ANALYSIS OF PERFORMANCE PARAMETERS OF GREEN BUILDINGS AGAINST CONVENTIONAL BUILDINGS

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ABSTRACT- Growth in population increases the construction of houses; building construction is the major impact on the environment. To reduce the environmental effect and save the environment need to implement the "Green Building" construction. The project considers the performance and cost of both green and conventional building construction. Now a day's many green building rating systems are available. Generally used LEED and GRIHA rating systems are considered. Rating criterions, pattern and marks awarding studied thoroughly. The project scope was to propose a new rating system by conducting questionnaire which can be applicable for small scale projects. The methodology of project work involves literature study and review, study of LEED and GRIHA manual, fixing of objectives, Questionnaire survey, proposing a new rating system and green building materials and cost.

1. INTRODUCTION

1.1 General

A building with roof or slab, walls, columns, beams etc. The buildings come in different shapes, sizes and functions. Buildings are serving for different purpose such as living, storing, privacy, comfortably live and work. Buildings are ranging from huts to maximum number of stories apartment blocks. Single family living residential building id called as residential house or home. Multifamily occupants building with more than one unit is called as duplex house. Buildings are nothing but permanent structures. Buildings also serve for commercial, educational, industrial and much other purpose.

Any buildings requires the several infrastructures for functioning of the building such as heating/cooling, water, electricity, waste water, rain water harvesting etc.

Fig-1: Multistory buildings

1.2. Conventional building construction

Conventional building construction is a traditional method of construction. This construction method and knowledge is passed from generation to generation. It involves placing of wet concrete in a place and allows it to harden the concrete. Form works are used for placing of concrete. Once the concrete is hardened and it achieves the sufficient strength the form work is removed. It can be mould to any shape and size. The conventional method is easy to monitor and coordinate as whole activity is on site.

The major construction material for conventional building construction is water, cement, sand, aggregate, wood, steel etc. Most of the conventional buildings are based on plans and simple measurements.

1.2.1 Construction sequence

The major sequences of conventional building construction involves paper work, excavation, foundation, brick work, concreting, flooring and finishing of work. This all work is to be done as per the design and drawings of the project.

1.3 Present progress of building construction

Construction industry in India growing very fast as it was 2.9% during 2011-2015 now it is expected to grow at 5.6% during 2016-2020. According to the BMI research it is expected that the Indians' construction industry grow fast over next decade.

1.4 Energy consumption in construction

Construction industry uses more material by weight during construction and performance of a building than other industry. Whenever the structures are build it produces noise, dust which directly impact on the environment in various forms such as carbon footprint, contamination of soil and water. The impact on environment by the building is due to excess use of energy during its life cycle.

Typically construction activity involves extraction of raw material, manufacturing of raw material, and building components, transportation, installation of building component, operation and maintenance and finally disposal of waste. Each face required energy. During the design and even before the construction it is very difficult to predict the amount how much energy required to the entire construction phase.

1.5 Green buildings

Buildings are the most environmental effective throughout it construction and maintenance. In today's world lots of new technologies have developed through which we can control the effect on environment and varying in climatic condition. A green building is also a new technique to save the environment.

Fig-2: Green building

As all the buildings generates large amount of waste throughout its life of building, aim of green building is to recycle and reuse of this waste material. The challenge of green is building to construct and reach the all benefits at a reasonable cost.

"The aim of green building is to use the renewable resources and reduce the demand of non-renewable resources".

1.5.1 Current scenario of green building

Many green building evaluating tools are available now. "Indian Green Building Council (IGBC)" plans to launch new rating system. This covers all range of buildings such as small scale project, large scale projects, new buildings, existing structures, schools etc. Green building technology saves about 20-30% of potable water and about 30-40% of energy.

1.5.2 Green buildings in India

In 2001 IGBC (Indian Green Building Council) was launched due to that "people aware about the benefits of the green buildings and found a place in the Indian market". CII- Sohrabji Godrej CBC of Hyderabad was first green building in India's market and it is evaluated by LEED rating system adapted by the IGBC on 1st January 2007.

Table- 1: Green buildings in India

Name of the project	Location	Built up area	Rating achieved
CII Sohrabji Godrej GBC	Hyderabad	20.000	Platinum
IIT Green Centre	Gurgaon	1,70,000	Platinum
Wipro	Gurgaon	1,75,000	Platinum
Techno polis	Kolkata	72,000	Gold
Spectral services consultant office	Noida	15,000	Platinum
HITAM	Hyderabad	78,000	Silver

1.6 Comparison between green and conventional buildings

Green buildings, uses efficient water, renewable resources, less affect to the environment and reuse of recycled material. Where the conventional building method produces pollution, generation of waste, harmful to living organisms and uses more water throughout its life cycle.

