitoring procedures.

~~(4) wetland is a land area~~

ENERGY

Production of electricity through the use of fossil fuels such as oil and coal requires extraction, transportation, refining, power generation and distribution. Energy consumption can be dramatically reduced through practices that are economical and readily available.

Energy production technologies include natural gas, nuclear fission and hydroelectric generators.

RENEWABLE ENERGY:-

1) Passive Solar heating, cooling and Thermal Storage

MATERIALS

Here in this chapter we focus on two elements of environmental life-cycle assessment for materials:

① minimizing natural resource use.
② Creating a healthy, comfortable, nonhazardous space for building occupants

While selecting a material following practices must be done:-

① Resource quantity - strategy for resource-efficient buiding

② Reused materials - Durable products such as doors, cabinets and other easily removed millwork and some architectural metals and glass, can be readily salvaged and reused

③ Recycled content :- 3 types of recycled content materials.
- (a) postconsumer material - generated by commercial, industrial and institutional facilities or household
- (b) Recovered ~~material~~ industrial process waste such as slag from metal and mineral smelting
- (c) Internally recycled materials such as scraps from trimming and returned or substandard product.

④ Renewability and use of sustainable management practices - Renewable materials include wood, plant, fibers, wool and other resources that are replaceable within a limited time period after harvesting.

⑤ Local content and reduced transportation — products made with local materials and labor can contribute to low embodied energy consumption and life-cycle cost for building materials

⑥ Regionally appropriate materials :- Eg - Utilizing thermal mass in building design has important energy and comfort benefits in US, where daily temp can be extreme. Here light weight construction and high ceilings may be beneficial.

⑦ Life-cycle cost and maintenance requirements :- Select environmentally and economically balanced building materials.

⑧ Resource recovery and recycling
- → metals are recyclable if they are separated by type eg - steel, aluminium.
- → Plastics are recyclable. Eg. PVC
- → glass products are recyclable if separated and uncontaminated
- → heavy timber is " by salvaging and reusing
- ⇒

Survey Of Materials

(A) CONCRETE:-

→ Use fly-ash concrete which can be replace up to 30% of portland cement.

→ Recycled aggregates and lightweight aggregates are available for some concrete application. Recycled aggregate may contain crushed concrete, brick and other masonry waste or crushed glass.

→ Anticorrosion agents such as epoxy coating extend the life of steel reinforcement and can be used in parking slabs where salt is used in winter.

Health and pollution issues:-

- Air pollution emissions from concrete are low.
- Concrete is confined to foundations and concealed structure where exposure to building air is minimal.
- Concrete additives such as water reducers or superplasticizers produce odors and risk of skin and bronchial irritation.
- Form Foam-release agents made from diesel oil or petroleum oils produce emissions. Wax or mineral oil-based products are available substitutes.

(B) MASONERY:-

- Masonry products are made from concrete, clay, glass and various types of standard and lightweight aggregates.

Resource-efficient options

→ Light weight concrete blocks and bricks made with expanded aggregates such as pumice to reduce weight and add insulating value.

→ Brick and block products with waste and recycled contents, such as sewage sludge and ash from incinerators and coal-burning plants.

→ Hollow blocks from waste wood fiber, native stone from cement and recycled aggregates, glass blocks can be used.

Health and pollution issues:-

→ Overall masonery products produce minimal air pollution.

ⓒ METALS :-

- Steel, aluminium, copper, stainless steel and brass products are recyc
- Metal plating is common in door, office systems and furnitur
- Other metals like chromium, nickel, cadmium etc can result in high level of pollution.

Resource-efficient options

→ Steel, aluminium can have 30% and 20% resp. can be made available from recycled consumer products.

→ Salvaged steel and aluminum beam, scraps can be made appropriate for non structural uses.

Health and pollution issues

→ Indoor air pollution is minimal problem with metal produ
Only exception require polishing, cleaning or repainting in place

ⓓ WOOD AND PLASTICS :-

Appropriate forest management is vital to more sustainab wood source.

Resource - efficient options

→ Low-grade fiber, small-diameter trees and fast growing, less-utilized tree species can be used in engineered wood Products and value-added products such as joists, laminated veneer lumber (thin wood assembled with adhesive), stressed skin wood panels etc.

→ Non structural insulating sheathing like wood or glass f boards can be used with steel-strap and bracket-shear b

Health and pollution issues

→ Indoor-air-pollution emissions from glues used in manufacturing process of some engineered wood products are substantial

→ Phenolic resins and urethane (polyurea) adhesives have lo emissions.

(A) Insulation

→ Mineral fiber insulation (basalt rock or steel mill slag)
→ Glass fiber insulation
→ Cellulose thermal insulation and acoustic sprayed coating
→ Foamed polystyrene " (from HCFCs) (less ODP)
→ Urethane foams (")
→ Vermiculite and perlite. (naturally occurring minerals) etc.

(B) Cladding and Roofing

→ Metals panels like galvanized steel or anodized aluminium
→ Fiber reinforced cement products.
→ Stucco (for moisture and frost damage) (fine plaster used for coating wall surfaces or moulding)
→ Torch on roofing or cold-process built up roofing. (drainage mats are used).

(C) Sealants

Acrylics, silicones and siliconized acrylics are safest sealants to handle for inside use and lowest solvent content

(D) For finishes :-

→ Gypsum products (can be recycled and easy for installation).
→ Engineered or composite wood or plastic panels
→ High pressure laminates
→ Ceramics and terazzo.
→ Wood flooring
→ Resilient floorings (Vinyl, rubber, linoleum, cork floor).
(rubber → recycled tyres; linoleum → linseed oil, wood dust.)
→ Carpets and Underpads (nylon 6, carpet tile, Wool-carpet, polyester and nylon-blended carpets)
→ Paints (acrylic latex paints of good quality), recycling paints.
→ Ceiling Tile (mineral fiber with clay or gypsum fillers)

(E) Furnishings

→ Tropical hardwoods
→ steel, glass and solid-wood furniture
→ Upholstery foams, → fabric coverings → foam fillings etc.
→ Power coated metal finishes can be a substitute for painting

Cement Substitutes for Sustainable Concrete

1) Flyash → It is a residue from combustion of powdered coal and transported by flue gases and collected by electrostatic precipitator. It can improve certain properties of concrete such as durability. as it generates less heat of hydration

→ Class C and class F flyash are there. Class F is produced by burning anthracite or bituminous coal and has pozzolanic properties only.
Class C is produced by burning lignite or sub-bituminous coal and can possess pozzolanic or cementitious properties

→ Flyash is a effective pozzolan which can contribute the properties of concrete like it can increase workability of concrete compared to OPC, It can increase final and initial setting time of cement. It can resist sulphate attack.

2) Ground Granulated Blast furnace slag (GGBS) :—
It is a by-product of the manufacturing of iron in a blast furnace where iron ore, limestone and coke are heated up to 1500°C. When these materials melt in blast furnace, two products are produced i.e. molten iron and molten slag. The process of granulating the slag involves cooling the molten slag through high-pressure water jets. This rapidly quenches the slag and forms granular particles generally not larger than 5mm in diameter. and then after drying GGBS is formed.

→ It can improve many mechanical and durability properties of concrete and generates less heat of hydra

Green Building

Topic:

Rice-Husk Ash (RHA)

Contributed By:

Amitava Roy

3) Rice-husk Ash (RHA)

It is an agricultural by-product material. It is highly Pozzolanic because of non-crystalline silica and high surface area.

→ RHA blended concrete can decrease the temperature effect that occurs during cement hydration and it can increase workability of concrete; increase initial and final setting time of cement, decrease porosity of concrete, reduce permeability, resistance to segregation of fresh concrete.

→ It can improve the compressive strength as well as tensile and flexural strength of concrete. 12% to 15% can be used as Partial cement replacement.

4) Wood Ash (WA)

It is the residue generated due to combustion of wood and wood products.

→ Can be used as filler than as a binder.

5) Cement Kiln Dust (CKD)

It is a by-product of cement manufacturing

→ Partial substitution of OPC and GGBS with CKD can increase compressive strength

6) Metakaolin (MK)

It is a pozzolanic material. It is a dehydroxylated form of the clay mineral kaolinite and obtained by calcination of kaolinitic clay at a temperature b/w 500°C and 800°C.

7) Silica Fume (SF)

It is a byproduct of the smelting process in the silicon and ferrosilicon industry.

→ It increases and strengthens cement-aggregate bond by forming a less porous region and ~~more homogenous~~ ~~mics~~.

8) Palm Oil Fuel Ash (POFA)

It is a by-product produced in palm oil mill. It is a pozzolanic material and can be replaced as partial cement replacement upto 35% in mortar mix.

→ POFA possess good characteristic towards chemical attack especially sulphate and acid.

9) Ceramic Waste

They are inorganic, non-metallic materials made from comp of a metal and non metal. It may be crystalline or partly crystalline.

→ With 20% cement replacement it has minor strength loss.

10) Recycled Aggregate

Construction debris and demolition waste constitute 25% to 33% of municipal solid waste.

→ Using such debris to produce new concrete natural resources and reduces valuable landfill capacity. Turning recycled concrete into useful or even high-quality aggregate poses well-known technical challenges. Not all applications require high strength concrete.

11) Quarry Waste as Fine Aggregate

Rock dust can be used an alternative to natural sand and its effects on the strength and increases workability of the concretes.

12) Ceramic Aggregates replacing aggregates

Strength is higher for concrete with both replacements coarse ceramic aggregate and ceramic sand than traditional aggregates.

13) Geopolymer concrete

They are a new class of concretes based on an eco-friendly non portland cement based binder derived from natural geological material such as silica and alumina by a chemical process that integrates minerals called as "geosynthesis".

→ It has greater setting process than OPC.

→ It is more heat resistant, fire resistant and superior thermal expansion, cracking and swelling properties compared to OPC

14) Straw Bale

Straw is strong and durable. It reduces the energy demand of a building because of its super insulating properties and locks up carbon for the life of a building.

→ Can be used in rural residential development

15) Fly ash as a partial replacement of aggregate

→ Compressive strength is increased with increase in flyash %ge.

* Pozzolanic Reaction

A siliceous and aluminium material that in itself possesses a little or no cementitious value but that will, in finely divided form in the presence of moisture, chemically react with calcium hydroxide (lime) at ordinary temperatures to form compound having cementitious properties.

