Affordable Self Sustaining Housing in Developing Countries of Composite Climate Region: A Case Study in Afghanistan

C.P.Ramesh[1], Babitha Rani H[2], Maroof Abdull Bashir[3], Gautham Krishna[4]

Abstract- **Developing Countries are struggling with numerous problems and have comparatively more responsibilities & liabilities than a fully or partially developed Country. Affordable practices and approaches contribute drastically in cost efficiency and balance of a particular development. Construction being a major factor of a country's overall economy plays a vital role in the same, so affordable housing techniques shall be analyzed and practiced in the proposed thesis. Having the fact in mind that our world is running out of resources and energy and for a developing country to fulfill the same in all the sectors particularly in construction and housing is a heavy burden and hereby is advised to practice sustainability, so Affordable Houses which are self sustained is the main purpose of this thesis. This proposed project is basically concentrated on a case study which is located in Kabul, Afghanistan and is a typical residential dwelling and is a prototype design by the municipality of the country. A series of simulations on this particular structure using the IES-VE Software is performed and the acquired data are analyzed in order to be able to find out the most suitable housing design parameters in the region which eventually will contribute in Affordable and self sustained housing designs in developing countries of composite climate region. A survey has been conducted in the region in which certain facts contributing to the overall outcomes of the project have been evaluated and analyzed and consists data regarding the traditional Heating and Cooling Techniques, Energy and resource consumption and respective costs which contributed to the LCCA of this project. All the necessary data are collected, evaluated and analyzed and designs such as the rain water harvesting design and affordable and self sustained housing designs are optimized and proposed and recommendations for further developmental studies are suggested and the project is then concluded.**

INTRODUCTION TO AFFORDABLE HOUSING

Developing Countries are struggling with numerous problems and have comparatively more responsibilities & liabilities than a fully or partially developed Country. Affordable practices and approaches contribute drastically in cost efficiency and balance of a particular development. Construction being a major factor of a country's overall economy plays a vital role in the same, so affordable housing techniques shall be analyzed and practiced in such regions. Terminologically Affordable relates to keeping the balance of income and respective durational expenses or in other words the ability of one spending certain amount on a certain product or practice without compromising the ability to sustain in the future and when it comes to construction industry it relates to overall cost saving right from the commencement of the project to construction of the structure and operation period of the structure including maintenance and refurbishment.

INTRODUCTION TO SELF SUSTAINED HOUSING

Having the fact in mind that our world is running out of resources and energy and for a developing country to fulfill the same in all the sectors particularly in construction and housing is a heavy burden and hereby is advised to practice sustainability. Conventionally in order to live in a house and stay comfortable and protected, it is necessary to adopt certain practices such us keeping the house warm in the winters and cool in summers, Fulfill water demands, keeping the indoor air quality high and harmless disposal of wastes which eventually consumes huge amount of resources and non-renewable Energy which are not easily available at

low costs at all and have significant impacts on the planet earth and living things as well.

AIMS AND OBJECTIVES

The main Objective of this RESEARCH is to Combine Affordable Housing and self sustained housing and optimize the design for the most suitable type of housing in Developing Countries of composite climate region. Composite climate is the type of climate which is the hottest in summers and coldest in winters with varying humidity and precipitation, there has been efforts in the past to suggest practices for hot-dry climates and hot humid climates in details such us Tropical housing, but there are very less data available for the Composite type of climate. For succeeding the above some of the common objectives are outlined as below:
To accumulate and acquire the best suitable design and approach for a construction which is supposed to be Cost effective and affordable, Self sustaining, Environmentally friendly ,Energy efficient in composite climate, to collect optimum data necessary to achieve the above, to analyze, differentiate and select the best alternatives, to set Benchmarks for further developmental studies, To contribute in the Sustainable Development of the country, to achieve the most suitable practices for this project the followings shall be studied, analyzed and selected for affordable self sustaining housing in developing countries of composite climate region. Heating, Cooling, Energy, Lighting, Water Footprint, Waste Management system, LCCA (Life cycle Cost Assessment), Structural Analysis and Design ,Indoor Air Quality, Environmental Impact Assessment.