The factors of green building are "sustainability, water resources, energy and atmosphere, material and resources and indoor environmental quality". Initial cost of green building construction is high, but operation and maintenance cost is less compared to conventional building. Green building designs more focus on efficient

energy, resources, renewable resources and less effect of buildings on humanoid safety and atmosphere. Globally studies conclude that the buildings are responsible for the climatic change and CO_2 emissions worldwide.

1.7 Green building materials

Materials are the most important element for any type of building construction work. Materials for the construction work are the same but different in quantities. The major role of material is construction is cost; the cost of the project may increase or decreased depending on the material. Several new replacing materials have hit in market.

The choice of material for construction of green building varies place to place depending on availability of natural resources, transportation facility and climate. Selection of prime material is important in green building construction. Selected material should be low emission, low energy material, renewable resources and fulfill the all benefits of green building with an affordable cost. Usage of locally available material should be maximizing. Following are the some green building material which can be used for the construction.

- **Hollow concrete blocks**

These blocks are light in weight and easy to place with high compressive strength of 40-150 kg/cm^2 and the less than 20% water absorption. These concrete blocks are made with the waste generated from industries such as fly ash blast furnace and slag is used. Labour involvement is less as compare to conventional and faster in construction work. It is cost effective, maintenance free and durable.

Fig-3: Hollow concrete block

Fig-1.4: Hollow concrete blocks wall

- **Locally available materials**

A locally available material reduces the transportation cost. The distance between the available material and project site for the material to be qualified is known as local materials. Locally available materials are sand, stone, timber etc.

- **Earthen materials**

Earthen materials such as adobe and cob are being used for the construction purpose. Chopped straws, grass and other added to earth to give more strength and durability. Structure made with cob can be seen in remote areas.

Fig-5: Adobe made structures

- **Earth bags**

Earth bags are used to construct the walls of the structure. These earth bag walls are most commonly used in military bases, water resources etc. Recommended bags are made of burlap but it is not very easy so polypylene bags are used now a days.

Fig-6: Earthen bag walls

- **Insulated concrete forms**

This insulated concrete form consists of two layers which are equally spaced. There are some arrangements in space to hold the reinforcement bars, after placing the reinforcement the concrete is poured in to the space. The result of using insulated concrete forms is these are light in weight, low dense and high sound and thermal properties.

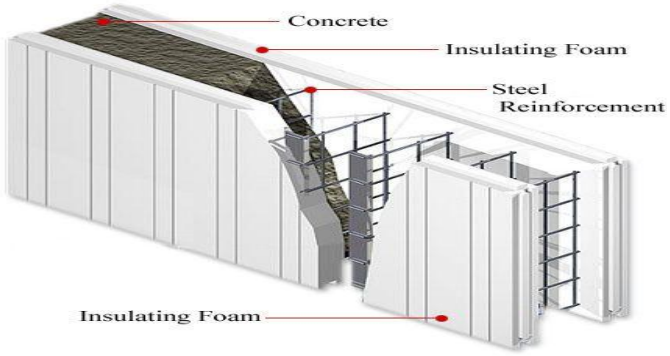


Fig-7: Insulated concrete forms

• Wood

It is the most commonly using building material for almost all types of construction and the wooden components which are commonly used in construction are doors and windows frames and shutters.

1.8 Green building rating system

"Green building rating system is an assessment tool" used to assess the functions of a building in various aspects such as energy consumption, generation of waste, impact on environment etc. throughout its life cycle. The points will give to each criterion and added all the points, and then final building is awarded bases on the total points.

All types of buildings such as residential, commercial, educational etc. can be rate. BREEAM, CASBEE, GB Tool, HK-Beam, LEED and GRIHA are the some rating systems. Each rating system has own rating criterions and rating pattern. These set of parameters and criterions are related to the planning, designing and performance of a building.

LEED is the commonly used rating system across the world developed in the US in 1998 and it is adapted by the "Indian Green Building Council (IGBC)" on January 2007. GRIHA is India's official international rating system made by "The Energy Resource Institute New Delhi (TERI) under the ministry of New and Renewable Energy (MNRE)".

