International Journal of Advanced Research Methodology in Engineering & Technology, ISSN 2456 6446
Volume 1, Issue 3, May 2017

Renovation of an existing building to sustainable barrier-free building

Ajish Ajoel Abraham
University Grants Commission
Karunya University
Coimbatore, India
ajoel95@gmail.com

J. Brema
University Grants Commission
Karunya University
Coimbatore, India
brema@karunya.edu

Abstract - *The world is at the verge of sustainable changes where building and construction holds 40% of overall global carbon emissions. Looking into the future almost all the buildings will be sustainable so the research is to find different methods, techniques and engineering ways to renovate existing hospital building to a sustainable barrier free building. Solutions have been found out to solve human problems related to shelter, water, health care and energy, where water is addressed by involving rainwater harvesting, healthcare to be addressed by improving Indoor Environment Quality and changing the materials to reduce the carbon dioxide emission by changing bricks, paints and involving barrier free solutions like adding ramp, grab bars, lift, etc., all are added to provide accessibility to the disabled/ all aged people, energy is addressed by changing from on grid to off grid by adding solar panel, inverters, battery and changing the necessary lighting systems, for example: changing 60 W tube light to led bulb and adding sensors that sense motion in order to understand the presence of the individual and switching it off in the absence of the occupants, automatic revolving doors to maintain the air pressure and adding air curtain and necessary changes in the building to support all these changes. The existing building was surveyed using total station and plotted in AUTOCAD and the existing plan is added to the building model which is created in AUTODESK REVIT (BIM software). Three models are created apart from existing building model which are: 1) Barrier free building, 2) Sustainable building and 3) Sustainable barrier free building. It is then analyzed using STAAD PRO V8i and estimated using manual estimation methods. The building is engineered in different ways so as to follow the solar path orientation, Indoor Environment Quality and heat gain and loss is also checked using ANSYS (CFD). The existing hospital can be readily renovated based on the model and the calculations generated.*

Keywords—Sustainable, barrier free, STEAM, AutoCAD, Autodesk REVIT, STAAD PRO V8i, ANSYS (CFD)

1. INTRODUCTION

Sustainable barrier-free building is an eco-friendly as well as 'old aged people' friendly building which provides above 40% reduction in annual electricity for the same amount of electricity used. It also emits less or no GHG than conventional building, making it safer and healthier option. These are through features such as cisterns, solar tops, inverter, battery, led lamps, wider, open glazing for natural lighting , common centralization for effective cooling than individual fans, etc. The barrier-free nature makes it easily accessed by elderly people through features such as ramps, slippery less tiles in bathroom, wide doors for wheel chair entrance, proper drainage for lesser water sagging, grab bars in bathroom, etc.

1.1 Aim and objectives

The main aim of the research is to effectively implement sustainable and barrier free design facilities in the existing building so the building is environmental friendly as well as improving accessibility for the disabled and old aged people.

To achieve this aim of the research following objectives were developed:

i. To turn the Type-2 institutional building also known as hospitals into SUSTAINABLE BARRIER-FREE institutional building according to the IBC 2003 Section 308.
ii. To model and design the existing building, green building remodeled, and barrier free remodeled and both combined.
iii. To plan and schedule the project
iv. To estimate the existing building, green building remodeled, barrier free remodeled and both combined.

2. GREEN BUILDING

Sustainable or green building construction aims to embody the principals of sustainable development i.e. environmental protection, economic development, and social development, in the siting, design, building, maintenance and occupation of buildings.

Sustainable buildings are designed and constructed to high environmental standards and thereby; minimize energy requirements, reduce water consumption, use materials which are of low environmental impact e.g. low embodied energy and resource efficient, reduce wastage, conserve / enhance the natural environment and safeguard human health and wellbeing.

3. BARRIER FREE BUILDING

A barrier-free building helps the people with physical or other disabilities, involving the provision of alternative means of access to steps (e.g. ramps and lifts (elevators) for those with

mobility problems). It is also called universal or barrier-free design.

4. METHODOLOGY

Initial stage of the research is to review and understand the subject of the research which is the sustainable barrier free design facilities. Then it is followed by formulation of the study aim and objectives. Then the next stage of study focused on the literature review. This stage also includes the legislation and challenges in providing facilities for an eco-friendly and a barrier free building.

