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ECONOMIC AND SUSTAINABLE STUDIES OF GREEN RESIDENTIAL HOMES IN REMOTE AREAS OF INDIA

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ABSTRACT

Our construction industry is one of the most rapidly growing industries in the world. Residential, commercial, industrial and infastructural development has taken a boom all over the world in the last four to five decades. As a result, due to ennumerous construction activities throughout the world, an issue of global warming has been a concern to the world. Climatic change throughout the world has been noticed. So to control the same and maintain a good environmental condition throughout the world, a remeady for it is green construction. A green building is the one which uses less water, optimizes energy efficiently, conserves natural resources, generates less waste and provides healthier spaces for the occupants as compared to a conventional building.

Also, the green building technology is one of the most trending topics all over the world which has been put forward to reduce the significance impact of the construction industry on the environment, society and economy. In the developed countries like United States of America, Russia, Australia, United Kingdom, there are already strict measures been taken to achieve a sustainable and an eco-friendly development of their nations. However, in the developing countries like India, China, Srilanka, Pakistan, etc., they are far behind in achieving a sustainable development and an eco-friendly construction. Also, there is a lack of awareness amongst the people about this global issue in these developing countries.

This paper presents the need of sustainable development all over the globe especially in the developing countries like India and China which have a huge land mass and also developing rapidly and heading towards becoming the new super powers of the world soon in the future. Also, it includes the sustainable and economic studies with references to the Indian contexts with a supporting live recent case study of a newly designed and constructed luxurious residential bungalow in a small town in India. The case study is specially selected as a residential bungalow which is designed and constructed as a sustainable and a green structure in a small town in the state of Maharashtra in India as India is also known as a country of villages with a second largest population in the world. According 20 the 2011 census of India, 68.84% of Indians i.e. around 833.1 million people live in 6,40,867 different villages. This paper will help Indian villages and their residential buildings develop sustainable and green by implementing easy, simple and economic techniques.

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Keywords:GRIHA (Green ratings for integrated habbitat assessment)IEQ(indoorenvironmentalquality,LEED (Leadership in energy & environmental design)

I. INTRODUCTION

According to the 2011 census of India, 68.84% of Indians, i.e. around 833.1million people live in 6, 40,867 different villages in India. The construction industry in India is one of the most rapidly developing industry. Also, in the world scenario, the construction industry is the most rapidly developing. At the same time the construction industry has significant economic, environmental and social impacts on the society. These impacts are largely seen during the lifecycle of the constructed structures. Also, there are positive as well as negative impacts of construction activities on the society. Some of the positive impacts include providing buildings and habitats along with the facilities to satisfy the human requirements, providing employment to the people of the nation and finally, contribute towards the economy of the nation. Also, the negative impacts include waste disposal during the construction activities, dust, noise pollution, water pollution, traffic congestion, etc. Also, the negative impacts continue throughout their life cycle. A building block accounts for 40% of total energy consumption according to the world business council for sustainable development.

Apart from the energy consumption, the buildings produce Green House Gas emissions (GHG's) which are responsible for the global warming. According to the researchers, the carbon emission of buildings across the world will reach 42.4 billion tons in 2035, adding 43% on the levels of 2007. Also, these activities will include the consumption of natural resources and energy, noise and other types of pollutions and also associated with the waste production post building demolition poses a new challenge to all those countries having an issue of limited land. There are many definitions of a Green building as per different researchers. It is also worth noting that the term green building is now a days used as an interchangeable word with the high performance buildings or a sustainable buildings or structures. The concept of Green Building basically stands on four main points which are:

1. Reduction of the effects or rather the side effects of the structure on the environment.
2. Improving and enhancing the health conditions of the occupants in a structure.
3. Savings and returns on investments to the investors and the community.
4. Life cycle considerations during the planning and development process.