Fig-8: Logo of LEED rating system

Fig-9: Logo of GRIHA rating system

1.9 Features of green building

Green building is beneficial for both occupant and environment. Every feature contributes to the environment. Energy saving is huge benefit from the green buildings. It makes us to use and launch the new techniques, maximum use of renewable resources and efficient use of equipment's for cooling, heating, ventilation and lightning. Emission of CO_2 content, greenhouse gases and climatic variation is controlled. Reduced in air, noise, water pollution during and after the construction which intern results better safety and health of living organisms.

2. STUDY OF EXIXTING RATING SYSTEM

"Rating system is an evaluation tool of the green buildings which evaluate environmental performance of a building" by considering all parameters. It consists of various set of parameters and criterions which are related to the planning and designing of a building

construction. Following are the some resulted international rating systems are listed.

2.1 BREEAM

It is earliest building evaluating tool; was developed in United Kingdom in 1990. This evaluating tool involves the large buildings such as offices, residential buildings, educational institutional etc. When the building evaluated; points are awarded for each base then points will add to the total score. Building is granted as "Pass/ Good/ Very good/ excellent" rating system on the bases of overall performance. The BREEAM rating system has their own different standard base and parameters for management and performance of a building.

2.2 CASBEE

"Comprehensive Assessment system for Building Environmental Efficiency tool developed in Japan in 2001". This evaluating tool is based on the existing buildings, new constructions and renovation. It introduces a new concept which differentiates the building from its environmental effect, its quality and building performance.

2.3 GB Tool – Green Building Tool

This evaluating tool is developed by the "International Framework Committee" for the given building challenge. It involves more than 25 countries from 1998. Bases for rating includes designing, planning, effect on environment, material uses, quality of environment etc.

Rating is given as 1 for the poor performance of a building and ranges from 1 to 5 to the buildings best performance. For the good performance of a building the building is awarded as a good with the rating is high as 5. The uses of renewable resources water, electricity, day light usage etc. are the basic standards for the evaluation.

2.4 HK-Beam

The Hong Kong evaluating tool was developed in December 1996. This evaluating tool is truly based on the bases of building performance. A base for the rating is different for the new and existing buildings. This method is majorly focuses on health and wellbeing. Building awarded in terms of %age.

2.5 LEED

"Leadership in Energy and Environmental Design assessment tool developed in 1998 in US". Commonly and resulted green building assessment tool in World. The LEED launched in Indian version on 1st January 2007 by the India green building council.

LEED rating system certified more than 650 buildings in India such as Green centre of Gurugram and Wipro Gurugram etc. The design of rating is as shown in below.

Table-2: % share of LEED Criterion

Ratings	Points
LEED Certified level	26-32
LEED Silver Certified Level	33-38
LEED Gold Certified Level	39-51
LEED Platinum Certified Level	53-69

2.6 GRIHA

"Green Rating for Integrated Habitat Assessment" developed by Teri (Energy Resource Institute New Delhi under ministry of New and Renewable Energy MNRE). The rating pattern of GRIHA awarded as "5 stars/4 stars/3 stars/ 2 stars and 1 star". This assessment method is limitedly applicable for only new buildings it may be commercial, institutional, residential or the building serve for any other person.

It consists of more than "34 criterions, for which marks are awarded out of 100 for the built up area more than 2000sq.m". The rating pattern according to the marks is shown in below table.

Table-3: % share of GRIHA Criterion

Marks	Stars
50-60	*
61-70	**
71-80	***
81-90	****
91-100	*****

The following table shows the rating points shared by the two broadly used green building rating pattern in India and across the world namely GRIHA and LEED. The rating criterions are coupled into six major categories and combines points are represented.

Table- 4: Rating points of LEED and GRIHA

1	Sustainable site planning	13	17
2	Water usage and management	06	15
3	Energy utilization and conservation	17	34
4	Sustainable building materials	13	13
5	Environment, Health and safety	15	21
6	Water usage and technology	05	04
	Total	**69**	**104**

