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Government of India
Ministry of Railways

GREEN BUILDING

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Centre
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Excellence in Maintenance

Maharajpur, Gwalior - 474 005

GREEN BUILDING

Foreword

The built environment has a profound impact on our natural environment, economy, health and productivity. The green buildings which are being now adopted worldwide to facilitate substantial reduction in pollution and energy and water consumption, are based on the concept of utilization of natural resources in effective manner.

Green buildings have tremendous benefits both tangible and intangible. Most tangible benefits are substantially reduction in operating energy and water cost. Intangible benefits are increasing productivity, better health and healthy environment to the occupants.

An effort has been made by CAMTECH through this book to elaborate some of the basic concepts and their application during construction of building to make them more eco-friendly. It is expected that this booklet will be quite helpful to civil engineering personnel in Railways.

CAMTECH/Gwalior ***S.C.Singhal***
Date : 03.02.09 ***Executive Director***

Preface

The concept of green building is widely accepted world over by the countries facing the challenges of global warming. Green concepts and techniques in the residential sector can help to address national issues like handling of consumer wastes, water efficiency, energy efficiency and conserving natural resources.

A green building uses less energy, water and non renewable natural resources, creates less waste and is healthier for the people living inside compared to a conventional buildings. The cost of such building may be slightly higher than a conventional building but as an added benefit, green design measures reduce operating costs, enhance building marketability, increase worker productivity and reduce potential liability resulting from indoor air quality problems.

This handbook is prepared with the objective to provide informative details on ***'Green Building'*** for the guidance of civil engineering personnel involved in planning, designing, construction and maintenance of buildings & other structures. It cover, what is green building, why people are attracted towards the green buildings, benefits, perceptions and realties regarding green buildings, energy efficiency in buildings and the rating system of green buildings. Some green materials like building insulation, paint, glass and carpets etc. are also discussed in brief.

This handbook is not statutory and contents are only for the purpose of guidance. Most of the data & information mentioned herein are available in some form or the other in various books and other printed matter.

We welcome any suggestions from our readers for further improvement.

CAMTECH/Gwalior ***Sushil Kumar***
Date : 03.02.09 ***Director/Civil***

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ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/2009/C/GREEN BUILDING/1.0/CS. # XX date ....……

Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No. of C.Slip	Date of issue	Page no. and Item No. modified	Remarks

GREEN BUILDING

1.0 Introduction

The housing sector in India is growing at a rapid pace and contributing immensely to the growth of the economy. This augurs well for the country and now there is an imminent need to introduce green concepts and techniques in this sector, which can aid growth in a sustainable manner.

Green concepts and techniques in the residential sector can help to address national issues like handling of consumer waste, water efficiency, reduction in fossil fuel use in commuting, energy efficiency and conserving natural resources. Most importantly, these concepts can enhance occupant health, happiness and wellbeing.

2.0 What is green building

A Green building should create delight when entered, serenity and health when occupied and regret when departed' – Perhaps this is one of the most inspiring definitions of a Green building, articulated in the book 'Natural Capitalism'.

A green building uses less energy, water and non renewable natural resources, creates less waste and is healthier for the people living inside compared to a standard building.

Green Building concept is essentially the increase of efficiency with resources for building activity, which includes energy, waste and materials. An attempt is made to reduce the building impact on the environment and health through better sustainable sites, sustainable architecture, sustainable development and integration of energy conservation. This goes in a long way in the ultimate goal for controlling the global warming and reduction of carbon emissions. A few case studies have been taken into consideration for generalizing and application of the same to one of the investigations. The process highlights the tangible and intangible benefits reaped through the holistic and integrated development ushering in a new era in the way building construction is practiced.

The appearance of a Green Building will be similar to any other building. However, the difference is in the approach, which revolves round a concern for extending the life span of natural resources; provide human comfort, safety and productivity. This approach results in reduction in operating costs like energy and water, besides several intangible benefits.

Some of the Salient Features of a Green Building are:

- Minimal disturbance to landscapes and site conditions:
- Use of Recycled and Environmental Friendly Building Materials.
- Use of Non-Toxic and recycled/recyclable Materials.

- Efficient use of Water and Water Recycling.
- Use of Energy Efficient and Eco-Friendly Equipment.
- Use of Renewable Energy.
- Indoor Air Quality for Human Safety and Comfort.
- Effective Controls and Building Management Systems.

