

Norms to be followed on Construction Site to Achieve Green Building Rating.

Janet John^{#1}, Deepa A. Joshi^{*2}

[#]Department of Civil Engineering, Dr. D.Y. Patil Institute of Technology, Savitribai Phule Pune University

¹janet9314@gmail.com

³joshi.deepa13@gmail.com

Abstract— The exponentially growing Building sector in India has a large scale direct and indirect impact on the environment. During the process of construction and in all the stages followed it, resources like water, electricity, energy, etc. are used and a large amount of waste is generated. The Indian Green Building Council (IGBC) is a frontrunner in introducing green concepts and techniques in the construction sector. This study intends to understand the norms and practices specified by IGBC in order to achieve Green Building Rating. A detailed examination of the IGBC certification process was conducted for the purpose of this study. Out of the several criterion to be met, the criterion in relation with actual construction sites were identified and the obstacles to execute the specified practices were also identified by conducting site visits. Possible solutions for these problems have been proposed in this study. The proposed solutions include several practices to be implemented on site along with formats and checklists that can be easily used on the construction sites.

Keywords— Green buildings, site execution, IGBC practices, construction

I. INTRODUCTION

The Indian Green Building Council, part of the Confederation of Indian Industry (CII) was formed in the year 2001. The vision of the council is, "To enable a sustainable built environment for all and facilitate India to be one of the global leaders in the sustainable built environment by 2025".

The council offers a wide array of services which include developing new green building rating programs, certification services and green building training programs. The council also organizes Green Building Congress, its annual flagship event on green buildings.

The council is committee-based, member-driven and consensus-focused. All the stakeholders of the construction industry including architects, developers, product manufacturers, corporate, Government, academia and nodal agencies participate in the council activities through local chapters. The council also closely works with several State Governments, Central Government, World Green Building Council, bilateral multi-lateral agencies in promoting green building concepts in the country^[1]

Globally buildings are responsible for a huge share of energy, electricity, and water and materials consumption. The building sector has the greatest potential to deliver significant cuts in emissions at little or no cost. Buildings account for 18% ^[2] of global emissions today, or the equivalent of 9 billion tonnes of CO₂ annually. If new technologies in construction are not adopted during this time of rapid growth, emissions could double by 2050, per the United Nations Environment Program. Green building practices aim to reduce the environmental impact of building. Since construction almost always degrades a building site, not building at all is preferable to green building, in terms of reducing environmental impact. The second rule is that every building should be as small as possible. The third rule is not to contribute to sprawl, even if the most energy-efficient, environmentally sound methods are used in design and construction.

The International Energy Agency released a publication that estimated that existing buildings are responsible for more than 40% of the world's total primary energy consumption and for 24% of global carbon dioxide emissions.^{[3][4]}

While the practices or technologies employed in green building are constantly evolving and may differ from region to region, fundamental principles persist from which the method is derived: siting and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization and waste and toxics reduction. ^{[5][6]} The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect.

On the aesthetic side of green architecture or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable buildings: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy.

Green architecture also seeks to reduce waste of energy, water and materials used during construction. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills.

When buildings reach the end of their useful life, they are typically demolished and hauled to landfills. Deconstruction is a method of harvesting what is commonly considered "waste" and reclaiming it into useful building material. Extending the useful life of a structure also reduces waste – building materials such as wood that are light and easy to work with make renovations easier. Construction and demolition waste corresponds to 50% of all urban solid waste, usually it is dumped in improper places. [7]

In the present world, population is increasing drastically day by day, and the construction of structures or buildings is also increasing. For construction, materials like cement, sand and coarse aggregates are required. The requirement of natural or river sand for construction is increasing but the availability of sand in nature is decreasing and the cost of sand is also increasing significantly in market. Utilization of Quarry Dust by replacing the river sand has been suggested for the same and results from the study reveal replacement of sand by Quarry Dust up to 30-40% gives the better compressive strength^[8]

Because of the increased interest in green building concepts and practices, several organizations have developed standards, codes and rating systems that let government regulators, building professionals and consumers embrace green building with confidence. In some cases, codes are written so local governments can adopt them as bylaws to reduce the local environmental impact of buildings. [9]

II. IGBC NORMS

The IGBC has specified a list of criteria to fulfil in order to achieve green building certification^[7]. These criteria carry specified number of points. The fulfilment of these credits will help to create a green building.