There have been a lot of research works carried out on the aspects of the green building in different contexts but they all lack in systematic reviews of the existing material of knowledge. The systematic research is very important to identify the common research problems and also highlight the future research methodology. This study will play a critical role to highlight the state of art and future need in this topic for our country India and also for other developing countries interested in developing green construction. This research paper will help developing green buildings and eco-friendly homes in India as it includes easy and simple ways to be implemented for achieving green homes and also the importance and long term profits involving green homes.

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II. LITERATURE REVIEW

A. GREEN BUILDING – COMMONLY USED RESEARCH THEMES

There have been a large number of studies carried out on green buildings as it is been observed that there are a large growing number of papers and journals been published online since last five to ten years. This is a global issue as it is observed that the studies have been conducted in developing as well as in developed countries. A review from the existing body of knowledge reveals that generally there are three common focuses of these studies. The figure below shows the mapping of green building related studies.

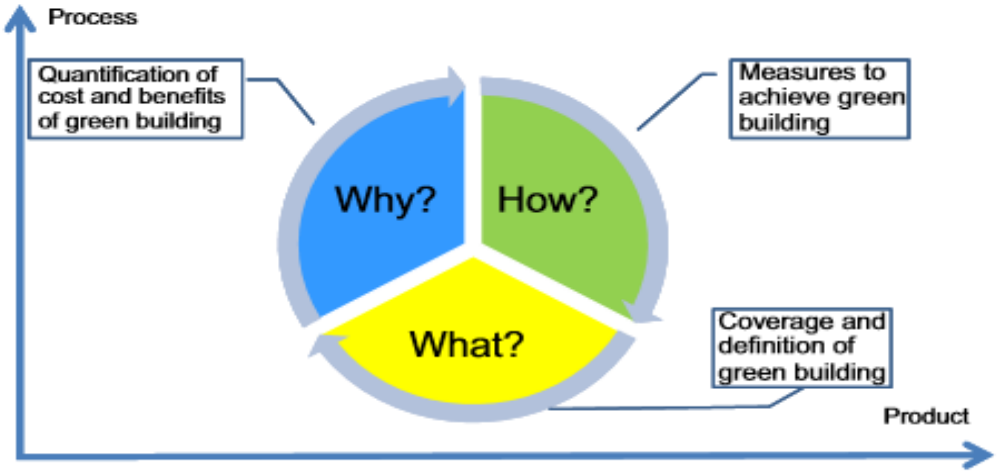

Fig. 1. Mapping of green building related studies.

The green building can also be approached from process or perspective i.e. either from "how to implement the process" of from "how to evaluate the process". The development and management approaches could be different as per the focus priorities to achieve the sustainability.

B. WHAT IS A GREEN BUILDING?

There is a growing level of awareness amongst the public about the green building technology as the global warming issue is bothering the entire world by showing its effectiveness on the atmosphere. Thus a large amount of research work is been carried out by old as well as new researchers about the green building technology. There are different definitions of green building according to different researchers. But according to my research, my definition of a green building concept basically stands on five main points which can be easily understood by the new as well as experienced researchers; which are as follows:

1. Environmental friendly
2. Energy efficiency
3. Natural resource saving (conservation)
4. Cost saving
5. Self-reliance

A Green building can easily be constructed by achieving the above five point definition which defines a green building or a sustainable structure.

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C.ASSISSMENT TOOLS FOR A GREEN BUILDING

To assist the development of the green building, there are a number of assessment tools which have been developed all over the world. Some of the leading green building assessment tools include: LEED or the Leadership in energy and environmental design (United States), BREEAM or the Building research establishment environmental assessment method (United Kingdome), GBCA or the Green building council of Australia, The Green mark scheme (Singapore), DGNB, Germany or the German sustainable building council, CASBEE or the Comprehensive assessment system for building environmental efficiency (Japan), Hong Kong building environmental assessment method or the HK BEAM, Green building index (Malaysia), the GRIHA or the Green rating for integrated habitat assessment by IGBC or the Indian green building council (India). All these green building assessment tools were developed by the green building council in each country or region which are all voluntary rather than mandatory which are undertaken by accredited professionals commissioned by the green building council. Also, to coordinate the efforts of the green building councils all over the world, a world green building council has been established.