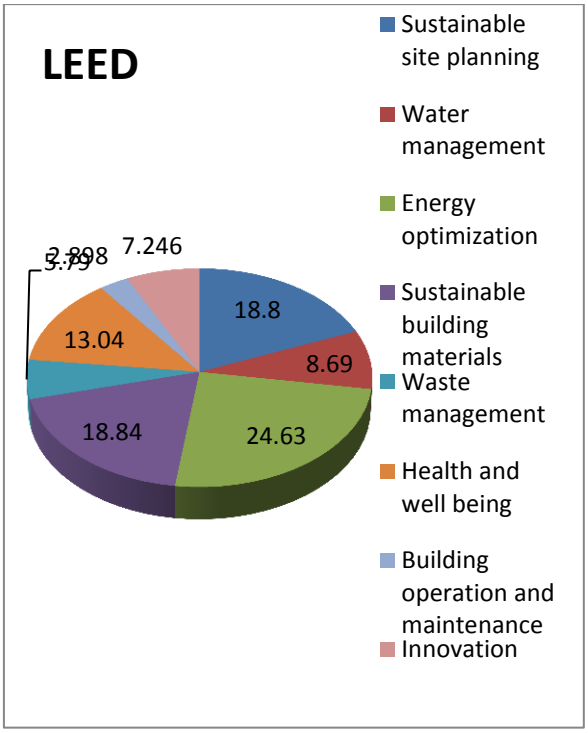


Fig-10: % share of LEED Criterion

The above graph represents the % share of marks in LEED rating system. As seen in the pie chart the LEED rating system gives maximum importance to the energy optimization having a share of about 24.63% of the total marks. Whereas the least importance is given to the waste management reference with 5.795% and building operation and maintenance reference with 2.898% respectively.

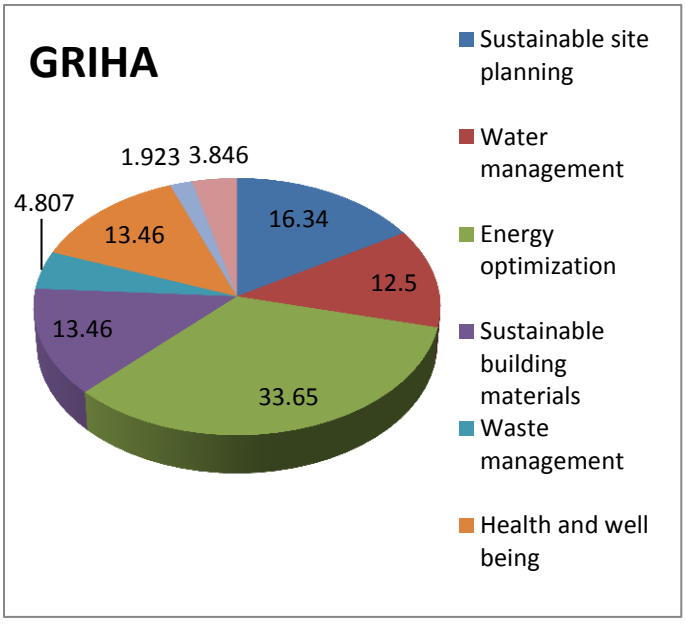


Fig-11: % share of GRIHA Criterion

The above graph shows the % share of GRIHA rating system. This rating system gives the more importance to the energy optimization whereas less importance given to the building operation and maintenance.

3. DRAWBACKS OF GREEN BUILDING RATING SYSTEM

LEED and GRIHA rating systems are not reliable at all the places of India or they are "suitable for high budget large sized projects only" These rating systems will not give efficient results when small scale housing projects of less and very less built-up area are considered.

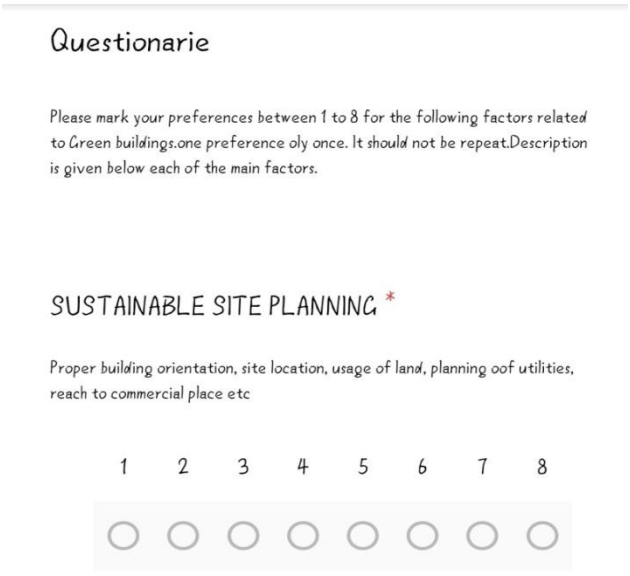
The rating criterions of these systems take into account metro cities and surrounding areas, where as small cities and towns are not considered. Both LEED (8.69%) and GRIHA (12.5%) give less preference to water usage whereas; in small cities water is given prime importance.