In the present work, IGBC certification process has been studied along with the weightage for each of the criterion. The various features of the IGBC New Green Building rating System and scope of the same has been studied in detail.

The various modules that need to be covered in order to achieve the Green Building Rating are:

- Sustainable architecture and Design (5 Points)
- Site Selection and Planning (14 Points)
- Water Conservation (18 / 19 Points)
- Energy Efficiency (28 points)
- Building Materials and Resources (16 Points)
- Indoor Environmental Quality (12 / 11 Points)
- Innovation and Development (7 Points)

Each of these modules carry a weightage specified by IGBC. The maximum number of marks that can be achieved are 100.

The various certifications awarded are as shown in table 1:

TABLE 1: CERTIFICATION LEVELS OF IGBC (IGBC GREEN NEW BUILDINGS RATING SYSTEM)

Certification Level	Points Achieved	Recognition
Certified	50-59	Good Practices
Silver	60-69	Best Practices
Gold	70-79	Outstanding Performance
Platinum	80-89	National Excellence
Super Platinum	90-100	Global Leadership

III. IGBC CRITERIA RELATED TO CONSTRUCTION SITE

In the present study, the criterion related to construction site activities are studied in detail and segregated. There are various points which needs certain precautions or actions to be taken on site. This work has been carried out in order to provide guidelines for the project manager/ site engineer for achieving maximum points in the IGBC New Green Building Rating System.

In this paper, the problems in implementation of IGBC criterion on site and possible solutions are proposed.

The following are the criteria specified by the IGBC, along with the problems that arose at the site and their solutions are as follows:

- SA Credit 2: Site Preservation (Points- 2)
- SSP Mandatory Requirement 1: Local Building Regulations (Points- Required)
- SSP Mandatory Requirement 2: Soil Erosion Control (Points- Required)
- SSP Credit 4: Natural Topography or Vegetation (Points- 1-2)
- SSP Credit 5: Preservation or Transplantation of Trees (Points- 1)
- SSP Credit 10: Basic Facilities for Construction Workforce (Points- 1)
- SSP Credit 11: Green Building Guidelines (Points- 1)
- WC Mandatory Credit 1: Rainwater Harvesting, Roof and Non-Roof (Points- 4)
- WC Mandatory Credit 2: Water Efficient Plumbing Fixtures (Points- 5)
- WC Credit 5: Wastewater Treatment and Reuse (Points- 5)
- BMR Credit 3: Handling of Waste Materials during Construction (Points- 1)
- BMR Credit 4: Use of Certified Green Building Materials, Products and Equipment (Points- 5)
- IEQ Credit 7 & 8: Indoor Air Quality Testing, after Construction and before Occupancy/ Indoor Air Quality Management during Construction (Points: 2 & 1)
- ID Credit 3: Waste water Reuse, During Construction (Points- 1)
- ID Credit 4: IGBC Accredited Professional (Points- 1)

The proposed steps to achieve above mentioned criterion are specified in Table 2.