The basic structure of all these above tools is quite similar to each other and the main motive is to promote green building development. They cover the various aspects of sustainability, different rating tools as per the project utilities, number of credits available in each categories, etc. For example, the green building council Australia (GBCA) released eight rating tools (I.e. Education, office, industrial, healthcare, office interiors, retail centers, public buildings and multiunit residential). The GBCA green star rating tools also have nine categories, i.e. management, indoor environmental quality, energy, transport, water, material, land use and ecology, emissions and innovations. Under each category, a certain number of credit scores are available to apply for. A total number of 105 points including 5 points for innovation category are weighted. Similarly, the GRIHA rating system by IGBC or the Indian green building council has more or less the same rating structure. The GRIHA rating system consists of 34 criteria categorized under various sections such as site selection and site planning, Conservation and efficient utilization of resources, building operation and maintenance and innovation points.

Following are the GRIHA criteria and weightages:

All the buildings more than 2,500.sq.m (except for industrial complexes), which are in the design stage are eligible for certification under GRIHA. Buildings include offices, hospital buildings, health care facilities, residential and multi-family high rise buildings. As mentioned above, GRIHA rating system consists of 34 criteria, Eight of these 34 criteria are mandatory, while the rest are optional. Each criterion has a number of points assigned to it. It means that the project intending to meet the criterion would qualify for the points. Different levels of certification (one star to five star) are awarded based on the number of points earned. The minimum points required for certification is 50.

GRIHA is a guiding and performance oriented system where points are earned for meeting the design and performance intent of the criteria. Each criterion has a number of points assigned to it. It means that a project intending to meet the criterion would qualify for the points. GRIHA is a 100 point system consisting of some core points, which are mandatory, while the rest are optional. Different levels of certification (one star to five star) are awarded based on the number of points earned. The minimum points required for certification is 50.

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Table no.1: GRIHA star ratings for green buildings.

POINTS ACHIEVED	GRIHA RATINGS
50-60	*
61-70	**
71-80	***
81-90	****
91-100	*****

The green buildings in different countries are designed and built according to the local climatic conditions and to suit the requirements of the assessment criteria for these green buildings are different. It is also been observed that there are extensive studies focussing on developing new green building rating tools or customizing the existing tools to accommodate specific local contexts such as climatic conditions, economic development level and geographic conditions.

D. ENVIRONMENTAL AND TECHNICAL ASPECTS

The focus on green building studies is traditionally placed on the environmental aspects of sustainability. Taking into consideration as an example, the GBCA tool, Green Star healthcare VI; environmental sustainability relativities have around 87% of weighted points. It also included a technical studies related to the environmental sustainability of the buildings; e.g. water efficiency, energy efficiency, resource efficiency and greenhouse gas emissions reduction. For example, fly ash which can easily found from the industries as a residual wastes can be used easily for the structural components of the green building which helps save energy and also reduce the wastes to the land fill. Similarly, by making the use of precast and prefabricated techniques, we can reduce the demolition wastes significantly. Also, precast and prefabricated structures also have other advantages such as cost saving effectiveness. Also, in addition to its benefits, prefabrication is recognized by both, the design as well as construction professionals as a method to prevent injuries while working at heights and in confined spaces.

E. SOCIAL ASPECTS:

Growing concerns on social sustainability in buildings have been witnessed in last decades. An intense and a wide amount of research work is also been observed at the same time. There is a wide awareness among the developed countries about the sustainable development, but the developing countries still lag behind in spreading the awareness and importance of a green and sustainable buildings. The developed countries already have rules and regulations for achieving and encouraging the sustainable development. But the developed countries are far way behind in developing sustainable buildings.