The next stage of the study is data collection and data analysis. Data was collected through questionnaire survey which held through phone calls, emails and distributed during two weeks field survey. The questions asked were

i. The current level of each floor is appreciable?
ii. Would few ramp additions to the current building be necessary?
iii. How about the addition of Handrails along the ramp, and hand rail at the necessary platforms such as bathrooms, rooms etc.?
iv. Non slippery floor would be required in bathroom, as well as on the current slippery floors?
v. Different route for accessing the other floor to reduce conjunction as well as to ease accessibility?
vi. Adding lifts to the structure for wheelchairs, bed-on-wheels?
vii. To ease the movement, new sensors or technologies is required?
viii. Comfortable seating space required at many places?
ix. Drinking fountain or easily accessible water platform?
x. Brighter LED energy saving light to illuminate the building?
xi. Would few more signboards and signboard that should be easily visible and readable to new/old patients needed?
xii. Is Better Parking spaces needed so as to have an entrance for emergency separate as well as the normal entry?
xiii. Location of the hospital wards and rooms is better arranged?
xiv. To support digital India movement, new payment facility required such as paytm required?
xv. How much more care should be given to aged people in terms of structural and safety factors?

The next stage was studying the area; the building is an existing hospital at Karunya Nagar in Coimbatore. This is a 30+ bed hospital. The average outpatient number is about 150 per day. The building has laboratory with semi-automatic analysers {for a wide variety of tests}, x - rays and ultrasound examinations require more energy than other residential buildings.

Then the next stage was collection of data. As per the primary report prepared through surveying the plot and comparing the blueprint, the building seems to have the exact exterior wall markings executed. With 34 beds and an average of 150 outpatients daily is calculated. Being a hospital, the ages of the patients vary from 0yrs to 90yrs. The building consists of two buildings. One being the Karunya Rural Community Hospital and the next being the Pain Relief Centre. The area of KRCH is 1340.51m2 with its perimeter from 227.131m and the Pain Relief Centre having the area of 515.278m2 and perimeter of 105.741m. The energy consumption list also have been received .for the past one year. With an average unit of 8136.166 pm with the cost around Rs. 90994.11 pm with Rs 11.18 per unit.

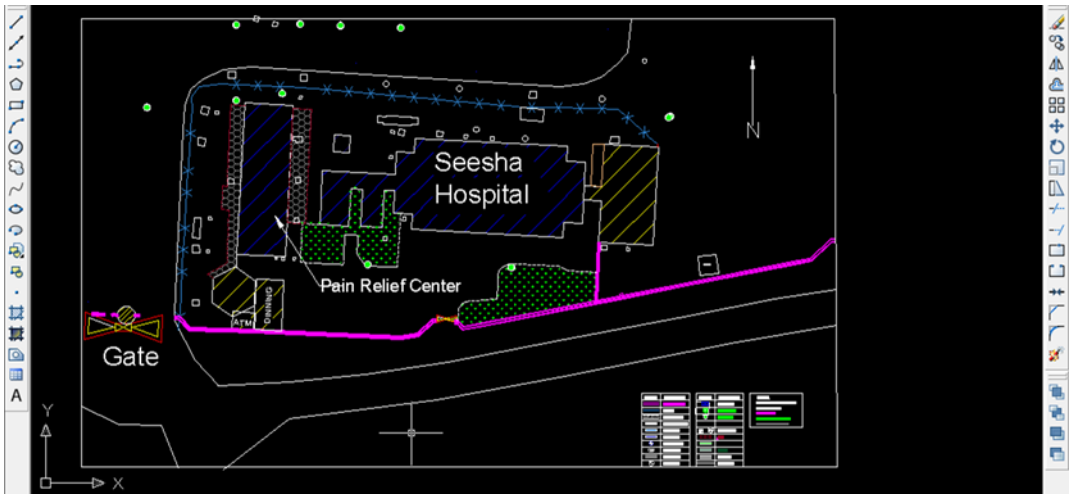
Month	Board	Building	Read start	Read end	Count	Cost	Sum(EB+Genset)
May	EB	KRCH	218507	230544	12037	120370	122155
	Genset		623	728	105	1785	
June	EB	KRCH	231227	236932	5705	57050	68661
	Genset		1524	2207	683	11611	
July	EB	KRCH	237802	246490	8688	86880	87458
	Genset		2207	2241	34	578	
August	EB	KRCH	247420	257133	9713	99440	100074
	Genset		2274	2336	62	634	
September	EB	KRCH	260133	272166	12033	120330	122115
	Genset		2445	2505	105	1785	
October	EB	KRCH	274557	285675	11118	111180	112148
	Genset		2602	2689	87	968	

The method followed is STEAM rule., where S stands for science that deals with Environmental science impact on building, Thermal conductivity in building materials; then T stands for technology that has BIM modelling, renewable energy system; next, E stands for engineering that deals with the structural engineering principles, green building practices; then A for Architecture that deals with form, colour, texture, aesthetics of the building, architectural styling; and at last M that stands for math that includes Math of solar orientation, Algebra of building design, Geometry of buildings and trigonometry of ramps.