TABLE 2: IGBC CRITERIA RELATED TO CONSTRUCTION SITE AND THE SOLUTIONS PROPOSED

IGBC Requirement	Proposed Solutions
SA Credit 2: Site Preservation (Points- 2)	
Encourage retaining the site features to minimise site damage and associated negative environmental impacts.	<ul style="list-style-type: none"> • Prepare detail contour maps • Design structure in such a way that at least 50% of the site features are preserved
SSP Mandatory Requirement 1: Local Building Regulations (Points- Required)	
Ensure that the building complies with necessary statutory and regulatory codes	<ul style="list-style-type: none"> • Follow all statutory norms as specified by the Central or State Government • Ensure all designs and building specifications are as per Building Regulations of National Building Code
SSP Mandatory Requirement 2: Soil Erosion Control (Points- Required)	
Control soil erosion and sedimentation, thereby, reducing negative impacts to the site and surroundings.	<ul style="list-style-type: none"> • Implement measures to control soil erosion • Cultivate vegetation on plot boundaries to prevent run-off • Add temporary bunds/ embankments at the boundaries of the plot or at locations where erosion is observed to be high
SSP Credit 4: Natural Topography or Vegetation (Points- 1-2)	
Minimise disturbances or restore the site so as to reduce long-term negative environmental impacts, thereby promoting habitat and biodiversity.	<ul style="list-style-type: none"> • Retain at least 15 to 20% of the natural topography by planning the design to preserve the natural contours of the site • Or Restore disturbed site area for at least 30% of the site area by planting the saplings that are homogenous with the local vegetation and ecosystem
SSP Credit 5: Preservation or Transplantation of Trees (Points- 1)	
Preserve existing fully grown trees and plant new tree saplings, so as to promote habitat and biodiversity.	<ul style="list-style-type: none"> • Format suggested to keep record of the existing trees on site • Preserve or transplant 75% of the existing trees • Place a fence around the canopy of the trees and mark it with bright colored flags

	<ul style="list-style-type: none"> • Build a temporary retaining wall around the tree to prevent damage to roots • Or plant tree saplings that mature into fully grown trees within 5 years • Tree saplings that are planted should belong to the local ecosystem
SSP Credit 10: Basic Facilities for Construction Workforce (Points- 1)	
Promote welfare of the construction workforce by providing safe and healthy work conditions.	<ul style="list-style-type: none"> • Checklist of facilities and safety measures is provided • Adequate housing to meet or exceed local / labour byelaw requirement. • Sanitary facilities: Provide at least 3 toilet seats & 3 urinals for the first 100 workers and one additional toilet seat & urinal for every 100 workers thereafter (or) as defined by local / labour byelaw.(The sanitary measures should be provided separately for men and women). • First-aid and emergency facilities. • Adequate drinking water facilities. • Personal protective equipment (by owner / contractor).Dust suppression measures. • Adequate illumination levels in construction work areas. • Site emergency alarm. • Day care/ crèche facility for workers' children.(Only if, more than 50 female building workers are employed full time)
SSP Credit 11: Green Building Guidelines (Points- 1)	
Provide building occupants, prospective tenants, and the facility team with descriptive guidelines that educate and help them implement and maintain green design features.	<ul style="list-style-type: none"> • Provide Building Occupants/ Tenants with descriptive guidelines that educate and help them to maintain the green design features • Guidelines must include information about the basic functioning of all the systems that have been installed • Basic operation and maintenance should be taught to the occupants • In case of any malfunction in the installed systems the contact for repairs and maintenance services must be available at the ready. • An annual knowledge development session must be set into place for refreshing the knowledge of the occupants regarding the operation and maintenance of the green systems • The garbage disposal system must be such that the wet waste is separated from the dry waste The water treatment system must be cleaned and maintained on a regular basis • The rainwater harvesting system must be regularly cleaned and maintained and the functioning must be regularly monitored and the inflow and outflow must be noted down.
WC Mandatory Credit 1: Rainwater Harvesting, Roof and Non-Roof (Points- 4)	
Enhance ground water table and reduce municipal water demand through effective rainwater management.	<ul style="list-style-type: none"> • Install a Rainwater harvesting system for the building