3.0 Why we make Green Building

The environmental impact of the building design, construction and operation industry is significant. Buildings annually consume more than 20% of the electricity used in India. Development shifts land usage away from natural, biologically-diverse habitats to hard scope that is impervious and devoid of biodiversity. The far reaching influence of the built environment necessitates action to reduce its impact. Green building practices can substantially reduce or eliminate negative environmental impacts and improve existing unsustainable design, construction and operational practices. As an added benefit, green design measures reduce operating costs, enhance building marketability, increase worker productivity and reduce potential liability resulting from indoor air quality problems. Studies of workers in green buildings reported productivity gains of up to 16%, including reductions in absenteeism and improved work quality, based on “people-friendly” green design. In other words, green building design has environmental, economic and social elements that benefit all building stakeholders, including owners, occupants and the general public.

4.0 Why people are attracted towards Green Building

This question has been posed to several occupants of a green building. Of all the many reasons, three top reasons often cited by those occupying these buildings are the following:

Operational Savings: Green Buildings consume at least 40-50 % less energy and 20-30 % less water vis-à-vis a conventional building. This comes at an incremental cost of about 5-8 %. The incremental cost gets paid back in 3-5 years time.

Daylights & Views: Working in environment with access to daylight and views provides connection to the exterior environment. This has a soothing effect on the mind. Various studies prove that the productivity of people who have access to day lighting and views is at least 12% -15 % higher.

Air Quality: Green buildings are always fresh and healthy. Every Green Building will have to purge continuous fresh air to meet the ASHRAE 62 requirements. The green buildings use interior materials with low volatile organic compound (VOC) emissions. A typical office building would require purging of fresh air of about 15 cfm/person which provides a fresh ambience inside the building.

5.0 Benefit of Green Building

A Green Building can have tremendous benefits, both tangible and intangible. The immediate and most tangible benefit is in the reduction in operating energy and Water costs right from day one, during the entire life cycle of the building. The Energy savings could range from 25 – 40 % depending on the extent of green specifications. Other tangible savings would be reduction in first costs and enhanced asset value.

Intangible benefits of Green Buildings include increasing productivity of occupants' health, safety benefits and a green corporate image. Several Corporate are now seeing Green Building Rating as a tool to enhance marketability.

6.0 Perceptions and realties about green building

Having covered on the benefits it is also important to know that people have different perceptions on green buildings; some are correct and some are otherwise. It is important to look at these:

Perception 1: Green buildings are costlier.

Reality: Considerable research and analysis has been carried out with regard to the cost impacts of a green building. The cost could be slightly higher than a conventional building. But then, this needs to be seen with a different paradigm. The question is how do we compare the costs? There needs to be a baseline cost for all comparisons to be alike.

The incremental cost is always relative and depends on the extent of eco-friendly features already considered during design. The incremental cost would appear small if the baseline design is already at a certain level of good eco-design; It would appear huge if the base design has not considered green principles.

The second and rather a critical paradigm is to look at the incremental cost in relation to the life cycle cost. This kind of an approach could be revealing. Who knows, buildings would last for a 50 years or 60 years or 100 years! Over its life cycle, the operating cost would work out to 80-85 % while the incremental cost which is a one-time cost is only about 8-10 %.There is a decreasing trend in the incremental cost over the years. This trend would continue and we all look forward to the day when the cost of a green building is lower than a conventional building.

Perception 2: Green buildings have to be air-conditioned.

Reality: Green building concepts and the LEED rating can be applied for non-air conditioning buildings. It has been applied on buildings at IGP office, Gulbarga and Hyderabad Institute of Technology and Management, Hyderabad. While performing the energy analysis using software tools, such buildings will input the same cooling system both in the baseline and the proposed design. This ensures that the building is recognized for any of the other energy efficiency measures incorporated, for example – the envelop, lighting, roof insulation etc. This kind of an approach also

ensures that an apple-to-apple comparison is made while evaluating two green buildings, whether conditioned or not.

Perception 3: Green buildings take more time.

