Planning Approach with "Better Than Before" Concept: A Case Study of Library Building at SVNIT, Surat, Gujarat, India

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Abstract Across the different parts of the world, the concept of green building is catching the attention of the architects, urban and town planners, engineers and even ordinary people. According to the experts, high-performance green buildings are the ones that benefit the environment as well as human beings by minimum waste generation at all the stages of its life cycle while being cost-effective, sustainable and providing comfort to the humans. This paper explains the planning of the new library building at Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat. SVNIT, Surat, is located in Surat city that has the tropical savanna climate, moderated actively by the Sea to the Gulf of Cambay. This is the first building of the institute that was planned and constructed by following the Green Rating for Integrated Habitat Assessment (GRIHA) guidelines to obtain a minimum of three stars. Various parameters such as planning parameters, building material parameters and building envelope were all addressed during its planning process. All the building planning principles, viz. aspect, prospect, grouping, roominess, ventilation, lighting, sanitation, etc., were considered while planning the building. This paper delineates the step-by-step process of planning a library of the national institute in Indian conditions to obtain high performance in the future. Also, the new library is compared with the old library that was built in 1961. The new library building is an example of a green and sustainable building. Its usage in designing library and learning spaces leads to limited yet significant literature on the design of green libraries is based on GRIHA guidelines.

Keywords Green building · Library · Planning · GRIHA rating system

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1 Introduction

The green building, as defined by American Society for Testing and Materials (ASTM) International (2001), is "A building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life". Furthermore, "A green building optimizes efficiencies in resource management and operational performance; and minimizes risks to human health and the environment".

Green Rating for Integrated Habitat Assessment (GRIHA) Green Building Rating System, conceived by "The Energy and Resources Institute" (TERI) and developed jointly by the Ministry of New and Renewable Energy, Government of India, is based on nationally accepted energy and environmental principles. Over 300 projects across India of varying scale and function are being built based on GRIHA guidelines [1]. Specifically, GRIHA focuses on the sustainability of projects after they are constructed by requiring ongoing reporting of performance factors as part of GRIHA recognition. GRIHA utilizes a 1–5 star rating system that focuses on energy/power consumption, water consumption, water generation and renewable energy integration [2].

The new central library at Sardar Vallabhbhai National Institute of Technology, Surat, was considered for case study. The parameters used in its planning and the data considered are elucidated in the "planning approach" section of the paper.

The Sardar Vallabhbhai National Institute of Technology, Surat (established in 1961), is one of the premier institutes of national importance and fully financed and controlled by the Government of India, New Delhi. It has experienced faculty and dynamic research scholars' team and office staff.

The planning of the new library building was done while considering the guidelines of GRIHA, India, to build the green building. By addressing the orientation of the building, daylight saving was achieved along with the reduced air-conditioning load. Furthermore, the excavated earth from the construction site was used to develop the landscape around to reduce the to and fro vehicle movement.

2 Need of Study

In the technologically outpaced world like today, more emphasis is laid on providing comfort to the users. Due to which more energy is consumed, more the consumption of energy more is the operation and maintenance cost that is borne by the users or the organization. Also, the resources used increase considerably contributing to uprising the carbon print and water print. All these are the contributing factors to global warming. In order to maintain and improve the climatic conditions, it thus becomes inevitable to reduce the consumption of resources. As more as 70% of buildings are there when looked upon the land use on the society level and 45% of

buildings when the city is considered. Moreover, a normal human living in an urban area spends almost 22 h in an indoor confined area. Thus, the planning approach plays an extremely vital role to use optimum resources along with providing comfort to the users.

3 Study Area

Surat, situated on the banks of river Tapi and the coast of the Arabian Sea, is in the Gujarat state of India. It is a high ranking industrial city of the country with a strong network of roads and flyovers. The campus of SVNIT, Surat, is located within the South West Zone of Surat city. The institute was initially established as Regional Engineering College (REC) in 1961 and was upgraded as a National Institute of Technology (NIT) with the status of "Deemed University" in 2002. The new library was constructed in recent years with full advanced facilities and green concept. The map of Surat city and the master plan of SVNIT, Surat, are shown in Figs. 1 and 2, respectively.