	<ul style="list-style-type: none"> The gutters carrying water to the storage tank should be cleaned on a regular basis A screen or mesh must be placed at the entrance of the storage tank to prevent debris from entering the tank and should be cleaned as needed PVC pipes (if used) should be painted to provide UV protection Filtration elements/ systems should be cleaned or changed from time to time
WC Mandatory Credit 2: Water Efficient Plumbing Fixtures (Points- 5)	
Enhance efficiency of plumbing fixtures, thereby minimizing potable water use.	<ul style="list-style-type: none"> Use plumbing fixtures with low flow rate Ensure that water closets, showerheads, faucets are such that they minimize the use of potable water Water closets - Average flow should be around 1.6 GPM (gallons per minute) The flushing system may have option for half flush and full flush depending on the type of waste Showerheads – Flow may be around 2.0 to 2.5 GPM Options of Laminar flow showerheads or aerating type of showerheads are available in the market Faucets/ Taps – Rate of flow may be 1.5 GPM
WC Credit 5: Wastewater Treatment and Reuse (Points- 5)	
Treat waste water generated on-site, so as to avoid polluting the receiving streams by safe disposal. Use treated waste water, thereby reducing dependence on potable water.	<ul style="list-style-type: none"> Install a water treatment plant to treat waste water generated on-site Checklist of parameters for operation and maintenance of water treatment plant is provided Reuse the treated water for at least 25% of total water requirement for landscaping, flushing, etc.
BMR Credit 3: Handling of Waste Materials during Construction (Points- 1)	
Facilitate segregation of construction and demolition waste at source to encourage reuse or recycling of materials, thereby avoiding waste being sent to landfills.	<ul style="list-style-type: none"> Use rubble and other such waste generated as filling material on sites Waste from demolition sites can be reused by undergoing some processing; e.g. crushed bricks can be milled to proper sizes to serve as aggregates, reinforcing steel can be recycled, other waste materials like crushed mortar can be used as rubble, excess of cement mix can be used as lean concrete paving, etc.
BMR Credit 4: Use of Certified Green Building Materials, Products and Equipment (Points- 5)	
Use certified green building materials, products, and equipment, so as to reduce dependence on materials that have associated negative environmental impacts.	<ul style="list-style-type: none"> Acquire knowledge about different types of materials available Understand how they can be used to replace conventional materials Allocate funds for the procurement of green building materials Use mathematical approach as multi objective optimization, ranking methods, index-based methods and other quantitative methods like cost-benefit analysis to identify which materials are to be used.

IEQ Credit 7 & 8: Indoor Air Quality Testing, after Construction and before Occupancy/ Indoor Air Quality Management during Construction (Points: 2 & 1)	
<p>Avoid occupant's exposure to indoor airborne contaminants before occupying the premises, so as to reduce the adverse health impacts on building occupants.]</p> <p>And</p> <p>Reduce indoor air quality problems resulting from construction activities, and promote comfort and well-being of construction workers and building occupants.</p>	<ul style="list-style-type: none"> Educate site officials about importance of IAQ Take measures to control pollution levels on sites Maintain regular logs to check air quality levels Purchase proper equipment to test air quality. Ensure that they are within specified ranges.
ID Credit 3: Waste water Reuse, During Construction (Points- 1)	
Enhance water use efficiency, thereby minimizing the use of potable water for construction activities.	<ul style="list-style-type: none"> Implement measures to enhance water efficiency as WC Credit 5 Reuse the treated water for at least 10% of water requirement for construction Treated water should meet the quality standards for reuse during construction as per BIS- Plain and Reinforced concrete and IS456:2000 standards
ID Credit 4: IGBC Accredited Professional (Points- 1)	
Support and encourage involvement of IGBC Accredited Professional in green building projects, so as to integrate appropriate design measures and streamline the certification process.	<ul style="list-style-type: none"> Involve an IGBC accredited professional in the design and execution teams to adequately understand the required criterion and streamline the certification process.

IV. CONCLUSIONS

This study highlights the important factors or credits required to be considered during construction, so as to get certification of a green building. Basically, all the site activities that need to be carried out to achieve a green building certification are highlighted here. Table 3 shows the brief of the weightage of the IGBC Rating system and the corresponding weightage as per the scope of this study.

TABLE 3: IGBC RATING AND CRITERIA RELATED TO CONSTRUCTION SITE

	IGBC Points	No. of Criteria
Total	100	52
Points Studied	32	15

The IGBC New Green Buildings Rating System can award a maximum of 100 points for 52 criterion as specified. This study covers 32 points based on 15 criterion related to the site activities.

Although, the concept of Green Buildings is becoming more and more popular worldwide with time, the awareness regarding the various activities to be carried out on site in order to achieve Green Building Certification needs to be enhanced among civil engineers in India

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