Reality: There is a general perception that going the green way may affect the project schedules. This was perhaps the case for the CII - Godrej GBC building when it was the first time that a green building rating tool was being applied in the country. The design in this case took about one-and half years while the construction was completed in about 9 months! Thanks to the Green building movement; now there is so much of capacity building that has happened in the country. Now, there is absolutely no difference in the time involved in constructing a green building vis-à-vis a normal building. The time schedule for the rating can be synchronized with that of the building. This has been amply demonstrated in all the LEED rated green buildings in India and Dubai.

7.0 Building Management System (BMS)

Building Management System (BMS) is one of the important components in constructing a green building. It ensures that the building remains green, through its life.

BMS basically a solution, which is put into a facility to ensure an environment that is safe, secure, comfortable and energy efficient.

When properly integrated into a facility, BMS can result the following benefit:

a) Optimize energy consumption.
b) Provide alarm system so as to take corrective action.
c) Monitor and control indoor comfort conditions.

The additional investment on BMS pays it self through saving in energy consumptions. The normal pay back period for investment in BMS varies from 2-4 years.

7.1 Typical Applications of BMS in a building

- HVAC and lighting control.
- Emergency lighting.
- Safety and security solutions.
- Intrusion alarm systems.
- Security management.
- Water management and control.

7.2 Benefits of Building Management System (BMS) :

- Operational energy saving to the extent of 15% - 20%.
- Maintenance of comfort conditions.

- Enhances indoor air quality.
- Provides critical alarms and remedial actions.

7.3 Optimizing Energy Efficiency: A fully optimized BMS can save energy cost to the extent of 15-20% as compared to a building without BMS.

Specific examples of BMS integration which result in energy saving are:

- Night time purging to cool the building.
- Chiller management.
- AHU fan speed control based on heat loads.
- Speed control of chilled water pumps based on heat loads.
- Lighting controls.
- Temperature and humidity control.

Safety of assets and security solutions: It is critical for building managers to ensure rapid detection, notification and evacuation in the event of fire, BAS can be integrated with Fire Safety Control Panels with back up power supplies, Audible alarms (through speakers, bells, horns etc.), Emergency Voice Evacuation Systems and PA Systems.

Other Security Solutions :

- **Access Control System:** Controls the movement of people and assets by integrating this data with back-end applications such as Time Attendance Systems, Assets Tracking, Payroll Processing, Hazard Monitoring, Vehicle Management etc.

- **Video Surveillance Solution:** It is the first line of security that allows security staff to monitor a large facility.

- **Perimeter Solution:** It detects intrusion around the perimeter of the facility.

8.0 Energy Efficiency and Building Design & Construction

A study conducted by Energy Information Administration (EIA), U.S. Department of Energy indicates that there is a visible trend across the globe wherein the growth rate in total energy consumption has been greater than the population growth rate. In the developed countries the energy consumption growth rate is only marginally higher compared to the population growth rate.

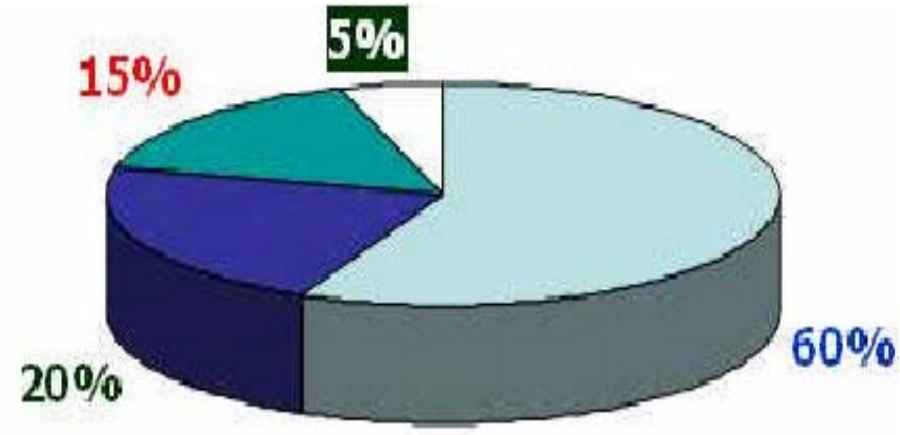
For example, in USA, energy consumption is projected to grow at 1.3% while the population growth rate is projected to grow at 0.8%. In contrast, in developing countries like India population growth rate is expected to grow at 1.3% while the energy consumption rate is expected to grow at 4.3%. This trend would strain the energy sector to a large extent. The construction industry in the country is growing at a rapid pace and the rate of growth is 10% as compared to the world average of 5.2%. Hence energy efficiency in the building sector assumes tremendous

importance. Commercial buildings are one of the major consumers of energy and are the third largest consumers of energy, after industry and agriculture. Buildings annually consume more than 20% of electricity used in India.