MERITS AND DEMERITS OF USING AFFORDABLE & SUSTAINABLE HOUSING, ECONOMICAL BENEFITS

Countries are economically weak and financial crisis has its huge impact on the region and for the communities to fulfill their basic needs is not less than a challenging task. In such a phase it is of utmost significance for a country to provide the nation with adequate shelter for residing at the minimum cost in a manner that none of the sides so called government and people endure huge expenses which would eventually become one of the major causes of GDP fall, so that is how an underdeveloped or developing country profits the most from Affordable housing and is most Applicable.

ENVIRONMENTAL BENEFITS

A developing country is mostly subjected to growing infrastructural activities and developments and it is of utmost importance to avoid environmental impacts and prevent resource degradation at the origin of the developments, so sustainability is a major need of such regions which will lead a country to an environmentally friendly development.

SOCIAL BENEFITS

Communities are the biggest stakeholders of a society and to full their needs regarding proper housing and sheltering is of a countries' liabilities and responsibilities to be taken care of by, in this manner countrymen assist their own development using social acceptance. Quality of life can be drastically improved in low income group of countries by using approaches as such.

GENERAL DIFFICULTY PERTAINING TO THE USE OF AFFORDABLE & SUSTAINABLE

In a country where almost half of the population live under the line of poverty and are living either in slums or rental properties, it is very challenging to be able to make them adapt to this event and approach directly as individuals, so the sole responsibility goes to the government which is also struggling with financial crisis and such a step of providing the communities with affordable and sustainable housing need a country itself to be able to afford the idea and respective investments which eventually leads to dependency to foreign investments and assistance and that is how one can see the general difficulty pertaining to the use of Affordable & Sustainable Housing.

LACK OF EXPERIENCE

When an ideology is uncommon in a region it is so obvious that the degree of expertise on that particular approach will be low, so for a country to adopt the same takes considerable efforts and hard work to develop capacities in the field and acquire expertise.

Since there is lack of experience one might tend to seek assistance from neighboring countries regarding their initial commencement of the project. Fear of failure in implementing affordable and sustainable housing is a clear indication of luck of experience in the field, but anyhow it is a vital need of society to be provided with low cost and affordable housing so a country would not have an option but to take the risk otherwise.

LACK OF PUBLIC AWARENESS

Implementation of the Affordable and Sustainable construction is mutually in need for public awareness for the purpose of ease in collaboration and coordination in activities taking place. When any matter becomes publically revealed and peoples doubts are cleared regarding the same, then only is the time a particular development is considered to be following the right path of infrastructural Development.