The library has been understood as, "A built-environment that ensures efficiency in the utilization of site through compact planning and conservation of land as a natural

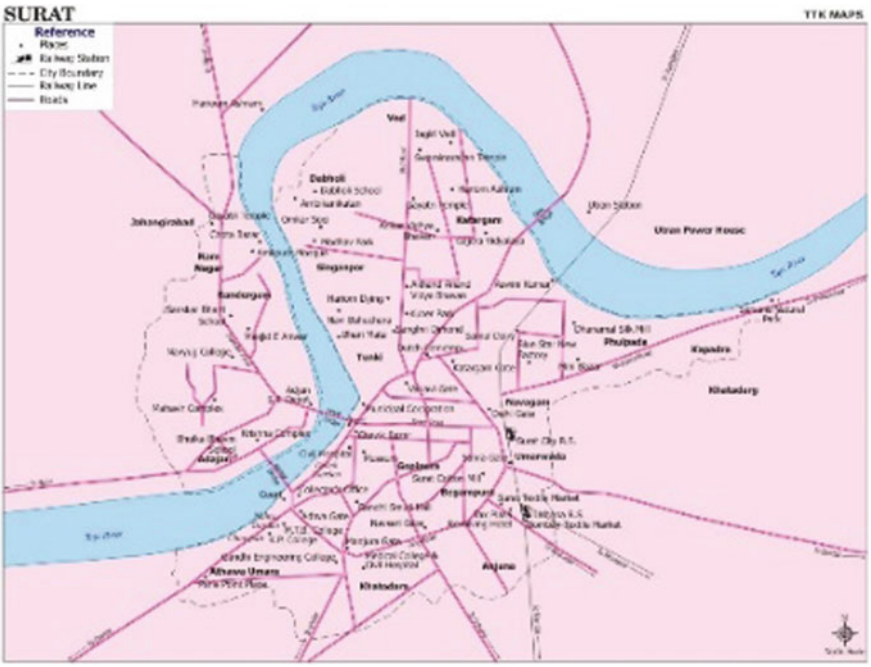

Fig. 1 Map of Surat

Fig. 2 Master plan of SVNIT, Surat

resource; thus creating an environment that inculcates the spirit of learning embedded in its space planning and architecture". It can also be defined as, "A timeless space that respects and dwells with biodiversity and sustainability as a lifestyle rather than an imposition, by inherent design gestures encouraging conducive microclimate through daylight utilization". Sidney Sheldon perfectly describes: "Libraries store the energy that fuels the imagination. They open up windows to the world and inspire us to explore and achieve, and contribute to improving our quality of life".

4 Objective

The objective of this research paper is to study the planning approach of the new library building with better than before concept.

5 Scope of Study

The scope of the study was limited to the new library building, SVNIT, Surat, and GRIHA guidelines.

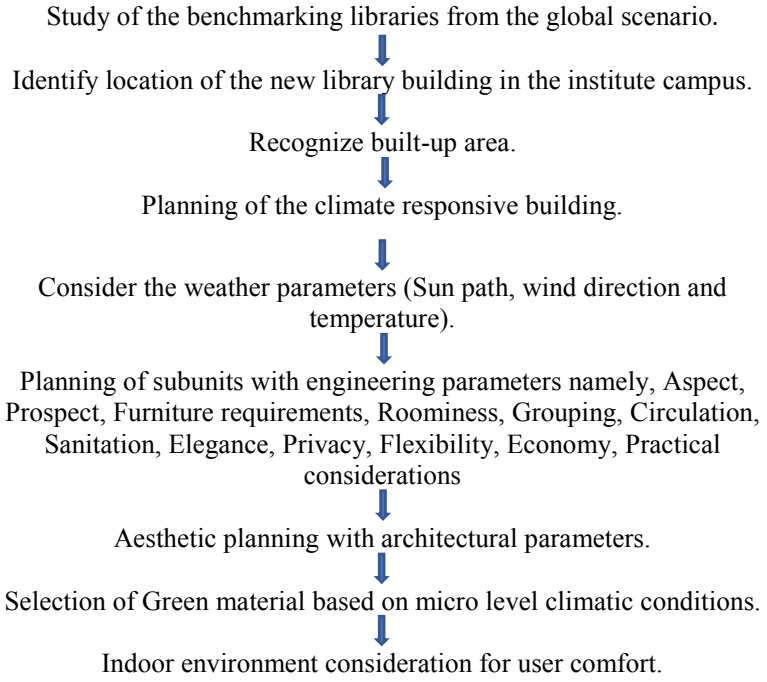

Fig. 3 Methodology flowchart

6 Methodology

The methodology for planning the green building with "Better than Before" approach is as described in Fig. 3. The flowchart shows the step-by-step procedure of planning that can be implemented to plan any type of building.

7 Planning Approach

The planning approach plays a vital role in getting the desired outcome [3]. The "Better than Before" planning approach aims at planning the building so that it has high efficiency and sustainability. By incorporating the climatic conditions and following the GRIHA guidelines, the planning can be done in much better way as compared to that in the past where only a few considerations were there pertaining to the sustainability and environment. The following steps elucidate the planning of the new library building at SVNIT, Surat.