→ If the concrete contains a pozzolan, less cement is required to obtain a specified strength

→ A highly reactive pozzolan has more cementitious strength value than the lower reactive pozzolan.

IGBC Green New Buildings rating system addresses under the following categories:-

1) Sustainable Architecture and design
2) Site selection and planning
3) Water conservation.
4) Energy Efficiency
5) Building materials and resources
6) Indoor Environmental Quality
7) Innovation and development

1) Sustainable architecture and design

Bioclimatic architectural principles

- Orientation.
- Thermal mass
- Surface to volume ratio.
- Positioning of windows, shading
- Selection of materials for wall, roof, windows, including insulation
- Landscaping

Buildings in hot climate

- Orientation to cut off sun protected insulated cavity external wall insulation.
- Lower surface to volume, lighter finishes, Water as landscape element.

Buildings in cold climate.

- Large windows to capture sun
- Thermal mass to store heat
- Minimum shading
- Insulated walls and windows
- Darker finishes

2) Site ~~Sel~~ Selection and planning

- Day lighting
- Earth Cooling
- Natural ventilation (night cooling)
- North-south orientation would reduce cooling loads by 1.5%

3) Water conservation

- Drought tolerant plants
- Drip irrigation, moisture-sensing irrigation technologies
- Recycled rainwater system

Water use reduction, 20 & 30% reduction.

- Dual flush water closets
- Ultra low-flow water closets and urinals
- Waterless Urinals
- Sensor-operated, low-flow lavatories
- Rainwater collection reuse systems
- Graywater reuse systems

4) Energy efficiency

- Use of photovoltaics as it produces free electrons when exposed to light resulting in power generation and also it doesnot reduce any green house gases when in use.
- 23 KW solar photovoltaic system 55% energy savings over base by building
- Can be used in flat roofs, shading elements, facades, roof top, atria & skylight
- Day lighting strategies.
- Low reflectance surfaces.
- Low angle spot lights.
- Use of effective solar control strategies.
- Minimize site lighting wherever possible

5) Building materials and resources

- Replace asphalt with concrete where possible.
- plant trees in vegetation strips around parking lots or sidewalks
- Consolidate parking into a parking garage
- Bioswales (designed to concentrate or remove silt and pollution out of surface runoff water)
- Detention ponds (general flood protection and help to manage the excess runoff generated by newly constructed impervious surfaces such as roads parking lots and rooftops).
- Vegetated filter strips
- Pervious paving
- Vegetated / Garden roofs.
- Energy star rated roofing systems

6) Indoor Environmental Quality

- Use of HVAC (Heat, Ventilation & Air conditioning) to provide the people working inside the building.
- Designing and sealing air destribution systems properly
- Systems may be clustered at a central location and serve an entire campus of buildings
- Replace CFC-based refrigerant
- Consider photovoltaic, solar thermal, geothermal, wind, biomass and bio-gas energy technologies
- Combine carbon dioxide monetors with demand based ventilation.
- Consider adjustable underfloor air diffusers, or thermostat controlled VAV boxes.
- Sophisticated electrical manages systems, building automation systems or direct digital control systems include most of the required monitoring points.

Green Building

Topic:

Types Of Rating System In India

Contributed By:

Amitava Roy

7) Innovation and development

- Use of integrated building and system design process yields a savings of up to 50-60% over conventionally designed buildings.
- Intelligent building systems.

Types of rating systems in India

1) LEED - Leadership in Energy and Environmental design)
2) 1) GRIHA - Green Rating for Integrated Habitat assessment.
   2) IGBC - Indian green building council.
   3) BEE - Bureau of energy efficiency

1) GRIHA was developed by TERI and ministry of new and renewable energy, GOI. (The energy and resources institute)
It has 34 criteria on 4 sections like 1) site selection and planning 2) conservation and efficient utilization of resource 3) building operation and maintenance & 4) Innovation.
Ex- Commonwealth Games Village, New Delhi.
Fortis Hospital
IIT Kanpur
Suzlon One Earth, Pune

2) LEED → It is the rating system developed for certifying Green buildings. LEED is developed by the U.S. Green building council (USGBC). The benchmarks for the LEED Green building rating system were developed in the year 2000 and are currently available for new and existing constructions.

CII - Confederation of Indian Industry, formed the IGBC in year 2001. IGBC is the non profit research institution having its offices in CII-Sohrabji

Godrej Green business centre, which is itself a LEED certified Green Building.

IGBC has licensed the LEED green building standard from USGBC

The following Green building rating systems are available with IGBC:-

1) LEED India for New Construction.
2) LEED India for Core and shell
3) IGBC green homes.
4) " " factory building.
5) " " SEZ
6) " " townships.

3) BEE :- It developed its own rating system for the buildings based on a 1 to 5 star scale. BEE has developed the Energy performance Index (EPI). The unit of kilo watt hours per sq. m per year is considered for rating the building and especially targets air conditioned and non-air conditioned office buildings.

Ex - RBI - Delhi

INDIAN GREEN BUILDING COUNCIL

Various level of rating awarded are:-

Certification Level	Recognition
Certified	Best Practices
Silver	Outstanding Performance
Gold	National Excellence
Platinum	Global leadership.

IGBC is designed primarily for New Buildings (owner-occupied and tenant-occupied).

The threshold criteria for certification levels are:-

Certification level	Owner-occupied buildings	Tenant-occupied buildings	Recognition
Certified	40-49	40-49	Best practices
Silver	50-59	50-59	Outstanding Performance
Gold	60-74	60-74	National Excellence
Platinum	75-100	75-100	Global Leadership

Benefits

Tangible benefits

- Energy savings: 15-30% (20-30%) } new
- Water savings: 15-50% (30-50%) }

Intangible benefits

- Enhanced air quality
- health & higher satisfaction levels of occupants.

Registration

→ Organisation interested in registering their projects under IGBC rating system should first register on IGBC website (www.igbc.in) under 'IGBC Green New Buildings Rating Systems tab'. It gives all important details on IGBC Green New Buildings rating system registration & certification-process, schedule and fee

Certification

The project must satisfy all the mandatory requirements and minimum number of credit points.

It needs to submit the following:

1. General information about project, including
   a. Project brief stating project type, different type of spaces, occupancy, number of floors, area statement etc.
   b. General drawings (in PDF format) only:-
      i) Master/site plan
      ii) Parking plans
      iii) Floor plans
      iv) Elevations
      v) Sections
   c. Photographs/Rendered images
2. Filled-in templates
3. Narratives and supporting documentation such as drawings, calculations (in excel sheets), declarations/contract documents, purchase invoices, manufacturer cut-sheets/letters/material test reports etc for each mandatory requirement and credit.

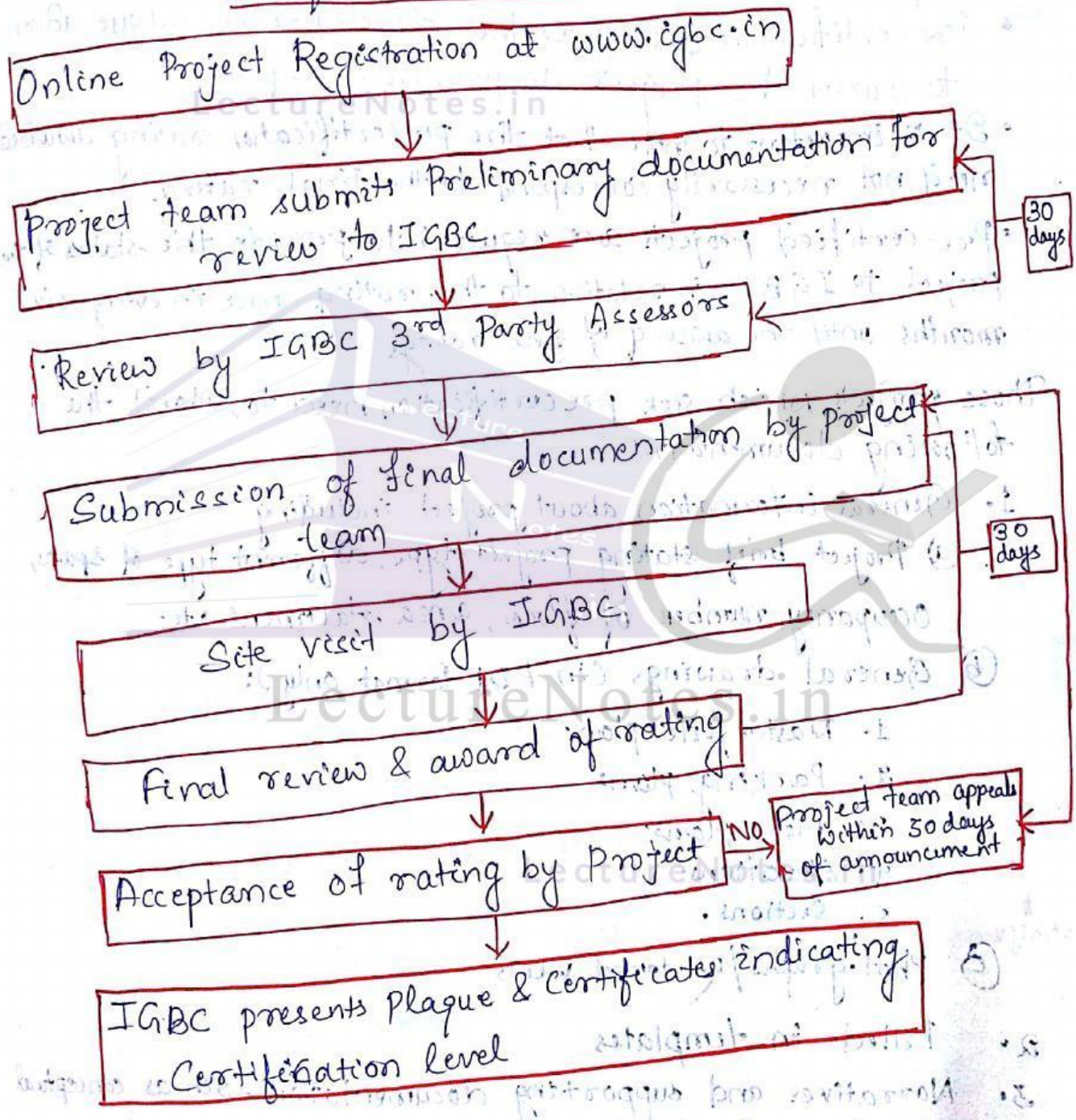
The project documentation is submitted in two phases

- Preliminary submittal.
- Final "

— Preliminary phase involves submission of all documents, which shall include the mandatory requirements and the minimum number of credits. After the preliminary submission, review is done by third party assessors and review comments would be provided within 30 days

– The next phase involves submission of clarifications to preliminary review queries and final submittal. This review will also be provided within 30 days, after which rating is awarded.