In the construction context, social sustainability mainly covers the quality of living, occupational health, safety and future professional development opportunities. Now a days in the developed as well as in the developing countries, the social sustainability is taken into consideration in a construction projects right from the planning stages. According to the chartered institute of building, in some cases the corporate social responsibility performance becomes a key motivation for the industries to place more focus on social sustainability of

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construction related activities. Social sustainability was also reported as important aspect of green building and its assessment. Thus, the social and cultural benefits are identified as key outcomes of sustainable building envelop through improved energy performance. And finally, the social sustainability performance of a green building assessment should cover well-being and comfort of the users, accessibility to the public facilities, and the level of awareness of sustainability issues. The level of awareness should considerably increase as the issue of sustainability should be seriously taken into consideration and be made a regular and a mandatory practice.

F. ECONOMIC ASPECTS

It has been observed from the research work that there are social and economic requirements of green building such as access, education, inclusion, cohesion, affordability, economic value, impact to local economy, indoor health, cultural perception and inspiration. The benefits of energy retrofitting or home renovation as a sustainable one not only save the cost in the long term but also add a potential value to the property. Thus, this helps reducing the payback period of investment for energy efficiency measures.

A green building could therefore take a narrow point of perspective, as in a purely environmental sustainability or a broad definition as in by adopting a triple bottom line approach .i.e. the social, environmental and financial approach. However, the significance of triple bottom line theory of sustainability of green building development is rarely discussed. Majority of sustainable structures related studies place their focus on environmental aspects of sustainability.

III. RESEARCH METHODOLOGY

1. WHY GREEN BUILDINGS?

There is a large amount of study done by the researchers investigating the costs and benefits in association with the green building development. The main purpose of this study is to spread awareness among the people, the value of going green which will assist the decision making process. This study plays an intense role for a country like India which has lack of awareness about the sustainable structures and also which is sensitive towards spending extra for sustainability of the structure. It is even more valuable where clients are comparatively small finance capacity under the context of global financial crises and more conservative in the terms of lending decisions. Basically, these studies focus on positives and negatives of green building development compared to conventional buildings. Also, a common link adopted in existing going on research studies is to compare the characteristics of green buildings to those of conventional buildings such as water efficiency, energy efficiency, indoor environmental quality, thermal comfort, health and productivity.

2. ENVIRONMENTAL BENEFITS

The study and the research work done up to today has a strong evidence about the numerous benefits associated with the green buildings. Keeping in mind the environmental perspective, a sustainable structure helps improving urban biodiversity and protects the eco system by the means of sustainable land use. Also, reduction of construction and demolition waste is one of the important component of the sustainable building design. The recycling rate should be above 90% in order to reduce the impacts on the environment and rather use the recycled material from the construction wastes in construction of new buildings.

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Green buildings generally provide higher performance compared with conventional buildings with reference to energy efficiency, water efficiency and carbon emission reduction. It is also found in studies that if LEED rating tools were adopted in all new construction works, all over the world, a large amount of carbon dioxide emission could be reduced. Also, it was observed that the commercial buildings benefits the most from the LEED certification in carbon dioxide reduction and then followed by residential and public buildings. Also, LEED certified buildings achieve more than 25% of energy savings compared to average national levels. The figure below justifies the above statement. A library building structure benefits the most among other buildings from the LEED certification in terms of energy efficiency.

3. ECONOMIC

Keeping in mind the life cycle perspective, the cost savings are also associated with the improved building performance; the result of which is that the operation cost is optimized eventually. According to the economists and the researchers, it can be clearly observed a cost saving of up to 25-30% of energy consumption in a green building when compared to a conventional one. According to the researchers, an extra cost of 4% to 10% is needed to achieve a GBCA green star (5 and 6 stars) rated building. But the costs of not going green are high as well, considering the rocket high energy prices and carbon trade costs. Also, according to a financial model made by a researcher, to achieve a LEED certified green building, an extra cost of up to 10% will be incurred. Further, its cash flow analysis also calculated about US$1.28 to $1.32/sq.ft savings per annum from a green building design as compared to a conventional building. Also, from a point of view of maintenance, a green building performs much better than a conventional one in the terms of energy efficiency, water efficiency and cost efficiency. Further, according to a researcher, repetitively concentrating on energy efficiency, his studies revealed that low energy office buildings with green features can save more than 55% of energy costs as compared to conventional buildings.