Fig. 4 Exterior view of the Philip Exeter Library, USA

7.1 Learning from the Benchmarks

To plan the library with all the optimization, four benchmark libraries were studied. They are Philip Exeter Library at New Hampshire, United States of America (USA); London School of Economics and Political Science (LSE) Library at London, United Kingdom (UK); Delft University of Technology (TU Delft) Library at Delft, Netherlands; and Parliament Library at New Delhi, India, all of which are shown in Figs. 4, 5, 6 and 7, respectively. The best output is obtained when one considers the positives from the legends. To plan the new library building at SVNIT, Surat, the inspiration was taken from the benchmark libraries of the world.

7.2 Design Data for New Library Building

According to the Indian Standard (IS 1553: 1989), space required per reader is 2.33 m^2. While planning, it was estimated that there will be 1000 readers present at a time. Also, during the examination period, reading room is open 24 $\times$ 7, and hence, it was so planned to have almost 200–230 students at a time. The design had to include separate reading area for newspapers, magazines and books. Along with there had to be the provision of the digitization section in the digital library.

Fig. 5 LSE Library, London, UK

Fig. 6 TU Delft Library, Netherlands

7.3 Selecting the Most Appropriate Building Form

The building form selected for the new library building was square form. Square is the most primary geometry to grow out of the conditions of orthogonality. Each

Fig. 7 Parliament Library, New Delhi

square is related to the previous one by a factor of 2. Square is rationally symmetrical in four positions about the centre. Also, there are number of benefits for the square form as stated in the Hindu Mythology. Furthermore, when central open to sky is provided in the square form of building, the light is dispersed equally in all directions. Figure 8a shows the compositions that illustrate reflective and rotational symmetries within the squares, and Fig. 8 b shows the comparison of the square and rectangular building form.

The square shape represents "unmanifested energy" as per Vaastu sciences of Hindu Mythology. It creates energy source of positive nature. As square shape has four straight lines, which are equal in size, Vaastu believes it to be the "most perfect shape that is sacred and balanced in nature".

Shape of the building is one of the major factors that plays vital role in green building analysis. Analysis of building shape can be done by various stimulatory models and manual methods. One of the methods is as follows:

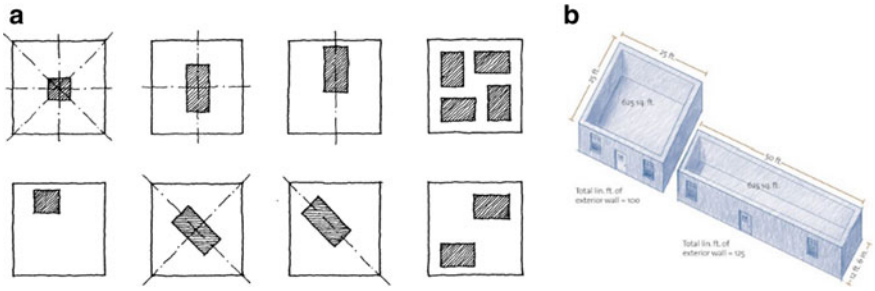

Fig. 8 **a** Compositions illustrate reflective and rotational symmetries within the squares. **b** Comparison of the square and rectangular building form

Shape Coefficient

$$C_f = \frac{S_e}{V}(m^2/m^3) \tag{1}$$

where S_e is the envelope surface area, and V is the inner volume of the building.

For library building,

Sides = 54.8 m.

Height = 48 m.

For library building,

$$\begin{aligned} C_f &= \{4(54.8 \times 48)\}/(54.8 \times 54.8 \times 48). \\ &= 0.076. \\ &\approx 7.6\% \end{aligned}$$

The result obtained by using the Eq. (1) shows that the shape is efficient energy responsive envelope. As there are number of benefits, square shape was chosen to plan the library.

7.4 Location of the New Library Building with Respect to the Campus

The planners must address the site location to create minimum disturbance to the existing surroundings including trees. The plot of the new library building was selected so that it is almost in the centre of the academic buildings and the hostels of the students, which would provide ease to the students (Fig. 9). Also, this location has the minimum external noises.

7.5 Location of the Built-Up Area

It can be seen in Fig. 10 that a particular portion of the selected site was chosen so that the maximum number of already existing trees can be saved and minimum harm is caused to nature. This location, along with benefiting the environment, also benefits in reducing the trip length and time that benefits the students. Also, following the criteria 2 and 3 of GRIHA manual [4], the excavated soil was reused to form contours and for landscaping in the site premises.