Certification Process



Green Building

Topic:

Precertification

Contributed By:

Amitava Roy

Precertification

Projects (Tenant-occupied Buildings) by developers can register for Precertification. This is an option provided for projects aspiring to get precertified at the design stage.

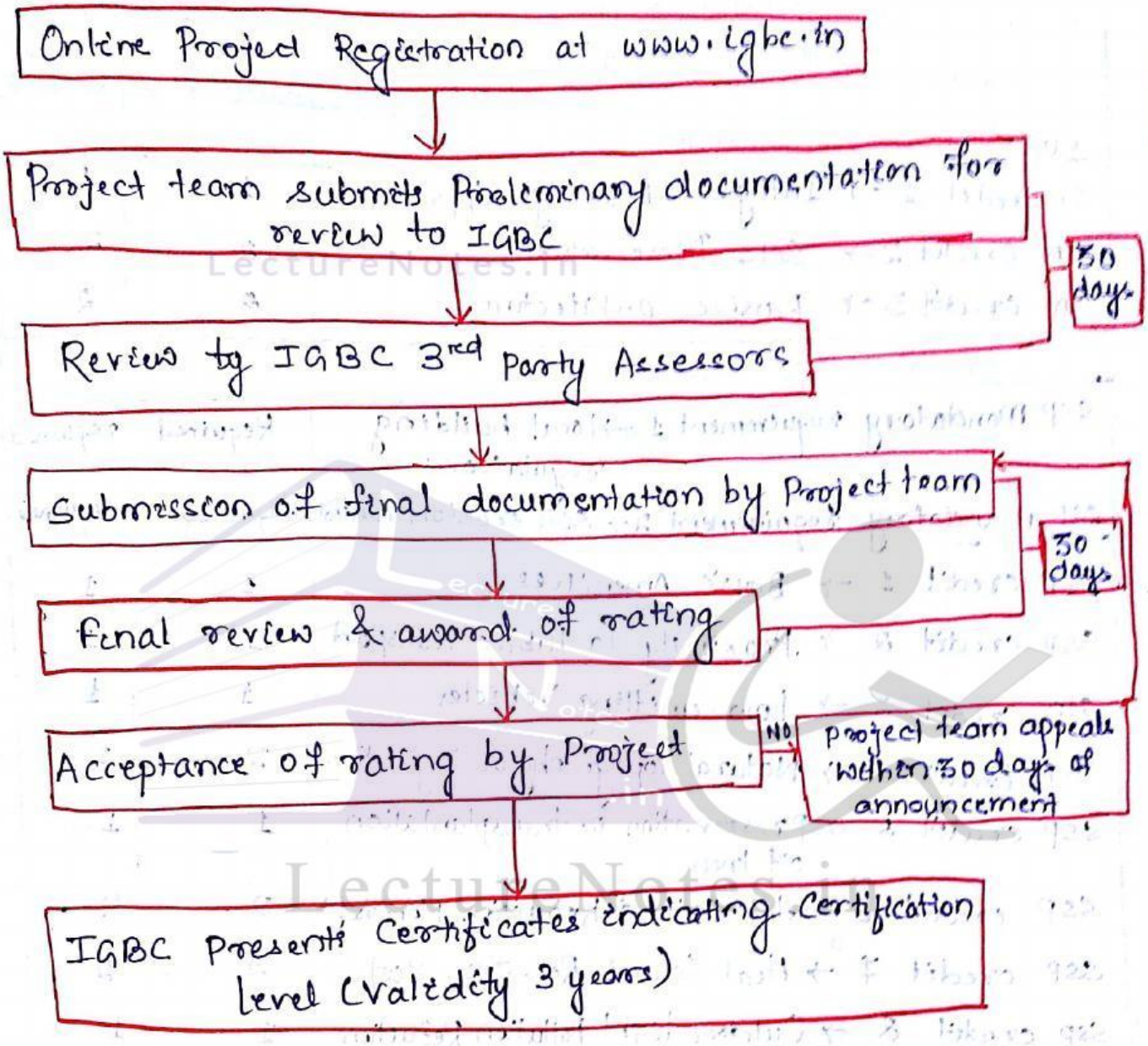
- Precertification also gives the developer a unique advantage to market the project to potential buyers.
- It is important to note that the precertification rating awarded need not necessarily correspond to the final rating.
- Pre-certified projects are required to provide the status of the project to IGBC, in relation to the rating, once in every six months until the award of final rating.

Those projects which seek precertification need to submit the following documentation:

1. General information about project including
   - (a) Project brief stating project type, different type of spaces, occupancy, number of floors, area statement etc.
   - (b) General drawings (in PDF format only):
     1. Master/site plan.
     2. Parking plans.
     3. Floor plans.
     4. Elevations.
     5. Sections.
   - (c) Photographs/Rendered views
2. Filled-in templates
3. Narratives and supporting documentation such as conceptual drawings, estimate/tentative calculations (in excel sheets), declarations from the owners etc for each of the mandatory requirement and credit.

IGBC takes 30 days to review and another 30 days to award the precertification.

Precertification Process



Precertification is valid 3 years from the date of award, after which projects are required to apply for the full certification. Progress reports once in six months to get an extension certificate for precertification rating.

IGBC Green New Buildings Rating System

Checklist

Modules	100 Owner occupied Buildings	100 Tenant occupied Buildings
SUSTAINABLE ARCHITECTURE AND DESIGN	5	5
SA Credit 1 → Integrated Design Approach	1	1
SA Credit 2 → Site Preservation	2	2
SA Credit 3 → Passive Architecture	2	2
SITE SELECTION AND PLANNING	14	14
SSP Mandatory requirement 1 → Local building regulations	Required	required
SSP mandatory requirement 2 → Soil erosion control	Required	required
SSP credit 1 → Basic Amenities	1	1
SSP credit 2 → Proximity to Public Transport	1	1
SSP Credit 3 → Low-emitting Vehicles	1	1
SSP Credit 4 → Natural Topography or Vegetation	2	2
SSP credit 5 → Preservation or transplantation of trees	1	1
SSP credit 6 → Heat Island Reduction, Non-roof	2	2
SSP credit 7 → Heat Island Reduction, Roof	2	2
SSP credit 8 → Outdoor light Pollution Reduction	1	1
SSP credit 9 → Universal design	1	1
SSP credit 10 → Basic facilities for construction workforce	1	1
SSP credit 11 → Green Building Guidelines	1	1
WATER CONSERVATION	18	19
WC Mandatory Requirement 1 → Rainwater Harvesting, Roof & Non-roof	Required	required
WC Mandatory Requirement 2 → water efficient plumbing fixtures	Required	required
WC Credit 1 Landscape design	2	2
WC credit 2 Management of Irrigation systems	1	1

WC credit 3	Rainwater Harvesting, Roof & Non-roof	4	4
WC credit 4	Water efficient plumbing fixutures	5	5
WC credit 5	Wastewater treatment & reuse	5	5
WC credit 6	Water metering	1	2
ENERGY EFFICIENCY		28	30
EE mandatory requirement 1	Ozone depleting substance	required	required
EE mandatory requirement 2	Minimum Energy efficiency	required	required
EE mandatory requirement 3	commissioning plan for building equipment & systems	required	required
EE Credit 1	Eco-friendly refrigerants	1	1
EE credit 2	Enhanced Energy efficiency	15	15
EE credit 3	On-site Renewable Energy	6	8
EE credit 4	Off-site Renewable Energy	2	2
EE credit 5	Commissioning, Post-installation of Equipment & systems	2	2
EE credit 6	Energy metering and management	2	2
BUILDING MATERIALS AND RESOURCES		16	16
BMR mandatory requirement 1	Segregation of waste, Post-occupancy	Required	required
BMR Credit 1	Sustainable building materials	8	8
BMR credit 2	Organic Waste management, post occupancy	2	2
BMR credit 3	Handling of waste materials, during construction	1	1
BMR credit 4	Use of certified green building materials, products & equipment	5	5

Modules		Owner occupied buildings	Tenant occupant buildings
INDOOR ENVIRONMENTAL QUALITY		12	9
IEQ Mandatory Requirement 1	Minimum Fresh Air Ventelation	Required	required
IEQ Mandatory Requirement 2	Tobacco Smoke control	Required	required
IEQ credit 1	CO_2 Monitoring	1	1
IEQ credit 2	Daylighting	2	2
IEQ credit 5	Outdoor views	1	1
IEQ credit 4	Minimise Indoor and Outdoor Pollutants	1	1
IEQ credit 5	Low-emitting materials	3	3
IEQ credit 6	Occupant well-being Facilities	1	-
IEQ credit 7	Indoor Air Quality Testing, after construction and before occupancy	2	-
IEQ credit 8	Indoor Air Quality management during construction	1	1
INNOVATION AND DEVELOPMENT		7	7
ID credit 1	Innovation in design process	4	4
ID credit 2	Optimisation in structural design	1	1
ID credit 3	Waste water Reuse, during construction	1	1
ID credit 4	1 GBC accredited professional	1	1

Passive Solar Design

It is a broad term used to encompass a wide range of strategies and options resulting in energy-efficient building design and increased occupant comfort.

"Passive solar design balances all aspects of the energy use in a building: lighting, cooling, heating and ventilation".

Basic idea is to allow daylight, heat and airflow into a building only when beneficial. The objectives are to control the entrance of sunlight and airflows so it is available when needed.

→ US department of energy show that PSB use 47% less energy than conventional new buildings and 60% less than older buildings.

It has following benefits:-

a) Energy performance – Lower energy bills year-round.

(b) Investment – high economic return on the incremental investment on a life-cycle cost basis and greater financial independence from future rises in energy costs.

(c) Comfort – Greater thermal comfort, less reliance on noisy mechanical systems, open floor plan, solid construction (more thermal mass)

(d) productivity – Increased daylighting, higher quality lighting systems.

(e) Low maintenance – Reduced building maintenance costs resulting from less reliance on mechanical systems.

(f) Environmental – Reduced energy usage and reliance on fossil fuels.