Then the building was plotted using total station and then to compare it with the blueprint of the building as the building is older than 20yrs. And blueprint to the existing building built can defer. The points are plotted using AutoCAD and a model of the existing building is made.

Sl No	BS	FS	N	E	Z		Inst Height		
Pt 1	-	-	0	0	100		1.52m		
Pt 2	1	-	8.062	2.405	99.78		"		
pt 3		1	19.124	2.773	99.819		"		
pt 4		2	10.582	8.222	99.854		"		
pt 5		3	11.897	10.358	99.892		"		
pt 6		4	8.047	12.585	99.898		"		
pt 7		5	6.59	10.687	99.89		"		
pt 8		6	2.543	13.249	99.978		"		
pt 9		7	0.236	14.655	99.977		"		
pt 10		8	-13.982	23.722	99.864		"		
pt 11	(BS for pt 14)	9	20.428	-4.552	99.755		"		
pt 12		10	27.024	-8.867	99.831		"		
PT 13	-	-	0	0	100		"		
PT 14	2		2.758	6.782	100.127		"		
pt 15		1	4.262	14.502	100.106		"		
pt 16		2	11.731	-0.454	100.371		"		
pt 17		3	9.546	-11.794	100.35		"		
pt 18		4	5.945	-11.241	100.446		"		
pt 19		5	5.394	-14.104	100.443		"		
pt 20		6	3.111	-13.712	100.398		"		
pt 21		7	-1.693	-37.356	100.143		"		

Fig No. 1 Detailed plan



The building has to be loaded and be altered to suit the barrier-free regulations and a model is prepared along with estimation. And another model is prepared by choosing all renewable materials and changing the window size for more light entrance, using sensors that control the light and systems that use less energy, replacing old light sources with led bulbs and strips, using Photovoltaic cells that consume solar radiation in running the building and so as to use renewable energy sources, sustainable building model is prepared and estimated. And the combined model of both sustainable and barrier free model is prepared along with an estimation. The building is analysed using different software such as Staad Pro V8, Autodesk Revit and AutoCAD and its plugins.

Fig no 2. Placed columns and building wall as per the plan of the building

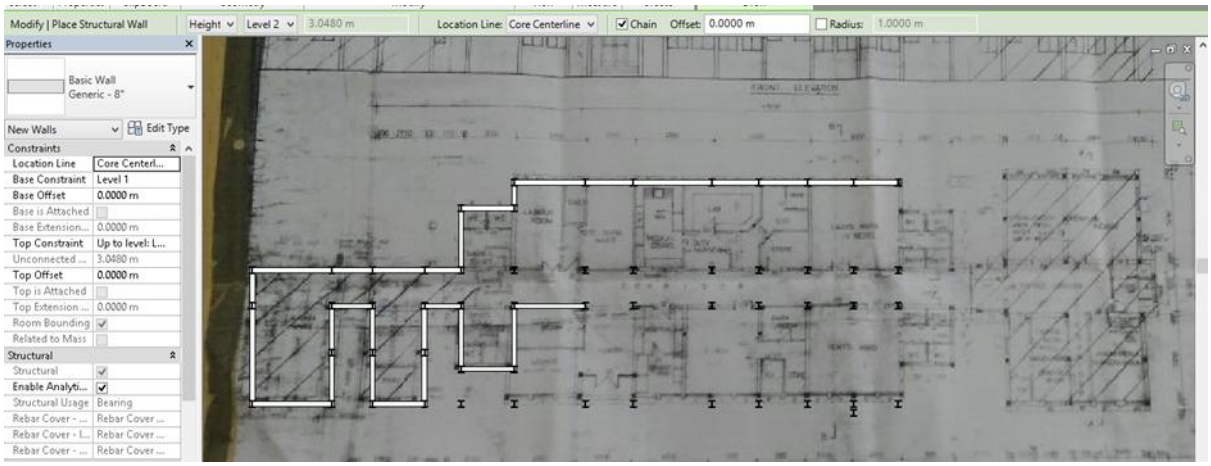


Fig No 3. Floor laid, thickness of the walls all set. Provided Supports and loads.