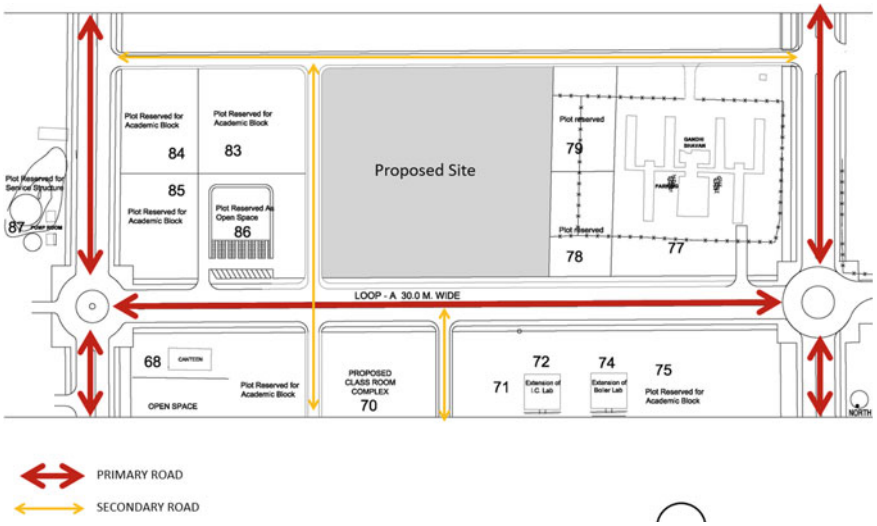

Fig. 9 Identification of the location for the library in the campus

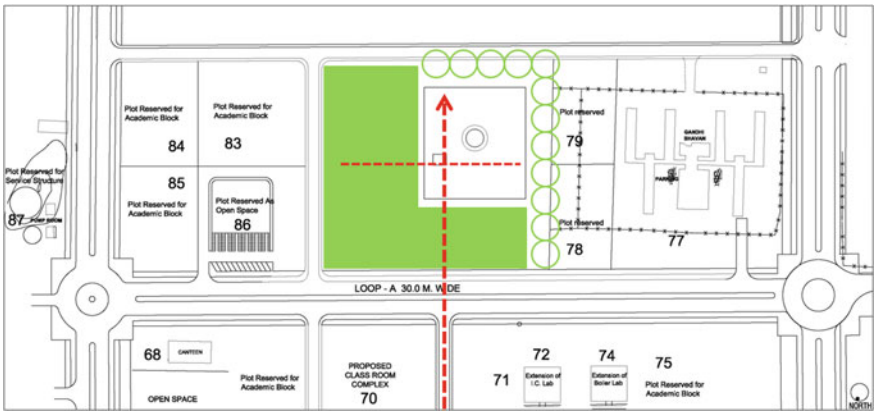

Fig. 10 Location of the built-up area

7.6 Climatic Considerations

To provide comfort to the users, it is inevitable to plan the building as per the climate. Surat has a tropical savanna climate, moderated strongly by the Sea to the Gulf of Cambay. The summer begins in early March. April and May are the hottest months, the average maximum temperature being 37 °C (99 °F). Monsoon begins in late June, and the city receives about 1,200 mm (47 inches) of rain by the end of September, with the average maximum being 32 °C (90 °F) during those months. Winter starts in

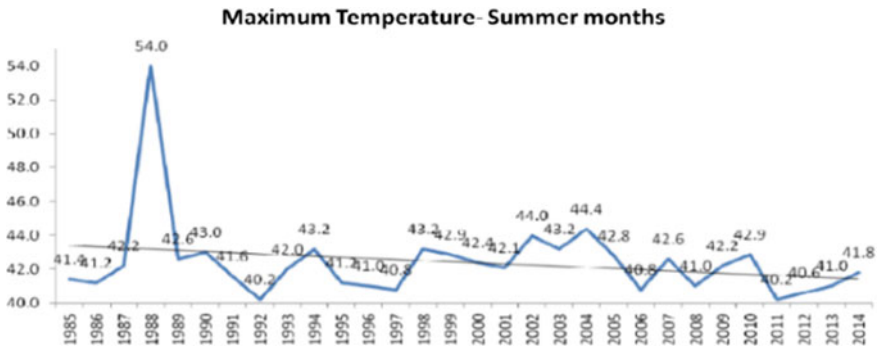

Fig. 11 Summer temperature (1985–2014)

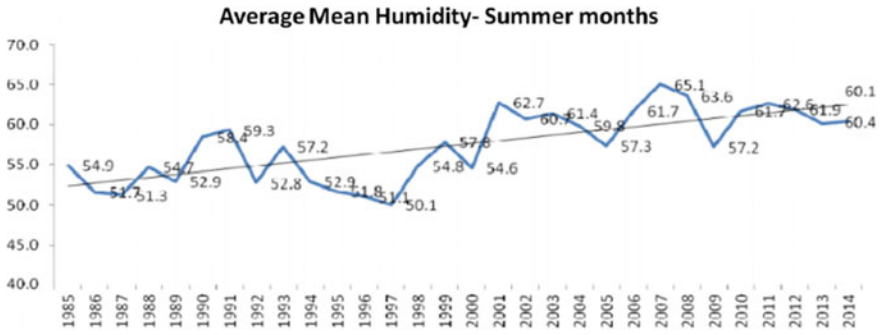

Fig. 12 Summer humidity (1985–2014

December and ends in late February, with average mean temperatures of around 23 °C (73 °F) and negligible rain [5]. The following figures depict the summer temperature and humidity from 1985–2014, respectively, in Figs. 11 and 12.