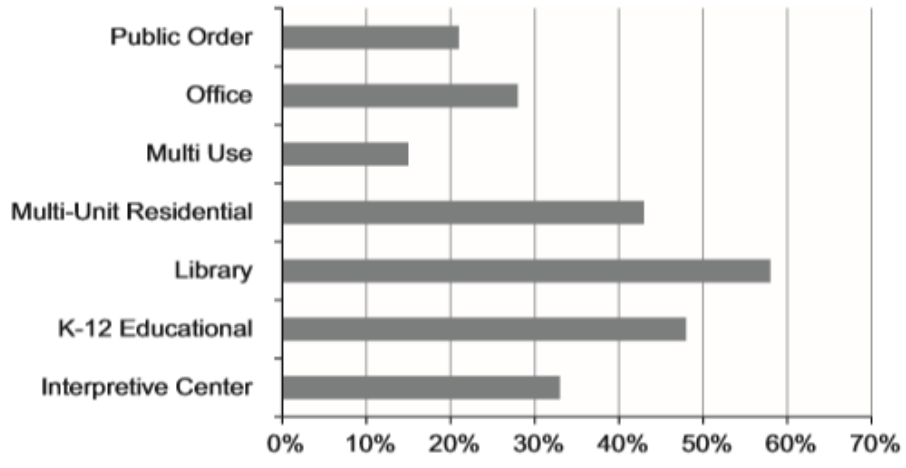

Fig1 .Energy savings from LEED certified buildings

4. INDOOR ENVIRONMENTAL QUALITY :

The IEQ or the indoor environmental quality plays a role as one of the most critical components of human benefits associated with the green building. Volatile organic compound emissions and similar such toxic

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contaminants are also some critical issues in the building which are included in the IEQ scopes. And thus, IEQ plays an important role in all the leading green building assessment tools. An extensive studies have already proved that the green building can achieve a higher level of IEQ than conventional buildings which has a direct impact on the health and the productivity of the occupants. This helps in enhancing the level of satisfaction of the building users. According to a web survey conducted by a researcher for around 180 buildings for some reviews on Indoor Environmental Quality, the survey concluded on a point that the green building outperformed conventional buildings except for acoustics, lighting and office layout. Further, the follow up study found that most complaints to lighting are: no enough day light, reflections in the computer screens, too dark or too bright rooms. Also, top acoustic related complaints were: people overhearing private conversations and people talking on the phones. The study was worth noting that the occupants in the green buildings were satisfied with the thermal comforts where as those in conventional buildings showed more dissatisfaction. It was also observed that the indoor air quality played a critical role to building users performance rather than their satisfaction. Other IEQ measures, e.g. office layout, acoustic and thermal comfort were not statically significant in the terms of impacts on occupants in green building.