The potential for energy savings is 40% – 50% in buildings, if energy efficiency measures are incorporated at the design stage. For existing buildings, the potential can be as high as 20% - 25% which can be achieved by implementing house keeping and retrofitting measures.

The incremental cost incurred for achieving energy efficiency is 5% - 8% vis-à-vis conventional design cost and can have an attractive payback period of 2 to 4 years.

8.1 Typical Energy Consumption Pattern in Buildings:



Air Conditioning	**60 %**
Area Lights	**20%**
Mis Equipment	**15 %**
Ventilation fans	**5 %**

Figure 1: Break-up of energy consumption in a building

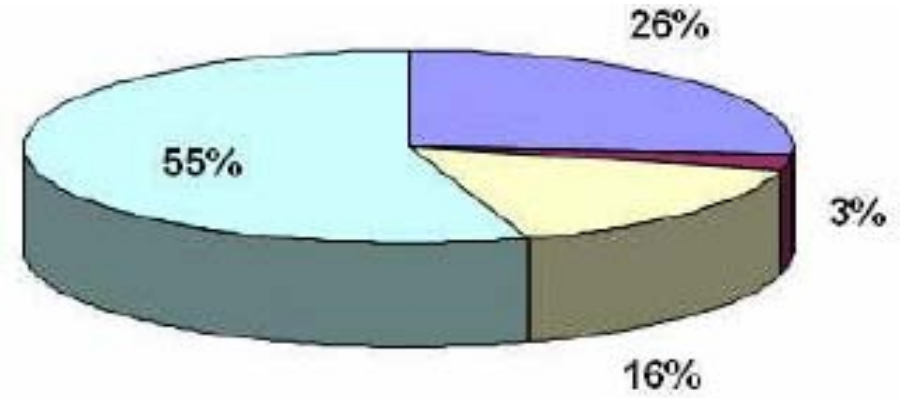
Typical break-up of energy consumption in a building is as shown in figure 1. In a typical building, air conditioning is the highest consumer of energy followed by lighting and other miscellaneous equipment. Therefore, if the initial design considers energy efficiency measures in these areas, substantial energy savings can be realized.

8.2 Energy Saving Approach in Buildings

8.2.1 Orientation: This is the first step to achieve energy efficiency. The Following measures can be adopted:

- Minimize exposure on the south and west.
- Use simulation tools and techniques which can help in designing the orientation to minimize heat ingress and enhance energy efficiency.

8.2.2 Building Envelope



Wall Conduction	**03 %**
Glazing Conduction	**55 %**
Internal Gains (Light, People, Computers etc.)	**26 %**
Roof Conduction	**16 %**

Figure 2: Break-up of heat gain in a building

Heat gain through the building envelope is shown in figure 2. The following envelope measures can be considered:

- Select high performance glazing with low U-value, low Shading Coefficient and high VLT (Visual Light Transmittance).
- Insulate the wall. The options for insulation materials can be – Extruded polystyrene, Expanded polystyrene (thermocol), Glass wool etc.,
- Brick wall with air cavity can also significantly reduce the heat ingress.
- Hollow blocks, Fly ash bricks and Autoclaved Aerated Concrete (AAC) Blocks are also good insulators.
- The heat ingress through the roof can be as high as 12% -15%. Insulating the roof can substantially reduce the heat ingress.
- Consider shading devices for window openings.

8.3 Equipment & Systems

- Select chillers with high Coefficient of Performance (CoP).
- Install Variable Frequency Drives (VFD) for supply & return air fans and pumps.
- Select high efficiency cooling towers.
- Use high efficiency motors, transformers and pumps.
- Install Heat recovery wheels and economizers.
- Consider night purging with ambient air to flush out the heat trapped within the building during the day.
- Adopt Controls & Building Management Systems for effective control.
- Engage a Commissioning Authority to ensure that savings are realised once the building becomes operational.