Figures 13 and 14 show the sun path and the wind direction of the library building. These play extremely important role while planning the location of the sub-units, windows, materials to be used, etc.

7.7 Strategies to Design Green Building

In order to plan the energy-efficient building, various points must be addressed along with considering the climatic conditions in the area, firstly, to reduce the amount of heat reaching the building by providing shading at proper locations through projections or by plantation [6]. Also, for this, the shades when planned considering the orientation play a vital role. Secondly, to control the heat absorption through walls and roof, the choice of materials used to build walls and roof plays a significant

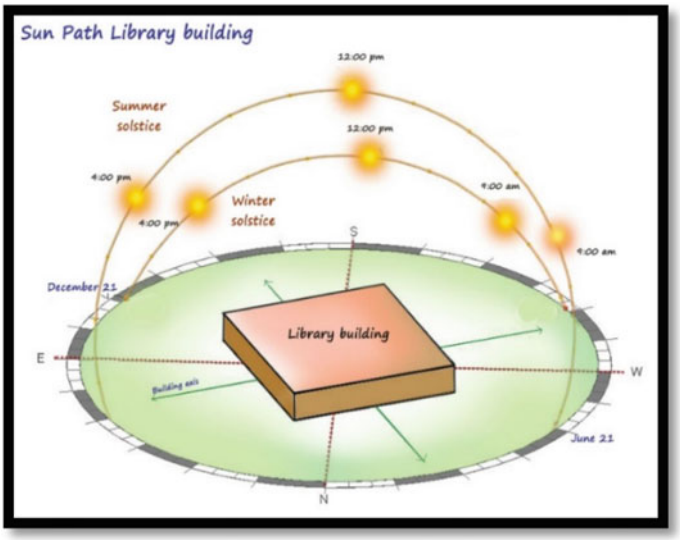

Fig. 13 Sun path of library building

Fig. 14 Wind flow

role to keep embodied energy low [6]. Add-on insulation should be judiciously used. Furthermore, heat gain can be controlled by using roof finishes with high solar reflective index or by shading the roof. Thirdly, to minimize the internal heat gain and improve the daylight, for this, the fixtures and appliances with low equipment power density [6] and with efficient Bureau of Energy Efficiency (BEE) rating should be used and by efficient planning of the artificial lighting, and lastly, to cool the building by using low-energy heating, ventilation and air-conditioning (HVAC) technologies. All the stated four strategies were considered while planning the new library building.

7.8 Floor-Wise Building Unit Planning

The planning was done while addressing various building principles, viz aspect, prospect, furniture requirements, roominess, grouping, circulation, sanitation, elegance, privacy, flexibility, economy and practical considerations [7]. The orientations of the building and sun path were considered while addressing the placement of service blocks, reading rooms, etc. Services such as toilet blocks and chiller plant are provided on the south side of the building (Fig. 15).

To utilize the daylight to its maximum, provision of dome skylight is provided. The daylight from the dome skylight is dispersed on all the floors equally as there is an open to sky (OTS) in the centre of the library as shown in Figs. 16, 17 and 18. The provision of OTS not only helps in getting the natural light, but also helps in creating oneness among different floors. Furthermore, three stair cases are provided for the easy vertical circulation and safety purposes.

The reading space and services are provided on all the floors. The first floor has the waiting area, cabins for the library and admin staff, space for procurement and cataloguing, book bank, conference room, faculty reading lounge and a separate girls reading room. The second floor has the waiting space, special book area, reprography, book binding space, issue counter, stack area and circulation. The third floor has the server room, digital library, discussion room and separate reading space for research scholars. The stacks were separated for text books, reference books, book bank and dissertation/ thesis, out of which the latter two do not have open access. The area and activity distribution are shown in the Figs. 19 and 20.