The following passive solar design strategies should be included during the building-design process

(a) Site selection :- Evaluate building site options/positions for solar access and use of landscaping elements

(b) Programming :- Establish energy-use patterns and set priorities for energy strategies; determine base-case conditions and conduct life-cycle cost analysis, establish an energy budget

(c) Schematic Design :- Maximise site potential by considering orientation, building shape and landscaping options, conduct analysis on building spacing.

(d) Design development :- Analyze the analyses of all individual building zones, including analysis of design element options and life cycle costs

(e) Construction documents :- Simulate total building projections and develop specifications that meet the intent of energy-efficient design

(f) Bidding :- Use life-cycle cost analysis to evaluate alternatives

(g) Construction :- ~~Or equal~~ Communicate to the contractor the importance of adhering to design elements and ensure compliance

(h) Occupancy :- educate occupants on the intent of energy design and provide an operations manual for maintenance staff

(i) Post occupancy :- Evaluate performance and occupancy behavior ~~for~~ comparision with the goals

Daylighting

Significance

Daylighting is the practice of bringing light into a building interior and distributing it in a way that provides more desirable and better-quality illumination than artificial light sources.

Design Process:-

(1) Programming phase:-

→ Establish daylighting performance objectives and requirements

→ Analyze lighting performance using following procedures:
- Perform a solar-path analysis for the latitude at site
- Determine design illumination levels.
- Perform a preliminary life-cycle cost-benefit analysis

(2) Preliminary design phase:-

→ Establish the location, shape, and orientation of the building on the site based on daylighting performance objectives

→ Establish energy-efficient artificial illumination systems based on design illumination levels and energy-efficiency targets

Recommended surface reflectance values

Surface	Range of surface Reflectance (low-high)
Ceiling	80%-90%
Walls	60%-65%
Floor	20%-50%

→ Determine the optimal effective aperture for toplighting strategies.

→ Incorporate fenestration into the basic building geometry (Arrangement of windows in a building)

③ Design Development Phase

Specify details for lighting systems and products

→ Specify glazing materials based on climate, fenestration, passive solar orientation

→ Specify finishes based on desired reflectance values for walls, ceilings and floors

→ Specify control systems, including photosensors, control zones and occupancy sensors

④ Construction Phase

Confirm that specified practices and materials are installed properly

→ Monitor direct sunlight penetration through fenestration

→ Observe skylight installations and observe that it is water-tight.

⑤ Post Occupancy Phase

Ensure that the building's daylighting features are in place and maintained for optimum performance

General Daylighting Principles :-

→ Avoid direct sunlight on critical tasks and excessive brightness

→ Bring the daylight in at a high location

→ Filter the daylight - trees, plants, draperies, screens etc.

→ Bounce daylight off of surrounding surfaces - Light shelves, louvers, blinds and baffles reflect and distribute light throughout.

→ Integrate daylight with other building systems and strategies → Eg. HVAC systems, including natural ventilation, passive solar heating and cooling, acoustic control systems, photocells, etc.

Some emerging glazings :-

Some ~~stech~~ switchable glazings are :-

(i) Photochromic glass – light-sensitive glass darkens at a predetermined density level.

(ii) Thermochromic glass – heat-" " becomes translucent at a predetermined temperature.

(iii) Electrochromic glass :- Electrically variable coatings become darkened with the application of current and clear as current is reduced.

(iv) Liquid crystal (LCD) :- It becomes clear with application of electrical current and clear as current is reduced.

BUILDING ENVELOPE

(Significance)

Building envelope or "skin" consists of structural materials and finishes that enclose space, separating inside from outside. This includes walls, windows, doors, roofs and floor surfaces.

- This balance requirements for ventilation and daylight while providing thermal and moisture protection appropriate to the climatic conditions of the site.

Suggested practices and checklist

(i) climate considerations :-

→ Assess the local climate to determine appropriate envelope materials and building designs.

- In hot/moist climates use materials with low thermal capacity.
- In ~~thermal~~ temperate climates, select materials based on location.
- In cold " , design wind-tight and well-insulated BE

→ Assess the site's solar geometry

(2) Building shape and Orientation :-

→ Choose the most compact building footprint and shape that work with requirements for daylighting, solar heating and cooling and function

Eg→ A sq. floor plan is more thermally efficient than a rectangular one because it contains less surface area over which to lose or gain heat

→ Site and orient the building so as to minimize the effect of winter wind turbulence upon the envelope

(3) Doors, Windows and Openings :-

→ Size and position doors, windows and vents in the envelope based on careful consideration of daylighting, heating and ventilating strategies.

→ Shape openings in the envelope during hot weather to reduce the penetration of direct sunlight to the interior of the building

→ In all but the mildest climates, select double or triple-paned windows with as high an "R" value as possible and proper shading coefficient within the project's financial guideline

• ("The "R" value is a measure of the resistance to heat flow across a wall or window assembly.

→ Select proper glazing for windows, where appropriate

• Glazing uses metallic layers of coating to either absorb or reflect specific wavelengths in the solar spectrum)

(4) Thermal efficiency :-

→ Determine the building function and amount of equipment that will be used.

→ Consider the reflectivity of the building envelope

→ prevent moisture buildup within the envelope.

→ specify construction materials and details that reduce heat transfer

→ Use thermal resistance to provide human comfort
→ Consider use of earth berms (→ artificial ridge or embankment, flat strip of land or tactical bands) to reduce heat transmission and radiant loads on building envelope.

⑤ Building Grounds :-

→ Coordinate building strategy with landscaping designs.
→ Reduce paved areas to lessen heat buildup around the building

RENEWABLE ENERGY

Passive Solar heating, cooling, and thermal storage

The passive solar measures and mechanical systems need to be evaluated to an interactive basis during the design process, since an increase in one, can lead to a decrease in the other.

→ Direct gain through south-facing glass is the most common method of passive solar heating. Other methods include indirect gain (eg-sunspace or atrium) and thermal storage walls. They benifit from PSD because they are "envelope-dominated" i.e. their space conditioning loads are determined primarily by climatic conditions and building envelope construction characteristics rather than by internal heat gains.

→ Passive solar cooling strategies include cooling load avoidance, shading natural ventilation, radiative cooling, evaporative cooling, dehumidification and ground coupling. Passive design strategies can minimize the need for cooling through proper selection of glazings, window placement, shading techniques and good landscaping design.

→ Thermal mass and energy storage are key characteristics of PSD. They can provide a mechanism for handling excess warmth, therefore reducing the cooling load, while storing heat that can be slowly released back to the building when needed.

Passive solar heating thumb rules:-

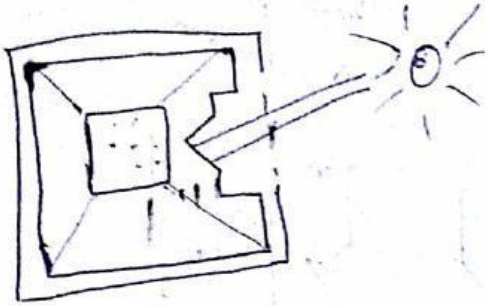
→ Analyze building thermal-load patterns
→ Building should be elongated on an east-west axis
→ The building's south face should receive sunlight b/w the hour 9am and 3pm during the heating season.
→ Interior space requires the most light and heating and cooling should be along the south face of the building. Less used space be located on the north.
→ An open floor plan optimizes passive system operation
→ Use shading to prevent summer sun entering the interior
→ Locate thermal mass so that it will be illuminated by low winter sun angles.

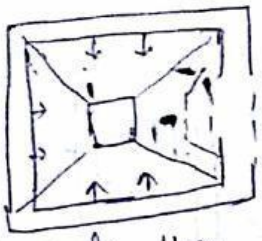
There are 3 approaches to the passive system:-

(1) Direct gain.
(2) Indirect gain.
(3) Isolated gain.

(1) Direct gain:- In this system, the actual living space is a solar collector, heat absorber and distribution system. Southfacing glass admit solar energy into the house where it is stored directly and indirectly thermal mass materials in the house such as masonary floors and walls. The direct gain system will utilize 60-75% of the suns energy striking the windows. On a direct gain system, thermal mass floor and walls are functional part of the house. It is also possible to use water inside the house to store the heat.

The thermal mass will temper the intensity of the heat during the day by absorbing the heat. At night thermal mass radiates heat into the living space.

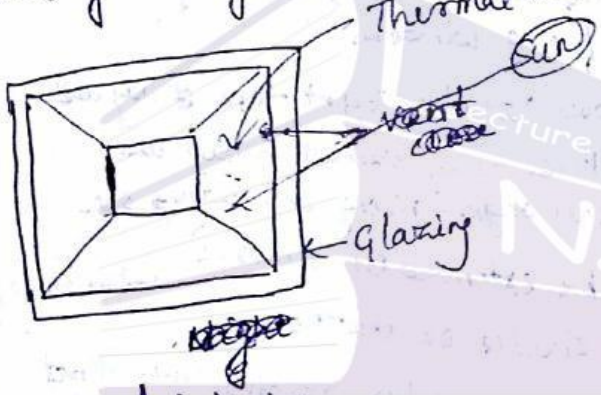


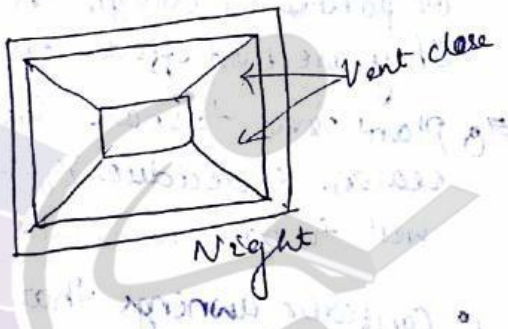


Night time.

② Indirect gain:-

In an indirect gain system thermal mass is located b/w the sun and the living space. The thermal mass absorbs the sunlight that strikes it and transfers it to the living space by conduction the indirect gain will utilize 30-35% of the sun's energy striking the glass adjoining the thermal mass.