8.4 Lighting

- Design in such a way that the building gets maximum day lighting.
- Overall lighting power density can be designed as less as 1.0 W /sq. ft.
- Use daylight-cum-dimmer controls.
- Install occupancy sensors.
- Select energy efficient luminaries like CFL, T-5, LED, etc.,

9.0 Green Building Material and Equipment

Stakeholders now are demanding for green buildings from consultants and architects. This has also resulted in increased demand for green building materials and products.

Many new materials and services have been introduced as a result of this movement. Some of these materials and equipments include High performance glass, Wall & Roof insulation, Low VOC paints, adhesives & sealants, CRI certified carpets, FSC Certified wood, high albedo roofing material, Fly ash blocks, Eco-friendly chemicals waterless urinals, high CoP chillers, CO_2 sensors, root zone treatment plants, wind towers.

The adoptions of green building materials are increasing over the years. There is also change in the mindsets of the stakeholders. Earlier, there was a general perception that materials with recycled content were inferior in quality. Vendors would go on the defensive when asked for the recycled content in their product. It had a negative connotation. However with increased awareness on green materials and their advantages, this trend is rapidly changing. The cost of green building materials and equipment is also showing a decreasing trend. The cost of many other materials would also show a decreasing trend as the movement accelerates. Some important material like building insulation. High performance glass, Green paint and carpet etc are described are as following.

9.1 Building Insulation

Builders, Architects and Service Consultants alike are constantly looking for ways to enhance energy-efficiency in buildings. Optimum level of building insulation not only helps lower monthly energy bills, but also adds to the overall comfort. Insulation helps maintain comfort temperature by reducing leakages.

With the advent of green technologies and practices, today the potential to save energy by design can be as high as40-50 %. Insulation in buildings is assuming tremendous importance and has a potential to reduce energy consumption to an extent of 5% -8 %.

9.1.1 Why Insulation?

Buildings without insulation and air-tight envelope can result in major energy wastage.

9.1.2 Benefits of Insulation

- 5% - 8% energy savings with a payback of 1-2 years.
- Provides thermal as well as acoustical insulation.
- Resistant to moisture.
- Resistant to air infiltration.

9.1.3 Applications of Insulation materials

Insulation materials like autoclaved aerated concrete blocks, extruded polystyrene, expanded polystyrene, glass wool etc. can be applied on the walls and roof. Air cavity walls are also used as insulation. Heat balance of a building would reveal that at least 15% to 20% of the heat ingress into a building can be through walls and roofs.

Walls can be insulated on exterior depending on the architectural aesthetic required. In many of the buildings insulation can be done on the interior also. Roofs can be insulated either over the deck or under the deck. Generally over deck insulation is preferred.

9.2 High performance glass

Glass has been used for hundreds of years in architecture. Glass forms a major part of the outer envelope of buildings. It is also used to form internal building features such as partitions, doors, and enclosures. Of late glazing is a favoured feature in buildings. Glazing not only adds to the aesthetic elements but also has a tremendous impact on energy performance of buildings besides visual and acoustic effects. The right choice of glazing can also lead to significantly lower cost in building energy consumption.

Increasing the air gap between the insulated glass units has a very significant impact on sound reduction**.**

9.2.1 High Performance Glazing

High Performance Glazing is one which can contribute to optimizing energy efficiency and at the same time enhance light penetration. High performance glazing has low U-value, low shading co-efficient and high VLT (Visual Light Transmittance) and is the ideal choice for today's energy stressed buildings.

Typical values of high performance glass are as shown in the table below:

Property	Range
Shading Coefficient	0.1 - 0.4 W/m^2 deg. K
U-Value	1.7 - 3.0 W/m^2 deg. K
Visual Light Transmittance	40% - 60%

9.2.2 Types of Glazing for Glass

The following types of glazing available for glass:

- Insulated (double glazed, triple- glazed)
- Gas filled glazing
- Heat-absorbing tints
- Low emissivity (Low – E) coatings
- Spectrally selective glass
- Reflective coating

9.2.3 Integrated approach in selection of glazing

9.2.3.1 **Architecture :** A Good glazing with a relatively high VLT will appear fairly transparent from the outside. A desire to have mirrored façade is often not conductive to day lighting.