7.9 Planning of the Building Envelope

In the south direction where there is provision of services, wall is provided, whereas in the other three directions, glasses are used to separate the outer environment from the inside of the library (Fig. 21). It was so planned so as to utilize maximum daylight. As only the light is required, not the heat, fringe vertical blind curtains are provided to avoid the glare and heat that can be operated manually making it a smart building. The other purpose of the glass walls is that one can get the vision of outside. The roof

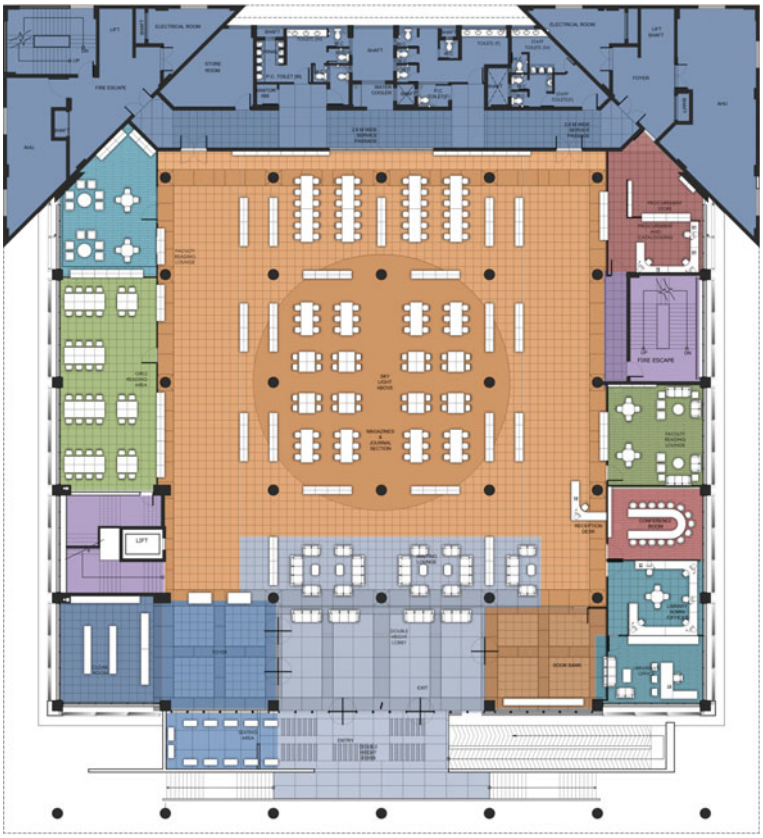

Fig. 15 Plan of the first floor

is exposed to the direct heat of the sun which results in heat gain. To prevent this, the solar panels are installed on the terrace, which serves the purpose of utilizing the renewable source of energy along keeping the roof cool (Fig. 22).

7.10 Selection of the Building Materials

It is very important to select the proper material for building as it adds on to the durability, heat gain and transfer and capital. The wall in the south direction is made of autoclaved aerated concrete (AAC) bricks. In contrast to this, the old library building had traditional red brick walls which were heavy and costly. Use of the AAC blocks also nullifies the need to paint the wall. The glass used to create the glass wall in other three directions is such that it prevents the glare and heat of sun.