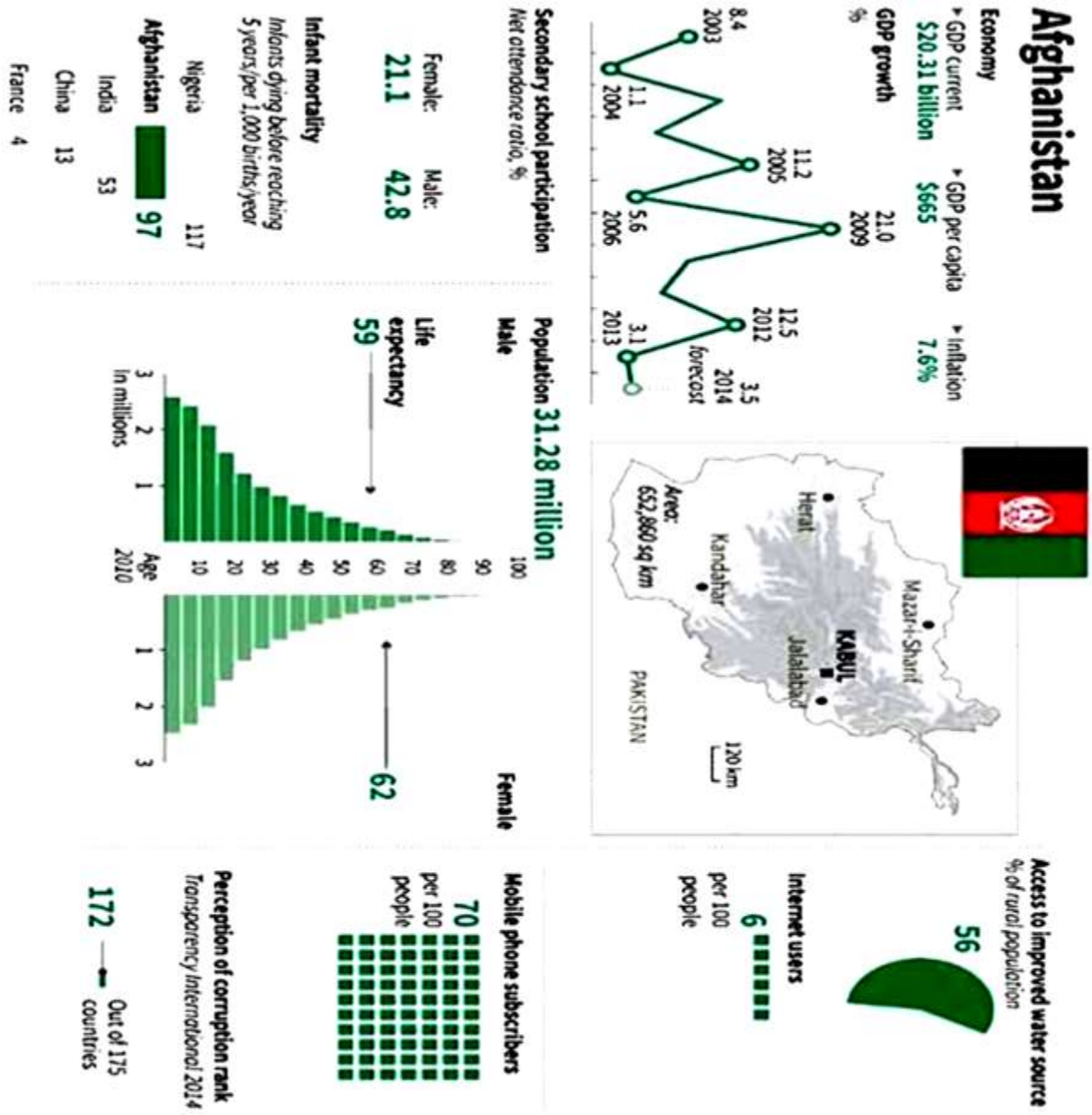
LITERATURE REVIEW OF AFFORDABLE & SUSTAINABLE HOUSING

For any type of new research it is of utmost importance to head back to the already existing efforts taken and the origin of the case. In recent years, the term 'affordable housing' has been used as an alternative to terms such as 'public', 'social' or 'low cost' housing [4]. It starts with the significant increase in poverty in different regions and the evolution of triggering the same with sustainable Development. National affordable housing summit group of Australia has defined affordable housing as "housing that is adequate in location and standards for middle income households and does not cost as much that a household wouldn't be able to meet other basic needs on sustainable basis" [5]. Affordable housing became widespread in the 1980s in Europe and North America in the words of Alain Bertaud, of New York University. "It is time for planners to abandon abstract objectives and to focus their efforts on two measurable outcomes that have always mattered since the growth of large cities during the 19th century's industrial revolution: worker's spatial mobility and housing affordability [6].

CASE STUDY

Introduction: For the purpose of finding out the best approaches towards the affordable and self sustained housing in developing countries of composite climate region, it was important to select a case study which is most resembling in geographical, climatic and developmental factors and Afghanistan being a developing country which is composite in climate and is of a rocky terrain stereotype is selected as the country where a case of affordable and self sustained housing is studied. Kabul is the Capital of Afghanistan and the site and structure which is going to be studied is located in the centre of the city. Figure 3.1 shows a general facts about the country and is included in this project because it is of utmost significance to have a general awareness of the country where certain activities regarding the case study are going to take place and are important part of the data needed for the success of the project. This structure is a Residential building which is comprised of three floors as the superstructure part and one floor basement as the substructure part; type of construction is basically framed and has a RCC foundation blow.

Due to higher energy demand and respective stresses this building is believed to be inefficient nevertheless the household is paying huge annual bills towards getting a certain liveable degree of comfort. During the winter season a huge expenses are endured by the residents just to keep the house warm and during the summer season it becomes difficult to get a satisfying degree of comfort due to heat gains and increase in temperature. Keeping the fact in mind that insulation is the first common remedy which comes to ones consideration on behalf, the structure is not only insulated at all but large openings are also provided irrespective of weather and climate shift considerations.