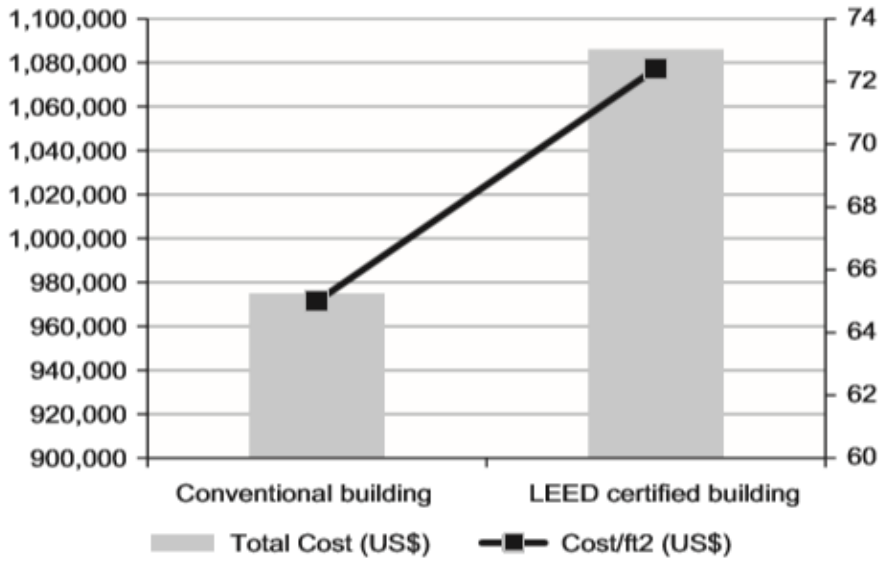

Fig.3. Total cost and cost per unit of floor area, Conventional building Vs. LEED certified building.

5. THERMAL COMFORT

It was observed that the satisfaction of building users was closely related to thermal comfort which was a complex dynamics of temperature and humidity. This attracted a large amount of researchers to stimulating and measuring the thermal comfort level in a green building compared to a conventional building. As a result, the indoor room temperature ranges were to be proposed. Factors such as psychological, physiological, cultural and behavioral factors play an crucial role as well attributes to adopt thermal comfort.

6. HEALTH AND PRODUCTIVITY

The basic concept behind the green building technology is that the sustainability of the structure and the conservation of energy should not be on the cost of health, satisfaction and productivity of the building users.

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And thus, the indoor environmental quality of a sustainable structure and the occupant's satisfaction plays a crucial role in any certified green building structures. Indeed, it stands to be a complex issue for a designer to maintain a fine balance between indoor environmental quality and energy and cost efficient operation of the heating, ventilation and air conditioning (HVAC) plants. Keeping in mind the Indian contexts, heating is necessary only in some northern regions of the country, while ventilation and air conditioning system is needed nearly throughout the country.

Health and productivity in office buildings plays a crucial role in getting a good output from the work person and officials. By a good health and productivity, good outputs and work results can be obtained easily as the environment at the work place also affects the working ability and efficiency of the workers. Also, studies found that the health conditions and level of productivity improve when occupants move to a green building from a conventional one. A study also found that there is an increase of 25% of productivity and the absenteeism is also significantly reduced when occupants move from a conventional building to a green building. It has also been observed through a survey f around 31 GBCA certified office building showing that employers rather than employees recognized the health and productivity benefits associated with the green offices. This study further found that level of visual comfort is associated with the indoor lighting environment such as Il luminance distribution which eventually affects the psychological wellbeing and productivity of the occupants. A broader scope is being developed by these health related benefits of a green building such as social and economic sustainability rather than traditionally environmental focused one.

7. CASE STUDY

Photo 1: Actual photograph of the case study

This is a live case study of a residential green bungalow. It is specified specially as a "live case study" as I was personally involved in the project as an assistant planner and designer and also as a contractor for the construction work of this bungalow. This green home with a smart design can be taken up as a case study and also for green home assessment purpose.

This bungalow is situated at a hill station named Lonavala which is located between the two metro cities of Mumbai and Pune. The bungalow is basically designed by a Mumbai based architect, Mr. S.Shirsat and the green concepts were designed by myself as it is a core subject in my post-graduation studies. The bungalow was designed keeping in mind to get the green home concepts into it and also a smart and a modern design to be achieved at the same time. And we are successful in achieving them both, a green home and a smart stylish design in this project.

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The plot size on which this bungalow has been constructed is around 1100sq.m plot which comes under a town planning scheme plotting. The bungalow area is around 450sq.m which is a ground plus one floored structure which consists of a bedroom, a kitchen, a living room and a dining area at the ground floor which also includes a lift up to the first floor and two bedrooms and a lounge area connected to a semi-covered balcony on the second floor. The children's bed room on the first floor has a open to sky elevated garden. The roof is divided into three sections with different shapes; one fully curved, one straight and one half curved towards both sides. All include gutters in structure itself to collect rain water. The work of the bungalow started in January 2015 and the possession was given in May 2016.