9.2.3.2 **Interiors :** Glazing colour strongly influences the colour rendering of interior finishes in day lit areas. Colour also affects the view and the occupants sense of connection with the outdoors. Glazing with lower light transmission makes interiors gloomy when overcast but may help in glare control on a sunny day.

9.2.3.3 **HVAC :** High performance glazing reduces annual energy use, peak loads, individual zone fluctuations and occupants complaints. Glazing selection could also be an opportunity for equipment downsizing.

9.2.3.4 **Cost Effectiveness :** High performance Glazing cost more than their standard alternatives but may pay for themselves in four ways: reduced energy bills, reduced first cost in mechanical equipment, increased occupant productivity and avoided future retrofit costs (like addition of chillers/fans/evaporative coolers) doe due to unanticipated occupants discomfort.

9.3 Green Paints for Green Buildings

Paints can have a major impact on the overall aesthetics of a space; sometimes more than even flooring and furnishings because of the enormous square footage of coverage.

Paints may also have a major negative impact on the indoor air quality of a building, because they may contain chemicals called **V**olatile **O**rganic **C**ompounds (VOCs) and other toxic components that evaporate into the air and are harmful to the health of the occupants. VOCs are primary contributors to smog generation. Low and zero VOC paints have little or no smog forming emission.

9.3.1 Benefits of low VOC paints

9.3.1.1 **Environmental :** VOCs react with sunlight and nitrogen oxides in the atmosphere to form ground level ozone, a chemical that has a detrimental effect on human health agricultural crops, forest and ecosystems. These problems can be eliminated using low VOC paints.

9.3.1.2 **Economic :** Healthy occupants are more productive and have less illness related absenteeism. Use of high VOC content materials can cause illness and may decrease occupant productivity. These problems result in increased expenses and liability for building owners, operators and insurance companies.

9.3.1.3 **Indoor Environment :** Selecting materials that are low in VOC helps reduce sources of pollutants during the construction process and in the finished building. Also low VOC paints have little odour.

Since low or no VOC paints have a lesser impact on air quality, they are excellent for use in building where it is desirable to have a very low level of toxicity, such as hospitals schools, or the homes and workplaces. Low VOC paints are manufactured and soled by numerous companies.

9.3.1.4 **Difference between green and conventional paint:**

Green paints	Conventional paints
Cleaner air, reduced ozone depletion	Causes to environmental pollution and ozone depletion
Minimum health risks	Significant health risks
Total cost same as any high quality paint and low operation and maintenance cost	Low but with high operation and maintenance cost

9.4 Carpets and Carpet Tiles

Used by millions of people world over for years, carpets have several benefits. Some of the benefits in using carpets are:

- Carpets provide insulation against extreme heat or cold. In colder climates or seasons, they retain warm air longer and in warm climates, insulate against invasive heat.
- A stable and non-slick walking surface is possible by using carpets. By cushioning footsteps, carpets prevent slips and falls and resulting injuries.
- Carpets are very effective as insulation against airborne sounds. With the addition of carpet, sound is absorbed rather than bouncing off onto the walls and furniture.
- Carpets hold dust particles until they are extracted by vacuuming.
- Aesthetic appeal is another quality which makes carpets the most popular element in interiors.

9.4.1 Carpets and Indoor Air Quality

Carpets and other floor covering are often cited as primary contributors to indoor air contamination.

- When a new carpet is installed, it is glued to the floor with an adhesive. These adhesives are derived from a variety of different chemical compounds. Chemical compounds are added to improve stain resistance and adhesive properties.

- Some of the chemical compounds release VOCs and other emissions contributing to poor indoor air quality.

- Emissions can also be due to the type of fibbers used in carpet making. Synthetic fibbers in particular release toxic chemicals over a period of time.

- During the manufacturing process, carpets are treated using chemicals to make them stain resistant, flame resistant, soil resistant and to keep them from fading. These chemicals also add to poor air quality.

Better indoor air quality is possible with the right choice of carpet, installation procedure and effective maintenance. Emission can be minimized for healthier indoor environments.