Both the rating processes are designed for new buildings only which are either under construction or newly constructed neglecting large scale old buildings which are under operational and maintenance stage consuming a lot of resources.

For the above drawbacks, proposed a new rating system which will be applicable for Tier 2 cities as well.

4. QUESTIONNARIE SURVEY

A questionnaire survey based on the green building rating system is prepared and answers are collected from common people and industrial experts. Based on the results of the survey a new green building rating system suiting to Tier 2 cities is formulated.

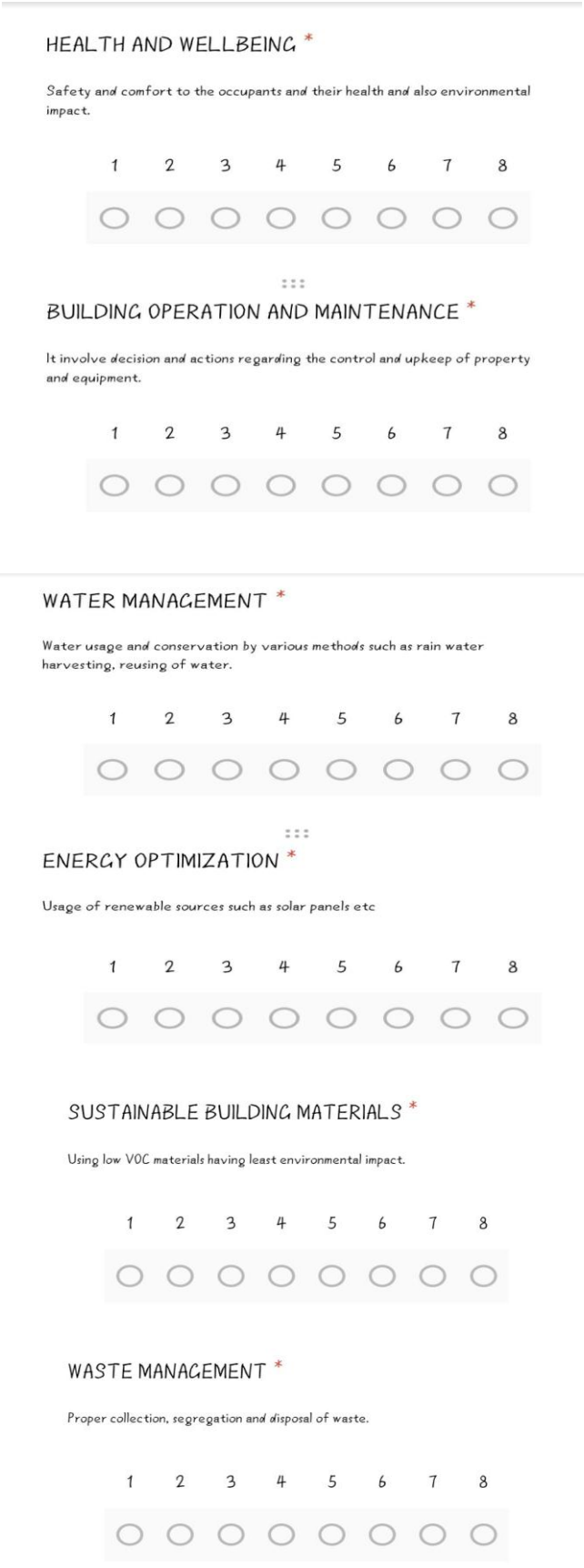

Questionarie

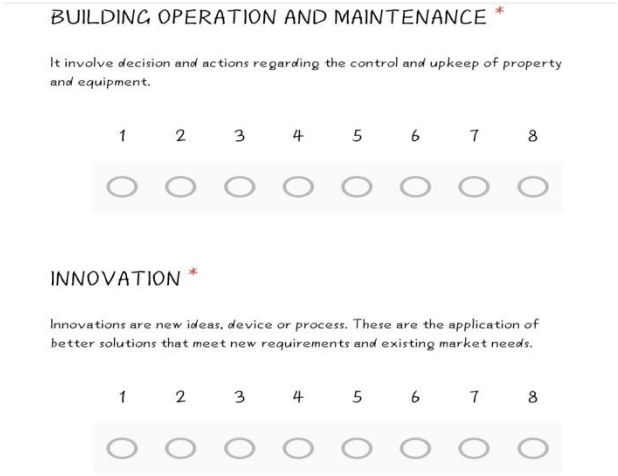
Please mark your preferences between 1 to 8 for the following factors related to Green buildings.one preference oly once. It should not be repeat.Description is given below each of the main factors.