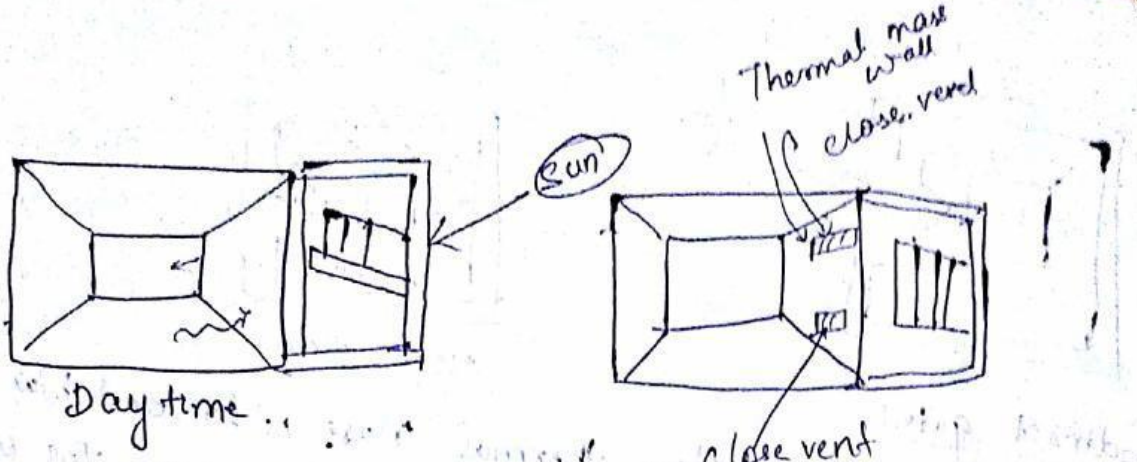
③ Isolated Gain:-

An isolated gain system has its integral part separate from main living area of house.

→ The isolated gain system utilize 15-30% of the sunlight striking the glazing toward the adjoining living areas Solar energy is also retained in the sunroom itself.

→ Solar green house is the direct gain and in direct gain system features

→ The sunlight entering the sunroom is retained in the thermal mass and air of the room the sunlight is brought in to the house by mean of conduction through the masswall or vent that permit the air b/w sunroom and living space to be exchange by convention.



Passive Solar Cooling

→ Design buildings for cooling load avoidance

→ · Choose one or more shading strategies

o Install fixed shading devices using correctly sized overhangs or porches or design the building to be "self-shading". They are most effective on south facing windows.

o Plant trees to shade the windows at the right time of day and season. Ex deciduous vegetation, trees to be planted in east and west to block undesirable low sun angles, rising and setting sun.

o Consider awnings (a roof like cover, canvas) that can be extended or removed.

o Consider exterior roll-down shades or shutters.

o Limit east/west glass (North facing glass receives little direct solar gain, but does provides diffuse daylight.)

→ Consider other cooling strategies.

o Design the building to take natural ventilation. eg. Wingwalls, fresh air inlets, atriums, stairwell towers etc.

o Consider radiative cooling in appropriate climates. (Radiative cooling allow stored heat to be released to the outside)

o Consider ground coupled cooling. It is achieved by conductive contact of the building with the earth. It is done to cool air by channeling it through an underground tunnel.

o Consider evaporative cooling strategies (used in dry climates eg. south west)

o Use dehumidification in humid climates. It is done by dilution of interior moisture by ventilating with less humid air, condensation on cooled surfaces connected to a heat sink.

Thermal storage

→ Determine if excess heat should be stored or vented.
- Thermal mass meets two needs. One to quickly absorb solar heat for use over diurnal cycle and second to provide slow release of the stored heat when the sun is no longer shining.

→ Choose one or more thermal storage strategies.
- Two types of storage are there
  - i) "Direct" thermal storage (Placed directly in sunlight)
  - ii) "Diffuse" " " (Placed throughout building)
- Consider concrete, tile, brick, stone or masonry floors.
- Use dark colors.
- Consider a Trombe wall - a south-facing masonry wall covered with glass spaced a few inches away.
- Use double gypsum board
- Consider water-storage containers for thermal mass.

Active solar hot water systems:-

→ Thermosyphon systems → uses glycol which raises by natural convection from collector to the storage tank and placed at high level
→ Direct-circulation " → where freezing temp are infrequent, it pump water from storage to collectors and freeze protection is obtained by recirculating hot water from storage tank or by flushing collectors (drain-down)
→ Drain-down " → water is circulated through a closed loop and heat is transferred to potable water through a heat exchanger. collector fluid is drained by gravity to avoid freezing and convection loops in which cool collector water reduces the temp of stored water.
→ Indirect water-heating systems → water-ethylene glycol solution and water-propylene glycol ion are used and circulated through a closed loop and its heat is transferred to potable water through heat exchangers with 80% to 90% efficiency
→ Air systems → The collectors heat the air which is moved by a fan through an air-to-water heat exchanger. The water is then used for domestic or service needs.

Photovoltaics (significance)

Photovoltaic (PV) technology is the direct conversion of sunlight to electricity using semi-conductor devices called solar cells. They are maintenance free and have a long life span. PVs are currently cost-effective in small off-grid applications such as microwave repeaters, remote water pumping, and remote buildings. While the cost is high for typical applications on buildings connected to electric power grid, the integration of PVs into commercial

buildings is projected to greatly increase over the time. PV produce direct current, which can be easily stored in batteries e.g. inverter.

Now-a-days single-crystal PVs use wafers of silicon wired together and attached to a module substrate. Thin films look like a tinted glass can have lower cost per sq. ft., but also have less efficiency than single crystal PVs.

1) Installation sites

→ ~~Conventional~~ use include consider conventional and remote electrical uses for PV power.
- Applications in off-grid areas
- Recreational areas
- Water districts to power monitoring equipment

→ Consider utility-integrated PVs where utility demand charges are very high and there is extensive sunshine during the facility's peak electric loads.

→ Consider PV-driven battery backup systems

2) Building integration.

→ Rack-mount PV systems or mount them directly on roof and wall surfaces.
- Buildings to be designed with sloped surfaces that can optimise PV exposure

→ Watch for the commercial-availability in the near future of partially transparent PV panels for use as window-shading devices

3) Landscape integration

→ consider the use of large PV arrays to generate electricity while shading parking lots or other outdoor areas.

→ On a smaller scale, PVs can be used to economically power night-time walkways and landscape lighting.

Green Building

Topic:

Indoor Air Quality

Contributed By:

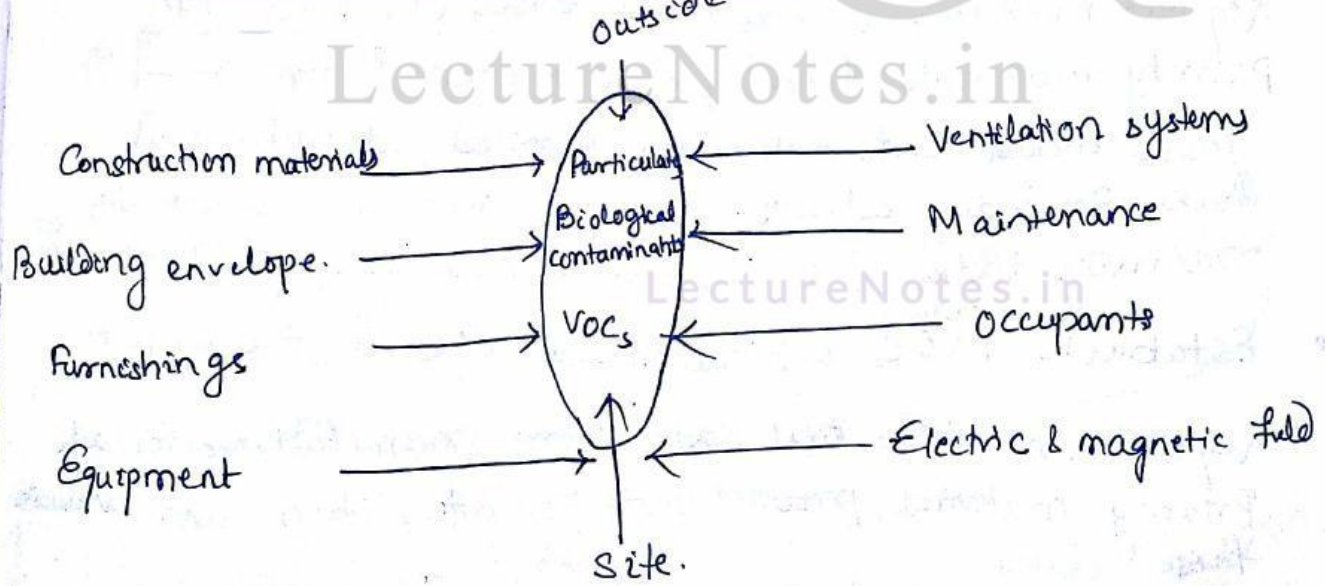
Amitava Roy

INDOOR AIR QUALITY

Factors that contribute to IAQ are as follows:-

1) Construction materials, furnishings and equipment — They emit odor, particles and VOCs and may combine with VOCs to form new chemicals.
2) Building envelope
3) Ventilation systems.
4) Maintenace - Lack of maintainance allows dirt, dust to increase.
5) Occupants
6) Electric and magnetic fields (EMF) - generated by power lines and electric appliances. Possible health effects.
7) Sick building syndrome (SBS)
8) Building-related illnesses (BRI)
9) Multiple chemical Sensitivities (MCS) - It can recur and disappear in response to exposure to the stimuli (VOCs).