9.4.2 What is Volatile Organic Compounds (VOC)

VOC (Volatile Organic Compounds) are a group of organic (carbon-containing compounds which evaporate (volatilize) readily at room temperature. Some familiar substances containing VOCs are paint sealants, adhesives, thinners, paints, solvents, gasoline, and nail polish remover.

9.4.3 Maintaining Carpets for a better Indoor Environment

Installation

- Install a carpet which has been tested for low VOC emission.
- When the carpet is to be glue down, insist on using a low VOC adhesive.
- When installing a new carpet, vacuum the old carpet and cushion prior to removal. Before laying the new carpet vacuum the floor to minimize airborne dust and other particulates.
- Ventilate with fresh air up to 72 hours after installation with windows open and by running a fan.

Routine maintenance

- Regularly clean carpets with an effective, well functioning vacuum cleaner that has strong air flow.
- Quick removal of spills is important to avoid stains and fungal growth.
- Clean more often in high-traffic, commercial areas. Ensure that there is adequate ventilation during the cleaning process.
- If a wet method of cleaning is used, be sure to dry quickly.

9.4.4 Carpet Tiles

- Carpets are available in the form of tiles and have significant advantages over carpet rolls.
- In the event of wear and tear, individual tiles can be replaced instead of replacing the entire roll. This results in decreased stress on landfills because of used carpets.
- Product wastage while laying carpet tiles is also minimal.
- Laying a carpet roll results in product wastage of 10% and more. With tiles, product wastage drops to around 1% or 2%.
- Lifetime costs of carpet tiles are much lesser than that of rolls. These include maintenance, material wastage, product and installation costs.
- Water resistance of carpet tiles is very high. Because of the solid vinyl back, water penetrates only into the surface of the tile. Each tile may then be separately washed and reinstalled which is not possible with carpet roll.
- Installation of tiles is also easier and more use friendly as compared to carpet rolls.

10.0 Rating System for Green Building

The IGBC (Indian Green Building Council) has launched two rating programmes LEED (Leadership in Energy and Environmental Design) India NC (New Construction) and LEED India CS (Core & Shell). In new construction it may sub divided for individual homes and multi- dwelling units.

The LEED green building rating system evaluates environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a green building.

The LEED green building rating system developed by the US Green Building Council is now recognized as an international rating system and followed by more than 24 countries. The LEED rating system has been indigenized by the Indian Green Building Council (IGBC) to suit the national context and priorities.

Maximum possible points for rating system for different type of buildings are as follows:

Sr. No.	Items	Core and Shell (CS)	New construction (NC)	
			Individual homes	Multi-dwelling units
1.	Sustainable site / site efficiency	14	09	10
2.	Water efficiency	06	23	23
3.	Energy efficiency	14	20	19
4.	Material and resources	11	13	10
5.	Indoor air quality	11	10	09
6.	Innovation and design process	05	04	04
	Total	**61**	**79**	**75**

Green building may be classified on the basis of obtaining of points as Leed certified, Leed silver, Leed gold, and Leed platinum.

Requirement of points for classification are as under:

Classification	Core and Shell (CS)	New construction (NC)	
		Individual homes	Multi dwelling units
Leed certified	23-27	32-39	30-37
Leed Silver	28-33	40-46	38-44
Leed Gold	34-44	47-54	45-52
Leed platinum	45-61	55-79	53-75

For further details, please refer to IGBC Green building rating system for Core and Shell and New construction.

11.0 Green Building Movement in India

The Green Building movement in India is a step in this direction – to minimize the negative impact of construction activity on the environment. The Green Building movement in the country spearheaded by CII has gained tremendous impetus over the last six years. With a modest beginning of 20,000 sq. ft. of green footprint in the country in the year 2003, today about 80 green buildings with a footprint of over 25 million sq. ft. are being constructed in India. India ranks fourth in the world after USA, Australia and Canada.

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⇒ NOTES ⇐

OUR OBJECTIVE

To upgrade Maintenance
Technologies and Methodologies
and achieve improvement in
productivity and performance
of all Railway assets and manpower
which inter-alia would cover
Reliability, Availability,
and Utilisation.

*The contents of this handbook are for guidance only & are **not statutory**. It also does not supersede any instructions from Railway Board, RDSO, and Zonal Railways & the provisions of IRWM, BIS Codes/Reports on the subject. If you have any suggestion & any specific comments, please write to us :*

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