SUSTAINABLE SITE PLANNING *

Proper building orientation, site location, usage of land, planning oof utilities, reach to commercial place etc

1 2 3 4 5 6 7 8





4.1Proposed rating system

Regarding to this a survey was conducted to analyze the view of people about various aspects of building construction, green building practices and rating pattern.. A set of rating criterion were listed with brief descriptions and participants were asked to mark the preference to the criterion he/she would give when dealing with a construction project. The participant list includes Professionals, Students, Civil Engineers, and Gov. Employees etc.

After collecting all the responses from various places, sheets were studied. It was found that the "maximum preference is given to the sustainable site planning and water usage and management". The respondent's gives less importance to the building operation and maintenance and sustainable building material .Following pie chart gives the preference of respondents when dealing with the construction, operation and maintenance of housing.

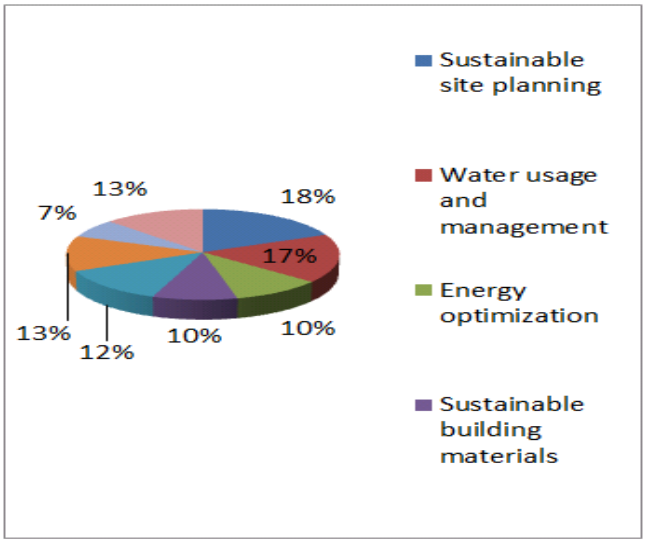


Fig-12: Proposed Rating System

The proposed rating system shows that the people in the state of Karnataka gives highest preference to the sustainable site planning and second preference to the water usage and management.

5. SUSTAINABLE BUILDING MATERIALS USED FOR GREEN BUILDING CONSTRUCTION

5.1. AAC Blocks

Autoclaved Aerated Concrete Blocks (AAC) are the composed of quartz, lime, cement, calcined gypsum, water and aluminum powder. These are light weight and the blocks are cured under the heat and pressure. It can be used for both load bearing and non-load bearing walls. These are widely used for high rise buildings.

Fig-13: AAC Blocks

5.2. Low VOC paints

"Low VOC paints are those that contain less volatile organic compounds". This is good for both environment and living organisms so that this is proposed in the project planning.

Fig-14: Low VOC paint

5.3 Fly ash

"Usage of fly ash in concrete reduces the permeability to water". Fly ash in concrete with properly cured gives less dense and it increases the strength and workability of concrete as well. Fly ash is cost effective, when it is added to concrete the quantity of cement may reduce. The fly ash is also called as pulverized fuel ash.

Fig-15: Fly ash

6. RESULTS AND DISCUSSIONS

6.1 Rating system

Result of conducted survey, we got around 100 responses which include professors, students, civil engineers etc. from Tier 2 cities such as Belagavi, Dharwad, and Vijayapur etc. The people have given more importance to the sustainable site planning and less preference to the innovation.