MAJOR FACTORS CONTRIBUTING TO IAQ



Design Principles

four principles of IAQ design:

1. Source Control
+
2. Ventilation Control
+
3. Occupant activity control
+
4. Building Maintenance

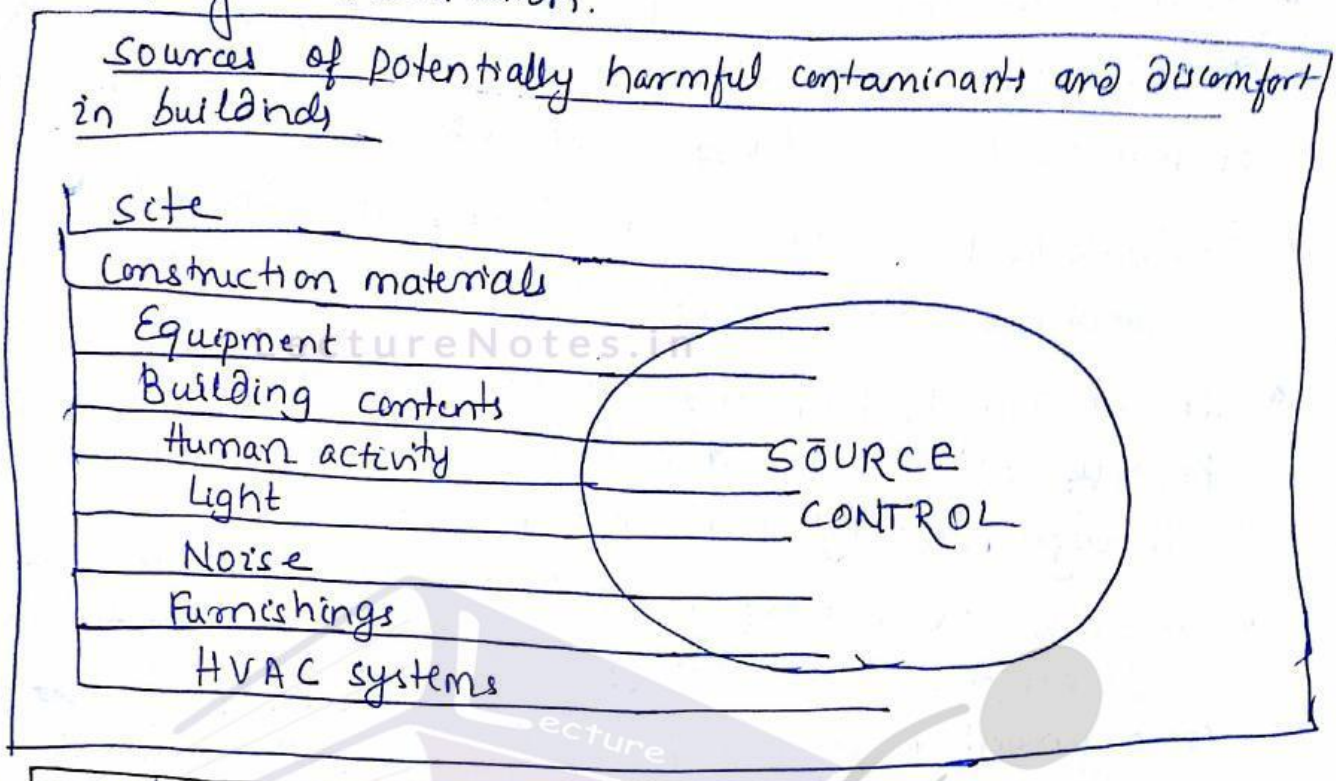
= Total Indoor Air Quality.

1) Source Control

- Set source-control priorities that are feasible within the project budget, project schedule and available technology.
- Establish the building owner's and occupants' criteria and guidelines for improved IAQ
- Request material safety data sheets (MSDSs) for priority materials from product manufacturers. — MSDS include information on chemical identification, hazardous ingredients, physical/chemical characteristics, reactivity data, spill, health hazard data, special precaut
- Establish TVOCs (total) and individual VOCs for the project.
- Request emissions test data from manufacturer for each priority material, product and furniture item. and evalu those datas.
- Take steps to control the MVOC (microbial) contribution to the indoor air from materials, products and furnitur

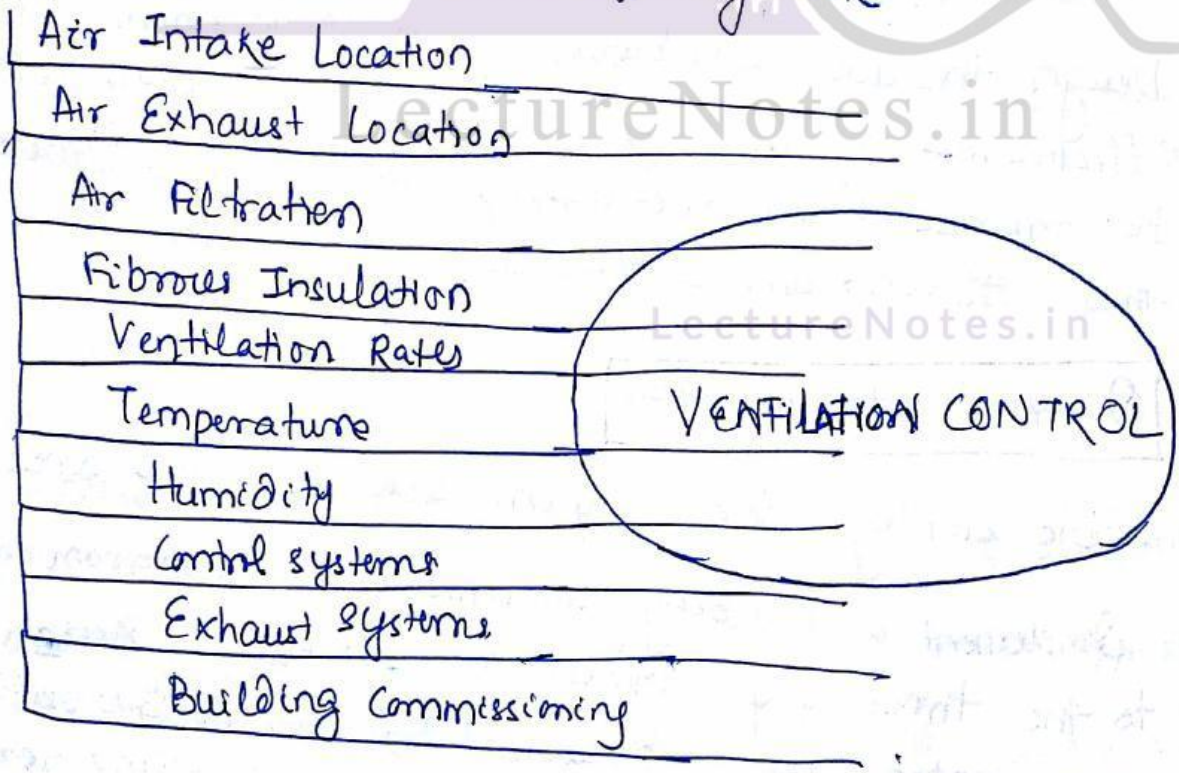
- In remodeling projects, test for and remove known hazardous materials such as asbestos, lead, poly chlorinated biphenyls (PCBs) and fungal contamination.

Sources of potentially harmful contaminants and discomfort in buildings



) Ventilation Control

Ventilation control factors affecting ~~IAQ~~



Strategies for ventilation Control:-

- Review the building occupant's use needs and program requirements and the energy conservation code requirements to determine whether fixed or openable windows will be pro
- Evaluate the HVAC system and develop the design criteria in accordance with applicable codes an.
- Install a high frequency air filtration system to remove particles of airborne dust from outside air prior to distribut through building's HVAC system.
- Consider the use of an outdoor-air-economizer system. It enables the building operator to use the energy management to vary the quantity of outside air brought into the building above minimum ventilation levels.
- Install dedicated local-air exhaust systems vented to the outside separate from general exhaust system
- Design the air-distribution system for maximum ventilation effectiveness by ensuring the proper location and performance of the air-supply and return diffusers, so that sufficient air is delivered to occupants.

3) **Occupant activity control**

Possible strategies for occupant activity control are:-

- Implement a building commissioning program similar to the three-step commissioning process. — Design the HVAC system design documentation and design criteria and these documents provided to the building operators, specify the maximum building population and permissible equipment designated by design parameters of HVAC systems.

- Consider the use of CO_2 and VOC sensors in occupied spaces – These monitors should be linked to the building or energy-management system computer, which can be used to regulate the quantity of outside air needed to ventilate the building based on actual occupant-load conditions
- Implement a no-smoking rule from the commencement of construction through the life of the building.

(4) Building Maintenance

- Select easy-to-maintain building materials and systems - eg. stone floors.
- Implement an integrated pest management program using only pre-authorized and non-hazardous chemicals that do not violate the integrity of building IAQ
- Select low-emitting, environmentally friendly cleaning agents for use in regular maintenance.
- Institute a tenant policy for IAQ practices, including a no-smoking rule.
- Prepare an IAQ plan to be administered by the building IAQ manager
- Prepare a maintenance plan with a schedule and budget for the HVAC systems, building materials and furniture. Maintenance plan should include HVAC systems carpets, chairs, office systems; Other finish materials.
- Develop and provide the building operators with complete operations and maintenance manuals and a plan for appropriate system operation training.
- Develop a plan to provide to provide post-occupancy building commissioning on a regular basis every few years.

Acoustics

Significance :- Acoustics have a significant impact upon the overall IAQ of modern buildings and amount of noise emission or pollution discharged to the outdoors. The levels of background noise, privacy and separation b/w particular types of spaces have important implications for the work environment of building occupants.

- There are numerous standards for acoustic quality in traditional building spaces and in speciality areas such as sound and production rooms, where acoustics is a high priority.
- At the start of a project, the design team should work with the buildings' users to establish requirements for background noise levels, sound isolation and speech privacy to ensure that sufficient levels are afforded to all spaces.
- On certain noise-sensitive areas, and particularly in renovations, white noise and active noise systems.
- Surface finishes, and mechanical issues are also important in the acoustic environment and can influence the character of the space as significantly as color or shape.
- Outdoor sound emissions must also be considered. like manufacturing areas industrial area

Some practices and checklist:-

→ Identify local zoning codes regarding noise and determine requirements for the project's adherence to such codes.

→ Determine the impacts of proposed building systems on surrounding areas and ambient conditions

→ Consider how the noise level from external sources around the building will affect occupants. and go design as per noise criteria. 55dB during day 45" " night 75 - 70

Green Building

Topic:

Building Operations And Maintenance

Contributed By:

Amitava Roy

Building Operations and Maintenance

Maintenance Plans

Author
Sal Agnello

★ SIGNIFICANCE

The O&M costs throughout a building's useful life far exceed its initial design and construction costs. Expenditures related to the salaries and health of employees working in a building often equal or exceed O&M costs annually. When these factors are considered, together with the impact that sound O&M practices can have on occupant satisfaction and productivity, it is clear that the financial benefits of creating and maintaining quality building environments surpass the costs directly related to facility operations alone.

Codes and professional standards for building design and construction exist to ensure quality buildings. But they alone are not sufficient, because even a properly designed and constructed building will not provide a cost-effective, healthy environment unless it is properly operated and maintained. Unfortunately, implementation of professional standards for quality building environments usually ends upon completion of building construction; sound building O&M is not assured by codes or other regulatory authority. This section is intended as an overview of practices that promote quality indoor environments while conserving resources during a building's operational phase.