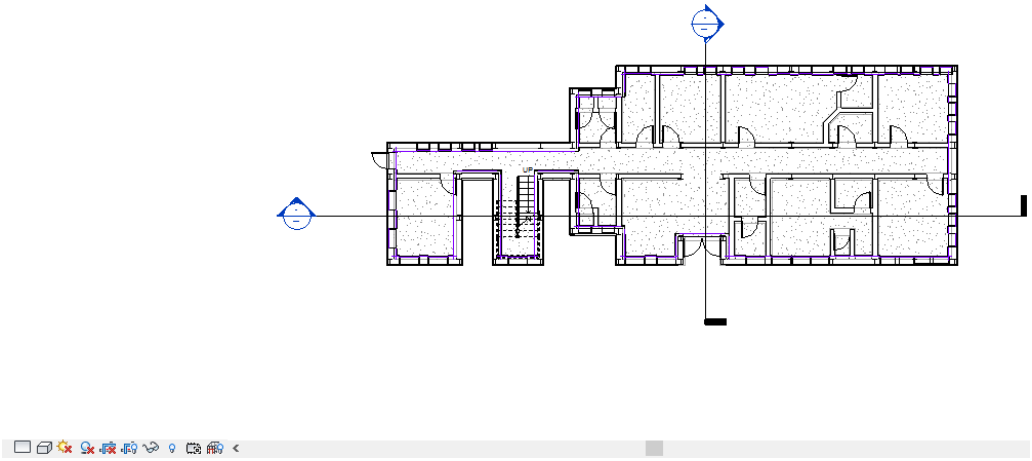


Fig No. 4 Regenerate of existing model

5. RESULTS

From the questionnaire survey it was concluded that

i. Approaches
ii. Change in level
iii. Ramps
iv. Kerb ramps at walkways and pedestrian crossing
v. Handrails/ Grab bars
vi. Floor surfaces
vii. Grading of slip resistance
viii. Accessible routes, corridor or paths
ix. Vertical Access
x. Control and Operating mechanisms
xi. Seating spaces
xii. Drinking fountain
xiii. Illumination
xiv. Symbols and signage
xv. Parking provision
xvi. Location
xvii. Accessible Vehicle Parking lots
xviii. Auto pay machine
xix. Ageing and safety

A model of the building is successfully prepared. Analysis is done so as to cover the area of redesigning the structure, architecture of the building by including necessary changes that produced a Sustainable Barrier-free building. The energy consumption is analysed using the plugins published by Autodesk so as to simulate the real life situations along with the direct solar orientation and lighting analysis. Using STAAD Pro v8, the load and structural analysis is done for accurate results.

Fig. No. 5 Regenerated model of renovated building

7. CONCLUSIONS

Hence it can be concluded by saying that many changes can be incorporated in an existing building to promote a green sustainable healthy innovation. By doing so, we not only promote sustainability but also we could run completely off-grid without burning any fossil fuel and still promote healthier lifestyle for the same amount of comfort that we need. Conversion of existing building to green building/ sustainable building could have initial higher cost but in the long run, the cost of maintenance and running could be as low as Rs 500 per month for whole hospital during peak month of a year.

8. ACKNOWLEDGEMENT

This study was supported by SEESHA Old Age Care home that runs the hospital. I am thankful to the organizers of the workshop on 'NET ZERO ENERGY BUILDING' conducted at IIT,Powai.

9. REFERENCES

1. "Green Building A to Z: Understanding the Language of Green Building" by Yudelson and Jerry
2. "The HOK Guidebook to Sustainable Design" by Mendler, Sandra F., Odell, William, Lazarus, Mary Ann
3. "Building Green: A Complete How-To Guide to Alternative Building Methods Earth Plaster" by Snell, Clarke and Callahan, Tim
4. "Fundamentals of Integrated Design for Sustainable Building" by Keeler, Marian and Burke and Bill
5. "Green design and assembly of buildings and systems" by Elma Durmisevic
6. Accessibility for the Disabled: A Design Manual for a Barrier Free Environment, SOLIDERE, 1998