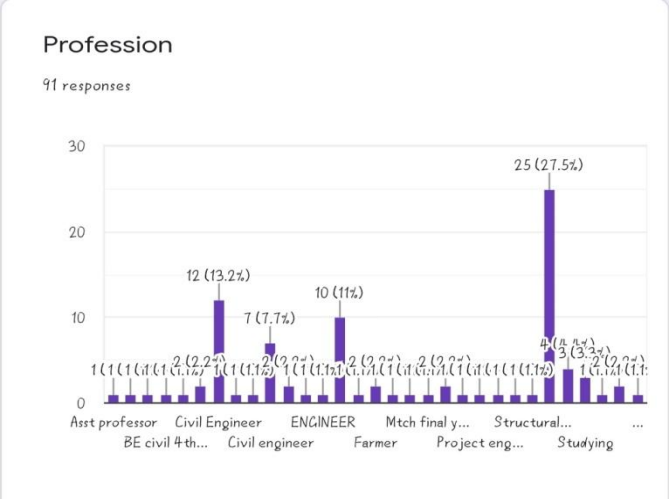


Fig-16: Respondants profession

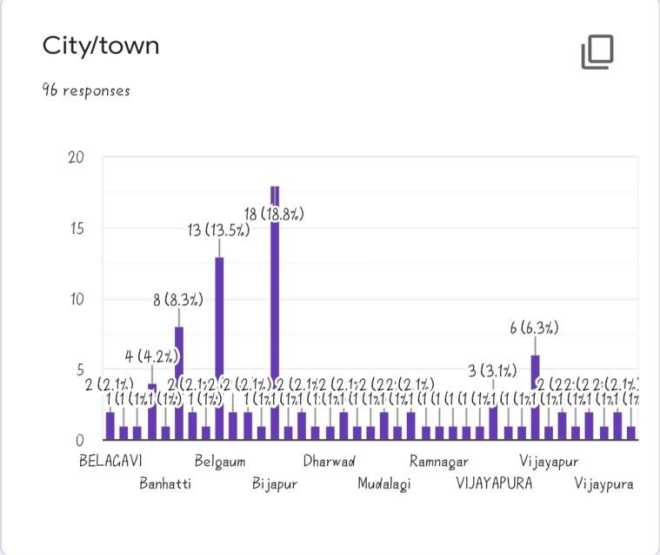


Fig-17: Cities of respondants

Fig-18: Sustainable site planning

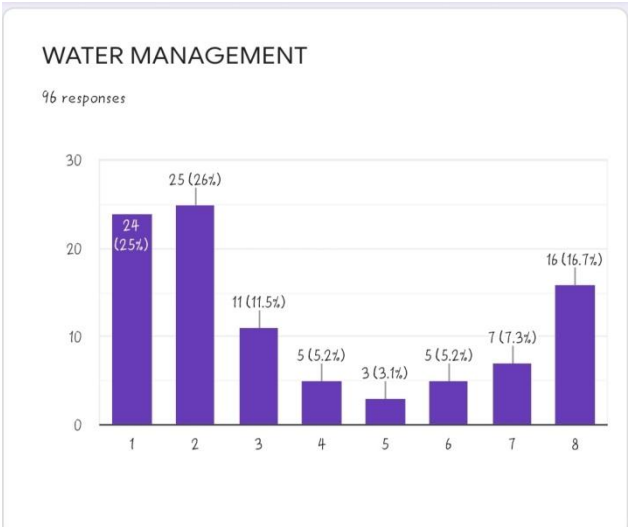


Fig- 19: Waste management

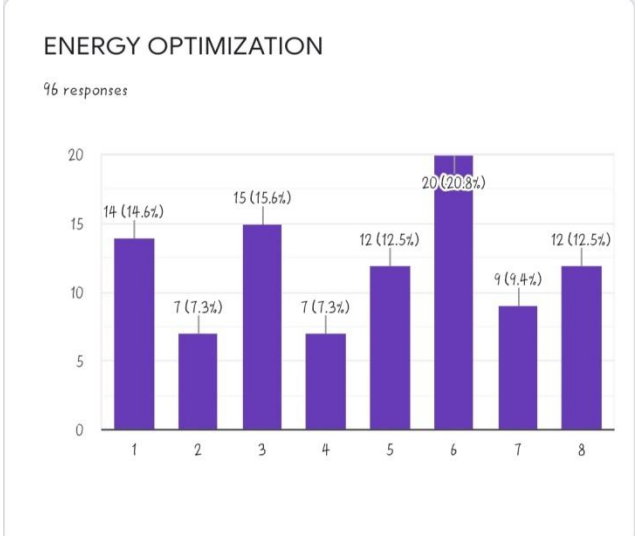


Fig- 20: Energy optimization

Fig- 21: Sustainable site planning

Fig- 22: Waste management

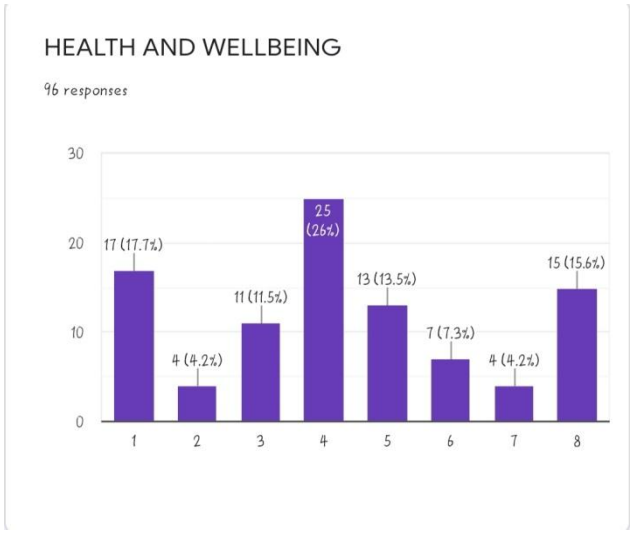


Fig- 23: Health and well-being

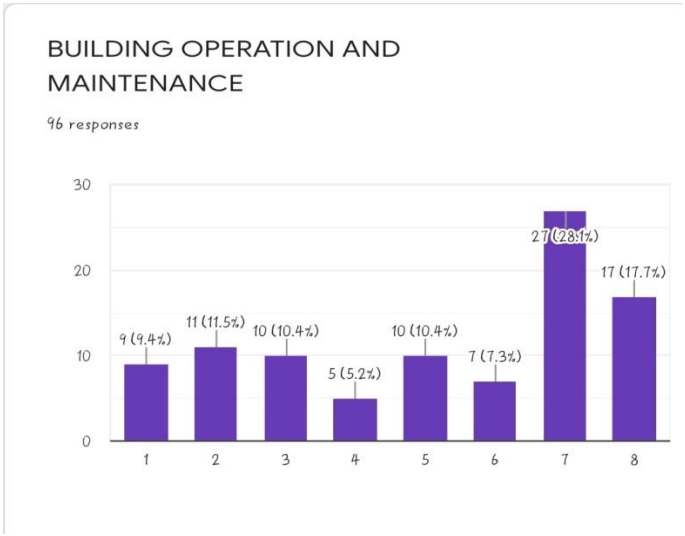


Fig- 24: Building operation and maintenance

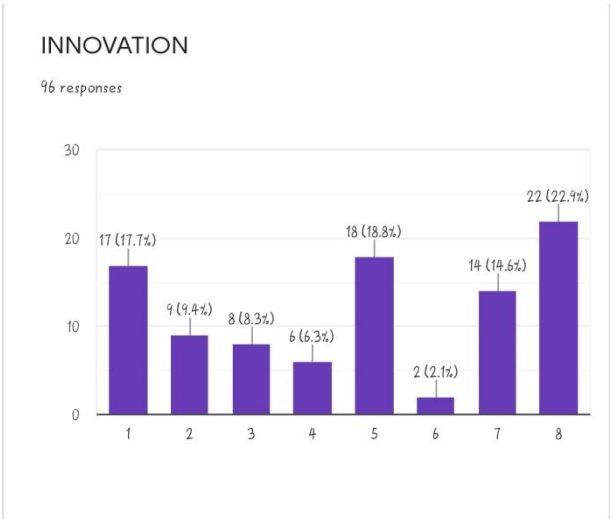


Fig- 25: Innovation

The proposed rating system is applicable for Tier 2 cities, small scale buildings and already constructed buildings.

6.2 Cost comparison

The construction cost of green building is high compare to the conventional building but the operation and maintenance cost of green building construction is less. In this project we replace the conventional building material by using VOC Paint, AAC Blocks and addition of fly ash in to the concrete. Cost of VOC paint is high compare to the conventional building paint.

6.3Performance

Green buildings produces less pollution and they generate less waste as well can use the renewable resources. The performance of green building is high throughout its life cycle.

7. CONCLUSIONS

The project has given more importance on green building performance, green building materials and cost effective. After studying the green building rating systems, proposed a new rating by conducting the questionnaire survey on Tier 2 cities. The proposed rating system is applicable for small scale projects and existing buildings.

The benefit of adapting green building construction is, because it is both environment and cost effective. Achieving the energy efficient building makes the city smart and sustainable growth.

The interest of the builders, people, and users towards the green building construction by this report may see as hike. The project satisfactorily full fill the all the objectives of the project.

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8. BIOGRAPHIES

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