☞ SUGGESTED PRACTICES AND CHECKLIST

☐ **Train facility staff to observe standards of care for a building.**
Modern buildings are complex, costly, and likely to expose occupants to risk. Identify and communicate to facility staff applicable American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards, codes, and regulations that minimize such risks.
- Develop policies and procedures for compliance with these standards and documentation of compliance.

- ❑ **Ensure facility staff have enough qualifications and training to operate special equipment.** Develop a plan for continuing education and keep equipment operations manuals readily available.
- ❑ **Establish written O&M policies and procedures for inspection, preventive maintenance, cleaning, and repair of mechanical system components.** Operate and maintain the facility according to its design intent and equipment needs, but change practices as the building itself changes and obsolete equipment is replaced.
  - Periodically assess occupancy loads, types of space use, and corresponding ventilation, temperature, and humidity requirements.
  - Establish methods for airflow and thermal parameter measurement.
  - Develop plans and schedules for checking operation of mechanical system components.
  - Develop plan and schedules for checking system cleanliness.
  - Establish a documentation system for repairs and replacement.
- ❑ **Include Material Safety Data Sheets (MSDS) and information on cleaning and pest-control methods in the building's environmental services and housekeeping policies and procedures.**

Indoor Environmental Quality

Indoor Air Quality

Tenant Complaints

☐ **Pay careful attention to the resolution and coordination of tenant complaints.** In many cases, these complaints indicate potential or actual problems. Early prevention can spare building management future occupant-related problems and liability, including the risk of litigation, worker's compensation claims, poor publicity, lost rent, and lower occupancy levels and rental rates.

- Investigate every complaint.
- Develop policies for communicating with occupants regarding pollutants, use of space, and activities.
- Develop a complaint response form. Refer to EPA's *Building Air Quality Guide* for examples. Aside from helping diagnose facility problems, accurate recordkeeping can document responsiveness to occupant complaints and help protect building management from potential negligence claims.
- Develop follow-up procedures to ensure complaint resolution.
- Bring in IAQ expertise to investigate complicated complaints.

Building Monitoring

☐ **Monitor your buildings for compliance with the latest environmental guidelines.** It is important to keep up with technical, regulatory, and professional-practice developments; to review adherence to established O&M policies and procedures; and to monitor the physical parameters associated with a safe and comfortable indoor climate.

- Stay informed of the latest IAQ developments by subscribing to the trade journals, programs, and resources of ASHRAE, the American Society for Testing and Materials (ASTM), International Facilities Management Association (IFMA), BOMA, and other associations.
- Establish measurable environmental guidelines for variables such as outdoor airflow, temperature, humidity, and filtration efficiency. Monitor performance against these guidelines.
- Continuously document the operation of the building's heating, ventilating, and air-conditioning (HVAC) system, particularly outdoor air measurement, filtration performance, exhaust system performance, temperature, and humidity. Use building-control-system technology to assist in this process.
- Follow the Ventilation-Rate Procedure of ASHRAE Standard 62-1989 (*Ventilation for Acceptable Indoor Air Quality)* to monitor, control, and document minimum outdoor airflows, even with variable-air-volume (VAV) systems. Consider available automated technologies such as indirect outdoor-air measurement and closed-loop control technology or outdoor airflow measuring stations for this purpose.
- In spaces with known hazards, such as areas adjacent to indoor parking garages, monitor specific contaminants like carbon monoxide (CO) and radon, the latter especially in below-grade areas located in geographic regions with high radon. Also, use carbon dioxide (CO_2) high-limit alarms for areas with hard-to-predict occupancy, such as conference and assembly areas, where periodic high occupancy levels may result in unhealthy conditions.

IAQ Practices and Maintenance

☐ **Perform regular maintenance on the major components of HVAC systems.** Regular maintenance keeps HVAC components operating properly to control potential IAQ contaminants and sustain appropriate environmental conditions. Exhausting fumes and odors from a building, filtering out dust and other particulates, maintain-

ing proper humidity, and diluting occupied spaces with outside air are all practices with a proven record of preventing and solving IAQ problems.

Outdoor-Air Intake

- Clean outdoor-air-intake plenums, louvers, screens, dampers, and other components, and check for necessary screening to ensure protection from outside elements. If necessary, retrofit the outdoor-air intake so that it is properly located outside and distanced from building exhausts and outdoor contaminants. When air is exhausted from special odor and contaminant areas (such as restrooms, smoking lounges, and printing areas), enough replacement air must be brought in to prevent the building from becoming negatively pressurized and drawing in outside contaminants through leaks and openings in the building envelope.
- Repair malfunctioning outdoor-air dampers to provide sufficient outdoor air for proper ventilation and exhaust-air makeup, to produce positive air pressure, and to prevent excessive influxes of outdoor air in cold weather from adversely affecting temperature control.
- Continuously measure outdoor airflows through installation of outdoor airflow stations or outdoor-air controllers with VAV systems, ensuring compliance with ASHRAE Standard 62-1989.

Indoor Ventilation and Air Ducts

- Evaluate heating, cooling, and ventilation capacity to see if such capacity matches up with occupancy and equipment loads.
- Check supply fans for coordinated fan size and duct layout, as well as the size of the duct opening and resistance in air velocity, to ensure proper static pressure in the ventilation system. Periodically test, adjust, and balance the system to achieve proper airflow and air distribution to all zones and occupants within the building. Check fans and damper modulation to promote proper space pressurization. Periodically maintain components, filters, and controls in accordance with manufacturers' recommendations.
- Provide sufficient exhaust to areas with significant contaminant-source activity. Install separate ducts from such spaces as laboratories, chemical storage areas, and restrooms to the outside, supply sufficient outdoor air to make up for local exhaust from these areas, and pressurize the areas properly.
- Check diffusers and return-exhaust grills for proper air distribution. Test, adjust, and balance air to reflect the impact of space modifications.
- Use CO_2 sensors as a supplementary ventilation strategy for variable or unscheduled occupancy. This strategy delivers outdoor air to a space when its occupancy produces a certain level of CO_2, triggering a sensor that opens the outdoor-air damper to increase ventilation. It is suggested only as a supplement to other ventilation mechanisms because, by itself, it does not meet provisions of the Ventilation Rate Procedure of ASHRAE Standard 62-1989.
- Inspect ventilation systems for supply-duct leaks and water damage. Repair leaks to prevent short-circuiting of supply and return air, and clean any areas where accumulated dirt may restrict airflow and encourage moisture to accumulate.
- Inspect and periodically replace or clean filters of air handlers and related equipment. Inspect filter tracks for gaps and repair them to prevent bypass of dirty air. Use the control system to monitor air pressure across filters and to determine timely filter servicing; particle counters may also be used for better filter maintenance. Clean clogged coils for unrestricted airflow and heat transfer.
- Provide sufficient outdoor air for combustion to achieve proper pressurization of the boiler room and functioning of flue-gas and exhaust systems.

Temperature and Humidity Control

- Check temperature controls for proper location and design the building zones for proper heating and cooling distribution.
- Inspect duct thermostats, designed to prevent cold outside air from freezing heating coils. Unnecessary activation of these devices could result in thermal discomfort from automatic shutoff of the system.
- Perform preventive maintenance and repair on chillers to ensure sufficient cooling and dehumidification in the building. Insulate piping to prevent condensation and mold and microbial growth. Retrofit or upgrade chillers for quick capture of refrigerants, including those from the building's exhaust room.
- Check and maintain appropriate humidity levels during heating and cooling seasons to ensure occupant comfort and to prevent condensation that could lead to microbial growth. Retrofit systems to provide appropriate humidification or dehumidification capacity as required. Use clean steam rather than treated boiler water for humidification.

Cleaning and Pollutants

- Inspect and test ducts for microbial contamination; replace duct lining in air handlers with cleanable liners treated with antimicrobial additives. Do not leave residue of contaminated lining on the duct metal.
- Inspect return-air systems for integrity and cleanliness to prevent the spread of pollutants from plenum areas such as mechanical rooms.
- Inspect and clean HVAC system components, such as drain pans, to prevent mold and fungus accumulation.
- Inspect and clean self-contained heating and cooling units to prevent and correct contamination from dirt and moisture.
- Clean cooling towers to prevent sediment and film accumulation. Clean and chemically treat water to prevent the growth of microorganisms such as Legionella. Install drift eliminators to prevent water-mist release and re-entrainment of contaminant mists into outdoor-air intake systems.
- Adjust boilers for proper combustion to minimize production of CO and nitrogen oxides.
- Inspect and maintain gaskets and prevent fuel-line leaks and resulting contaminants, fumes, and odors.
- Develop and implement source-control strategies in addition to the above ventilation practices. A comprehensive source-control program needs to address potentially high-pollutant items such as carpet, paint, adhesives, and adhesives and preservatives in furniture.

(See Chapter 12, "HVAC, Electrical, and Plumbing Systems," and Chapter 13, "Indoor Air Quality.")

Thermal Comfort

- ❑ **Establish temperature and humidity setpoints in accordance with occupancy patterns, scheduling, and outside climate and seasonal variances; follow ASHRAE Standard 55-1992 (*Thermal Environmental Conditions for Human Occupancy*).**
- ❑ **Use building-control systems (computerized temperature-sensing and control technology) to establish, maintain, and document building climate conditions.**

(See Chapter 12, "HVAC, Electrical, and Plumbing Systems.")

Light Quality

- ❑ **Adjust lighting levels to types of space use and occupancy, following Illuminating Engineering Society standards.**

- Repair lighting fixtures that produce glare, flicker, insufficient illumination on work surfaces, and other conditions that can cause eyestrain, headaches, and other discomfort.

(See Chapter 9, "Daylighting," and Chapter 12, "HVAC, Electrical, and Plumbing Systems.")

Green Building

Topic:

HAVC

Contributed By:

Amitava Roy

SUGGESTED PRACTICES AND CHECKLIST

HVAC

Operation Schedules

- ☐ Adjust operating hours of heating and cooling systems to levels appropriate for time of year, type of use, and occupancy patterns of the facility.
- ☐ Adjust operating hours of ventilation systems according to potential contaminant levels and the need to balance exhaust air.
- ☐ Use timing devices to operate exhaust fans only when needed; coordinate with supply fans and building pressurization requirements.
- ☐ Use programmable thermostats to schedule and establish heating setpoints for various building occupancy patterns.
- ☐ Schedule, control, and document ventilation rates to meet levels prescribed by ASHRAE Standard 62-1989 for type of facility, occupancy lead time, and load.
- ☐ Use building-control systems to operate HVAC equipment based on need, minimize simultaneous heating and cooling, and supply thermal conditioning from the most efficient sources.
  - Set automatic temperature control based on pre-established ranges.
  - Use time-of-day and occupancy-based controls.
  - Supply air-temperature reset control for VAV systems.
  - Supply hot- and chilled-water temperature reset controls based on outside-air temperature and hot- or chilled-water demand.
  - Use economizer control system to bring in outside air for cooling.