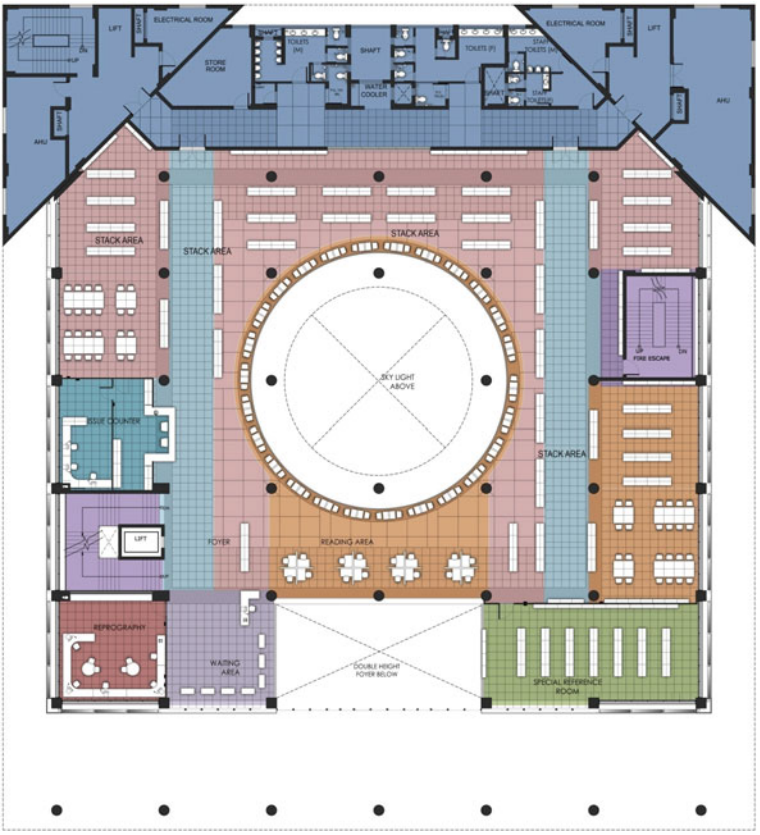

Fig. 16 Plan of the second floor

The criteria 17 of the GRIHA guidelines [4] encourages to utilize low-energy materials or products to a minimum of 70% of the total quantity of all interior finishes. When looked upon the material used for flooring, rubber was selected to minimize the noise level and provide maximum silence to the readers. Also, it should be noted that as there will be more movement and noise in the service block, the wall in the south direction has the sound absorbents in it. The indoor noise levels, thermal comfort requirements and artificial lighting lux level are within the acceptable limits as specified in National Building Code (NBC) 2005. It meets the minimum requirements of Central Pollution Control Board (CPCB) and National Ambient Air Quality Standard (NAAQS) for the quality of fresh air [8, 9]. Facilities as per Harmonized Guidelines and space standards for the barrier-free built environment for the disabled and elderly people for public buildings provided.

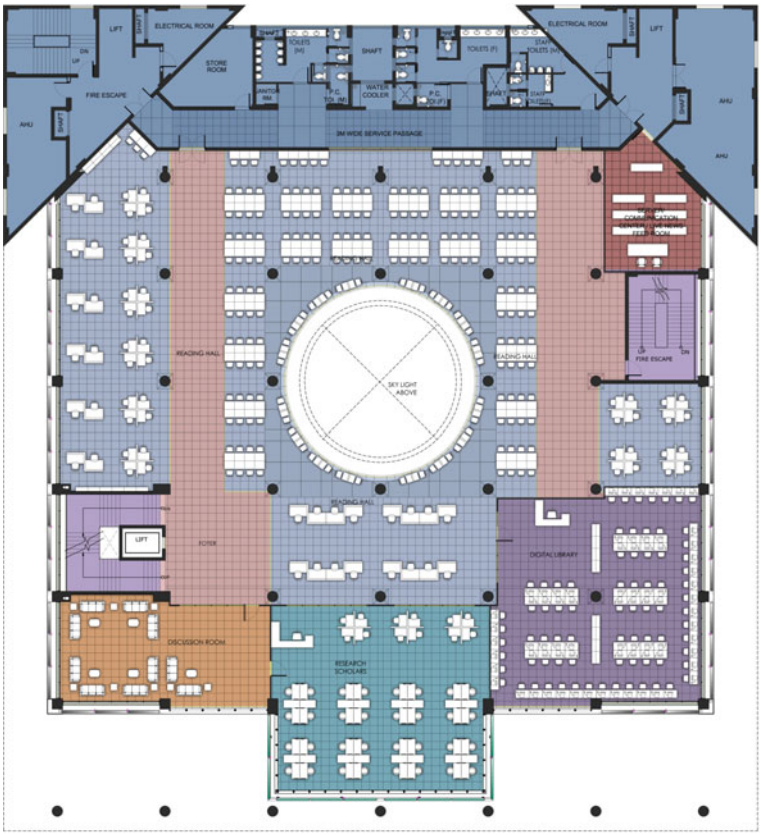

Fig. 17 Plan of the third floor

7.11 Energy-Efficient Building

To design the energy-efficient building, the glass walls, dome skylight and solar panels play a vital role. The use of artificial lights considerably reduces because of the glass walls and the dome skylight, meeting the requirement of useful daylight illuminance (UDI) for 90% of the potential daylight time in a year.

To add on to the efficiency of the building, 1000 KW capacity solar panels are installed on the terrace of the building (Fig. 22) that helps in producing enough electric energy to run the appliances in the building. According to the criteria 6 of the GRIHA manual [4], at least 25% of the total number or 15% of the total connected load of outdoor lighting fixtures (whichever is higher) should be powered by the solar energy. The installed solar panels efficiently fulfils criteria 6 and 18 of lighting and the use of renewable resources, respectively. This provision also helps in keeping the roof cool by absorbing less heat of the sun where the area of the terrace is covered