Following are some of the contents which the bungalow consists making it a green home:

1. Use of PPC (cement) instead of OPC with 50% flies ash content.

The overall construction of the bungalow was done using the PPC with fly ash which reduces the heat of hydration and gives out fewer amounts of heat and carbon dioxide as compared to the ordinary Portland cement. Also, the regular traditional bricks were substituted by fly ash based porous "Syporex" light weight blocks. The internal walls were gypsum plastered which again comparatively releases fewer amounts of heat and Carbon dioxide.

2. Smart architecture:

The bungalow was planned and designed in such a way that the interiors of the bungalow receives maximum of natural light and superior ventilation. That means minimum electric consumption for illuminating and ventilating the home.

(Observation: it was observed that the natural light in the whole bungalow was so sufficient that there is no need of artificial lighting from 6.30am to 6.30pm throughout the year. Also, due to large glass open able; some sliding doors throughout the bungalow ventilates the bungalow decently and there is no need of fans and air conditioners throughout the year, not even in the summer)

3. Double glazed glasses (for doors and windows) :

The DG glasses are installed which acts as an insulator which avoids direct sun rays to enter the bungalow, keeping it cool throughout the day time and also helps maintaining room temperature in cold weather conditions.

4. Solar water heaters:

Solar water heater is installed to provide hot water to the bungalow. it is a racold dual heating system which is provided with an inbuilt electric coil heater as an option in case of poor sunlight or when the sunrays are not available abundantly.

5. A customized STP for bungalow:

A specially customized STP for treating wastewater is constructed in the bungalow premises which treats the sewage water from the bungalow and is left into the soak pit or increase in the ground water levels.

6. Compost pit:

A compost pit is also prepared in the garden which treats the kitchen wastes and is used for kitchen garden ass nutritious manure.

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7. Rainwater harvesting system:

The bungalow has been designed in such a manner that all the rainwater from the roof of the bungalow is collected in the gutters which are constructed at the roof top itself and is let into the ground water charging pits.

8. Solar lighting system in garden:

The garden is lightened up totally with solar lights which are kept on auto mode giving light backup up to SIX hours.

9. Auto pumping system:

The overhead water tank is operated with auto level sensors which are installed in water tanks itself. These save both water as well as electricity.

10. Special cladding:

The planning of the bungalow is done in such a way that at least one wall in every room of the bungalow is cladded with earthen tiles which serves two reasons;

-Interior effect

-Helps keeping the room cool

11. Solar charging inverter for backup

The solar charging inverter has been installed which charges hybrid on solar power giving light backup in case of power cut. A backup of up to four hours with normal usage is obtained.

12. General appliances used in the bungalow are 5 star rated energy saving appliances.

13. LED lightings: The whole bungalow is lightened up by LED fixtures which consume up to ^)% less energy than the conventional CFL's, tungsten bulbs.

14. Pavement blocks used in the car parking pathway area of the bungalow are fly ash blocks.

15. Also the concept of external vertical garden is adopted in this bungalow. According to the study, the cement plastered walls or the RCC structures releases a heavy amount of carbon dioxide in the atmosphere which the vertical garden helps in controlling.

16. Paints used in the bungalow are all water based paints which replaced the oil bond paints which are unhealthy for humans when inhaled, which contain VOC's.

Economic analysis of this case study in brief:

The total quotations of this green building was around Rs.1,12,50,000/- if it was to be constructed conventionally without imposing any green building elements. And the final cost of the whole project including all the above mentioned green building elements was Rs.1,19,15,000/-. This means an extra cost of Rs.6,65,000/- was spent for the bungalow to go green .i.e. around 5.9% extra cost was spent to achieve a green bungalow. Also, studies have proved that around 5-10% of extra cost is to be bared to achieve a green bungalow. Thus, for this project, an extra cost of around 5.9% is quite profitable which in future will continue to give 30-40% of savings in its life cycle.