Adjustment Control

- ☐ Adjust space temperature and humidity setpoints to minimize space-conditioning requirements.

  Do not set these limits below the lowest heating temperature—or above the highest cooling temperature—required to satisfy occupants' needs, in accordance with the thermal requirements of ASHRAE Standard 55-1992.
- ☐ Lower humidification and raise dehumidification setpoints based on time of year, occupant-generated moisture, and equipment- or material-protection needs, such as those required by wood finishes and electronic components.

System-Efficiency Improvements

- ☐ Install air-to-air heat exchangers, which preheat cold outdoor supply air by transferring heat from warm exhaust air.
- ☐ Install air-cleaning devices, such as particulate filters, activated carbon, electronic air cleaners, and other mechanisms that clean recirculated air.
- ☐ Improve chiller efficiency.
  - Clean evaporator and condenser surfaces to maintain their heat-transfer capabilities.
  - Treat circulating water in cooling towers with chemical filtering to control scale, algae, and other deposits.
  - Implement control strategies that raise evaporator or lower condenser water temperatures to reduce the differential between them.
  - Install evaporation-cooled or water-cooled condensers rather than replacing air-cooled evaporators.
- ☐ Improve boiler or furnace efficiency.
  - Properly adjust fuel-air ratios by installing flue-gas analyzers.
  - Reduce cooling effect of combustion air and cut energy consumption by preheating combustion air and reclaiming waste heat from feed water and fuel oil.

- ❑ **Prevent overcapacity by isolating off-line boilers with control valves and dampers, and replacing equipment with modular units whenever possible.**
- ❑ **Install automatic vent dampers.**
- ❑ **Install automatic boiler blowdown control to remove contaminants that can reduce heat transfer; for oil-fired systems, install air-atomizing and low-excess-air burners.**
- ❑ **Replace constant air-volume systems with variable-air-volume systems.**
- ❑ **Install economizer cooling systems that bring in extra ventilation air when feasible.** This system will work in temperate climates, for example, or in those with large day/night temperature differentials. Control supply-air and hot- or chilled-water temperatures according to heating and cooling load schedules.
- ❑ **Use fans to increase air movement and enhance cooling.**
- ❑ **Reduce fan and pump energy requirements by reducing flow rates (for steam, air, and water) and resistance to the minimum required for operation.**
- ❑ **Use one or more of the following heat-reclamation systems and strategies:**
  - Air-to-air recovery systems;
  - Hydronic recovery systems;
  - Chiller-condenser heat for coincident space- or water-heating needs;
  - Boiler blowdowns and combustion-system flue-heat recovery;
  - Heat-pump systems; or
  - Steam condensate through a heat exchanger.

System Upkeep

- ❑ **Maintain boiler or furnace efficiency.**
  - Clean heat-transfer surfaces.
  - Chemically treat boiler water to prevent build-up of scale, sediment, and sludge.
  - Check flues for proper draft.
  - Check for air leaks in combustion chambers.
- ❑ **Reduce energy losses from the HVAC distribution system.**
  - Repair duct and pipe leaks.
  - Inspect and maintain stream traps to prevent condensate build-up.
  - Insulate ductwork and HVAC system piping.
- ❑ **Replace air filters.**
- ❑ **Remove scale from water and steam pipes.**
- ❑ **Rebalance pipe and duct systems.**

(See Chapter 12, "HVAC, Electrical, and Plumbing Systems.")

Lighting

- ❑ **Reduce illumination to the level most suitable for a given task.**
  - Clean and maintain lenses, reflectors, and lamps.
  - Reduce lighting levels in accordance with Illuminating Engineers Society (IES) guidelines.
  - Implement a task lighting and ambient lighting strategy.
- ❑ **Adapt lighting levels to occupant needs.**
  - Turn off lights when not needed.
  - Use controls that dim or turn off lights automatically, based on occupancy.
- ❑ **Install the following energy-efficient lighting systems:**
  - Fluorescent lighting;
  - High-pressure sodium lighting, to replace mercury-vapor lamps;
  - Low-pressure sodium lighting, for night-time security; or
  - High-efficiency ballasts.

- ☐ Maximize use of daylight.
- ☐ Install dimming controls for use with windows and skylights.

(See Chapter 9, "Daylighting," and Chapter 12, "HVAC, Electrical, and Plumbing Systems.")

Plumbing

- ☐ Reduce hot-water consumption by restricting flow rate with restrictors and low-flow faucets, showers, and other fixtures.
- ☐ Lower hot-water temperatures by setting thermostats at the lowest temperature that meets occupant needs.
  For special needs that require additional heating, install a booster heater.
- ☐ Preheat feed water with reclaimed waste heat, such as boiler-flue heat and chiller-condenser heat, from other building equipment processes.
- ☐ Reduce hot-water heating system losses by insulating hot-water pipes and water storage tanks.
- ☐ Use energy-efficient water-heating systems, such as decentralized water heaters that operate only when needed and provide water only at the required temperature.
- ☐ If possible, use smaller water heaters for seasonal requirements.
- ☐ Replace old electric resistance water heaters with heat-pump models.
- ☐ Install automatic flush systems on toilets and urinals.
- ☐ Install automatic shut-offs on sinks.

(See Chapter 12, "HVAC, Electrical, and Plumbing Systems.")

Plug Loads

- ☐ Consider the energy usage of electrical appliances and building equipment in procurement specifications.
- ☐ Select office equipment based on EPA's Energy Star energy-efficiency ratings.
- ☐ Retrofit older equipment with EPA Energy Star-approved controls.
  Such controls can optimize the energy efficiency of older computer monitors, central processing units, printers, and fax machines.

(See Chapter 12, "HVAC, Electrical, and Plumbing Systems.")

SUGGESTED PRACTICES AND CHECKLIST

Solid Waste

☐ **Establish an efficient waste reduction, recycling, and reuse program.**
Any building owner can establish a recycling program. Tenants should assess their operations to determine where source-reduction and reuse programs can be implemented, then take the following steps to launch an effective program:
- Obtain top management support;
- Select a program coordinator and team;
- Analyze all waste streams;
- Identify one or more ways wastes can be reduced, reused, or recycled in each waste stream;
- Plan the program process;
- Train employees and tenants; and
- Continually monitor the program.

☐ **Lower costs of waste disposal through source reduction—that is, purchasing products with less packaging and producing less waste.**
- Purchase supplies in bulk to reduce packaging.
- Work with suppliers to reduce packaging and use returnable packing pallets.
- Set standards for on-site cleaning services, requesting use of only minimal amounts of cleaning chemicals and reusable cleaning rags.
- Photocopy on both sides of paper.
- Use electronic mail to reduce use of paper.
- In the cafeteria, replace disposable plates and utensils with ceramic plates and silverware.
- Provide reusable coffee mugs to employees.

☐ **Minimize toxic waste by recycling items such as lighting ballasts, mercury-containing fluorescent and high-intensity-discharge (HID) lamps, used oil, unusable batteries, and mercury-containing instrumentation.**

Water Conservation

☐ **Reduce building water use.**
- Establish leak-detection programs for air and water distribution systems.
- Reduce water-flow rate and subsequent waste by installing low-flow, water-efficient faucets and other fixtures and appliances.
- Educate facility maintenance staff and occupants about water conservation goals.

☐ **Reduce outdoor water use on grounds.**
- Repair and replace sprinkler heads to avoid watering paved areas.
- Minimize evaporation waste by watering in the morning.
- Shorten watering times to avoid runoff.
- Capture and use rainwater and graywater as practical, when approved by local and state health and environmental authorities.

(See Chapter 6, "Water Issues.")

Renovation

★ SIGNIFICANCE

The green building guidelines, design process, and team approach developed for new construction can also apply to building renovations. Green renovation practices include use of natural design elements, such as increased daylighting; installation of resource-conserving materials and systems; recycling and reuse of construction and demolition waste; and maintenance of good indoor environmental quality during construction.

Green Building

Topic:

Work Scheduling

Contributed By:

Amitava Roy

SUGGESTED PRACTICES AND CHECKLIST

Work Scheduling

☐ **Isolate occupants from environmental contaminants generated by construction-related activity in partially occupied areas; and if necessary, relocate hypersensitive occupants from the work site.**

☐ **Schedule work around occupancy times to minimize contamination.**
Contaminants include dust and emissions from paints and chemicals used in wall and floor coverings and their adhesives. It is best that the application of paints and adhesives, carpet installation, and generation of construction dust and other debris *not* occur while areas are occupied. If this is not feasible, then alternative measures need to be instituted that minimize adverse impacts on the health and productivity of occupants.

Barriers

☐ **When renovation takes place during periods of building occupancy, use the following methods to isolate construction activities:**
- Isolate the occupants and the HVAC system serving them from the renovation zone;
- Isolate the renovation zone from occupied areas with physical barriers, such as plastic sheeting, that limit air movement to those areas;
- Take special precautions to keep allergic or sensitive occupants away from the renovation area; and
- Attempt to minimize disruptive noise and other factors that interfere with normal work patterns and hinder comfort.

Ventilation

☐ **Mitigate air contamination with temporary ventilation measures.**
Even with physical barriers in place, renovation-related air contaminants such as dust, paint, and adhesive fumes can circulate through a building via its ventilation system (see Chapter 13, "Indoor Air Quality").
- Exhaust air from the renovation zone directly outdoors. Change ventilation and thermal capacity to match the reconfiguration of space. Keep the area negatively pressurized with respect to other areas.
- Remove window panels or other apertures, if necessary, to manage and dispose of construction-related debris and direct temporary exhaust outdoors.
- If an air-handling system serves both the renovation zone and occupied areas, seal

off the potential return-air paths to prevent dust and fumes from circulating.
Ensure that filtration is sufficient to deal with particulate debris during the renovation. This is best achieved by supplying the renovation area with 100 percent outside air. Inspect and replace filters frequently. Keep the ductwork of the renovated space free of construction-generated debris.

➜ RESOURCES

INDOOR ENVIRONMENTAL QUALITY

... Air Conditioning Engineers. *ASHRAE*