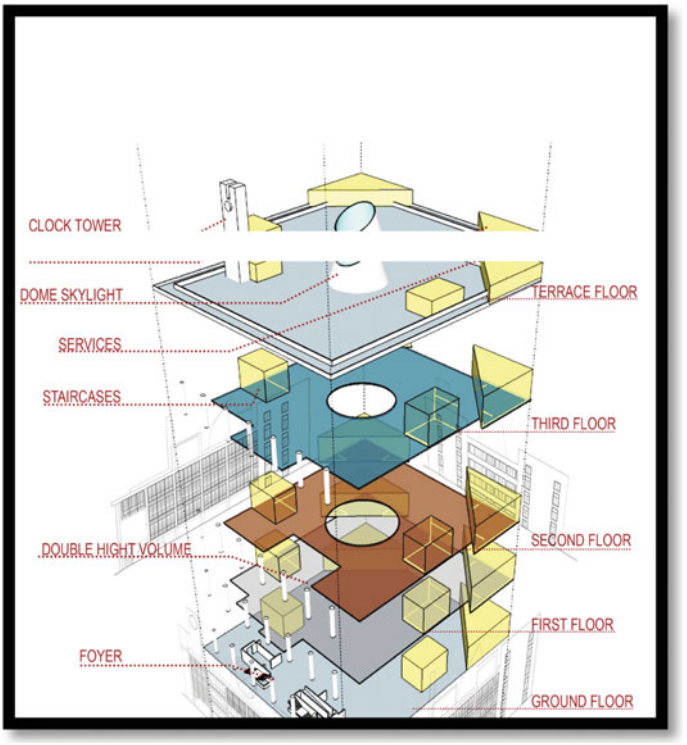

Fig. 18 Square form of library building with all layers

Fig. 19 Area distribution

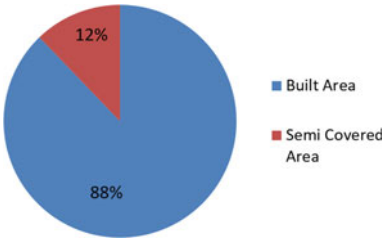

Fig. 20 Activity distribution

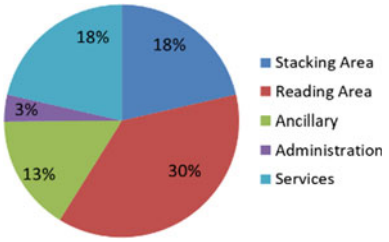

Fig. 21 Use of glass

Fig. 22 Installation of solar panels on the terrace

with the solar panels. The institute also has the tie-up with Gujarat Electric Board (GEB). This helps in switching to the power source when required.

Furthermore, design includes the provision of the rain water harvesting. There is an underground tank where the water from the roof top is collected. This water is utilized for flushing, washing and irrigation purpose.

7.12 Outcome

Addressing all the criteria of the GRIHA manual, the outcome of the detailed planning process was the energy-efficient and high-performance green building as shown in Figs. 23 and 24.

The total site area of the library building is 18,286 sq. m. which includes library building, pumping station, green spaces and parking space. The distance of library building from the main gate of campus is around 607.5 m. The built-up area of the library building is 11,115 sq. m. including parking, three floors and a terrace facing north-west direction.

The old central library of SVNIT, Surat, was planned with the traditional methods in 1960s. Previously, the planning parameters lacked the inclusion of the green and sustainable building concept. However, with the advancement in the technology

Fig. 23 Front and side view of the library

Fig. 24 Interior of the library

and developments in the field of construction industry, the materials used for the construction, the parameters considered for the planning, the consideration of the environment, etc., factors that make the building green and sustainable are now considered meticulously. Looking at the case study, it can be seen that the care is taken to preserve the environment and produce minimal waste throughout the life cycle of the building. This justifies that the Better than Before concept of planning is crucial and helpful not only for the humans but also for the environment.

8 Conclusion

The planning of the building has been done with special considerations for the performance of the building envelope in terms of window to wall ratio, window to floor ratio as well as daylighting and ventilation, to achieve better results in the indoor air quality and performance of the overall building. The building envelope performance has been met by analysing the site and locational aspects of the building at proposal stage and pre-design stage to achieve the optimum space and location for the building to be placed in such a manner that the orientation, internal space allocations, design of the building, etc., are done by ensuring minimum effect on the existing green cover spaces around the building plot. The pathways along the buildings are also designed

to limit the effect of construction to minimum, thus reducing the felling of trees on site.

As the building was planned, keeping in mind to achieve minimum 3 star GRIHA rating, the planning and design aspects of the building were chosen accordingly. The shape of the building was prepared in such a way that equal daylighting and ventilation were received on all parts of the building, thus creating a "symmetrical and balanced" condition for the building envelope. The built-up area of the library building is 11.115 m^2, where around 1000 readers can be occupied in the reading room at a time.

This building demonstrates the example of a "user-centric" green building, which adapts and provides for the students based on their activities and enables the students to achieve a prosperous, peace and calm place to study and grow for their future. This building is considered as a pilot project for the institute. Looking at the innumerable benefits of the green building, planning and construction of such buildings should be encouraged at the corporate level.

Looking at the proven benefits of constructing such green buildings, if more such smart buildings are built, then it will help in conserving the environment along with providing comfort to the users which is the need of the hour.

This study is the part of an ongoing research project. When the planning phase of the building was ongoing, GRIHA guidelines were to be followed as per the government guidelines. However, now there are separate guidelines of CPWD that are to be followed for the planning and construction of the new buildings.

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