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7. CONVENTIONAL CASE STUDY:

Photo 2: Actual photograph of the conventional case study

The conventional case study selected is a 3 row houses built conventionally without implementation of any green building elements.

General information:

Name of the property: Friends Villas

Name of the owners: Mr. N.Gaikwad, Mr. Zope, Mr. Bavsar

Case study background:

In May 2015, the construction work of 3 row houses was started by our construction company which was a turnkey type of project with pre-decided specifications. The clients were been tried to convince by us for the sake of construction of green homes with some green implementations but the client being conventional thinkers wanted it all conventionally constructed.

The purpose of selection of this case study is basically to plan for the green elements on the conventionally constructed homes and also convince the owners about the long term savings in the running and maintenance costs of the building.

Following are the green implementations which can be implemented on the conventionally constructed case study:

1. Convert to LED lightings
2. Solar water heaters
3. Solar garden lights
4. Solar invertor
5. Vertical garden concept
6. Double glazed glasses
7. Rain water harvesting system
8. Auto pumping and levelling sensors
9. Low discharge fixtures for plumbing
10. Solar powered electric pumping system
11. Energy saving green star appliances
12. Use of local natural resources for daily domestic purposes.

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Thus by implementation of these 12points, the conventional home can save up to 30% to 40% of energy and water and also can be converted into a better place for living than before.

IV. CONCLUSION

This paper study reported all the technical and also the economic aspects related to green buildings worldwide. Also, through this live case study of a small residential bungalow in a small town of India it is expected to attract at least the researchers all over the world especially in India and also to all the readers towards planning of their new homes or retrofitting their old ones by simple modifications and converting it into a green or a sustainable building for future long term savings (economic aspects) and also for saving our environment (environmental aspects).also the conventional case study will help researchers to study about the green elements which can be implemented on a conventional home. The conclusion for the studies can be classified into three different categories i.e. definitions and scope of green building, benefits and costs of green building and ways to achieve green building. It has been observed that in most of the literature reviews, the focuses are on environmental aspects of sustainability such as energy consumption, water efficiency and greenhouse gas emissions and also with their technical solutions. Also, the life cycle assessment approach, which is extensively applied in the environmental aspects of green building can be a useful tool for social sustainability. New rating tools are developing rapidly worldwide. But more studies in these fields are required to support these new rating tools and also help in assisting the decision-making for the investors and the developers. Also, awareness amongst the people should be spread about the green building concepts and its long term profits.

V. FUTURE SCOPE

Current scenario is that people in countries like India are ignorant about this concept and also lack of awareness can be observed. Government initiative will help largely in spreading awareness. Also, provisions of educating and training people or the occupants will help to regulate their behavior of using the green building which may affect the building performance significantly. The discussion on cost and benefits of the green building are quite noticeable. It is also worth noticing that all the leading green building assessment tools are designed according to their local climatic and geographic conditions. Thus to set benchmarks for the world with references to green building, this point needs to be taken into considerations when comparing the effectiveness of these green building rating tools. The case study considered into this research paper is specially selected, designed, and constructed keeping in mind the green building concepts and its necessity to the environment and also to our pockets in the long term considerations. Also, this case study will help in studying awareness about the green building concepts amongst the people of towns and villages of India and help them develop their own green home and promote them to after building it. It is important to spread awareness amongst the people of the villages and towns in a country like India as the majority population of India lives in villages and towns and not in cities. Also, special population such as aged people, students, and teachers could be paid more attention. Aged people tend to be more vulnerable to the overheating and the indoor environmental quality. Students will become practitioners in the future, also leaders in various sectors. Teachers play a critical role to shape the attitude and behavior of students towards the sustainability related issues such as the matter of using buildings.

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Thus, the above mentioned issues serve as items of future agenda for green building related research and also promoting amount of green and sustainable development.

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