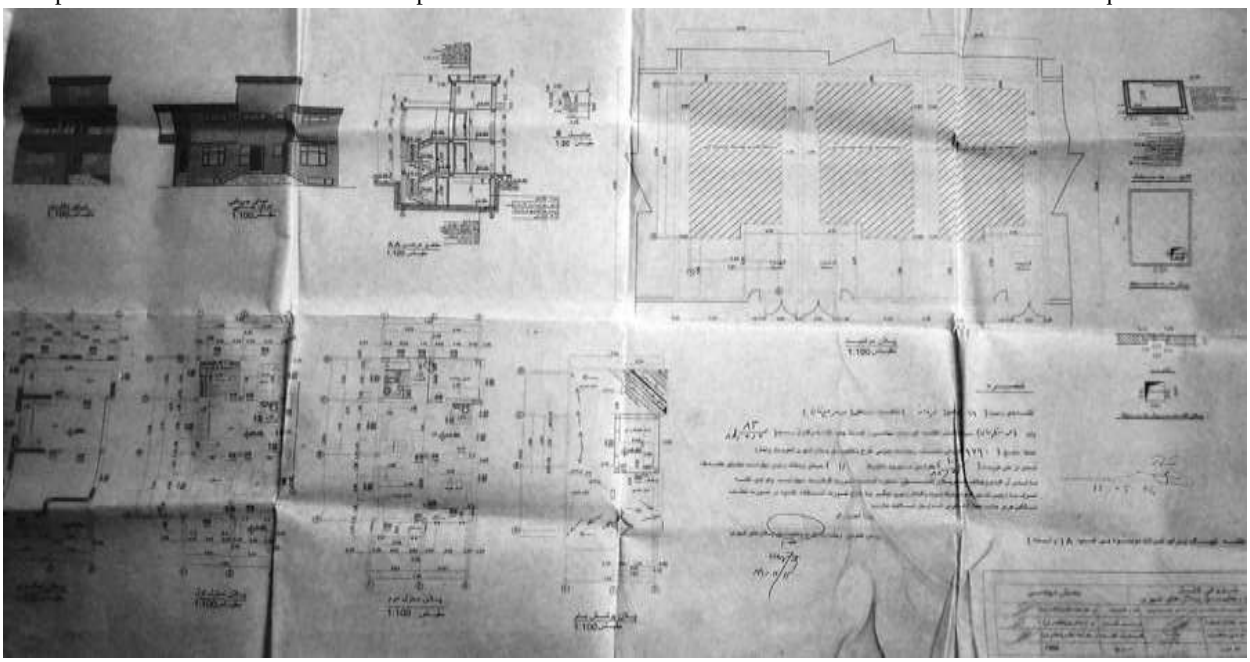


General Information about Afghanistan

HOUSING IN AFGHANISTAN AS A DEVELOPING COUNTRY

Considering the climatic and Ethnic diversity of the country in deferent zones people had different approaches towards housing , people used to reside in the yurts traditionally in the villages, in the northern and western parts of the country people used to reside in houses made of stone and mud-brick known as qalʿahs ("fortresses") because of the cold locality and people in the eastern and southern parts were used to wooden and multi-storeyed housings typically called "Nuristani". The same types of construction was being practiced for centuries and remained unchanged for centuries until in the mid 19th century the region was inclined towards Western models, including high-rises, city services and paved roads, but then due to political instabilities cities suffered severe damage to their infrastructures during the 1990s and early 21st century[9] and people were made to migrate to comparatively more stable and safer regions and were abandoned in terms of

government support and they had to rely on private means for shelter which is individual dwelling systems. Afghan Municipality is in charge for preparation of prototype house designs as shown in the figure 3.2 .Now "The population of Afghan cities is expected to double within the next 15 years and by 2060, one in every two Afghans will be living in cities", UNHabitat reports and still there is no significant housing and development board's initiatives towards resettling the people into safe and comfortable and affordable shelters. In recent Decade housing from individual dwelling has started to shift to apartments and several townships have been developed ever since but affordability and sustainability has not been practiced yet. 2018 is the year in which Afghan President Mr. Ashraf Ghani has initiated operation of prefabricated housing by the help of Turkish government in collaboration with ministry of Urban housing and development of Islamic Republic of Afghanistan .which is a step closer to sustainable and affordable housing techniques initiative taken by the government and the 1st school out of those prefabricated elements has been built in 3 months time costing 250000 Us dollars, This School has 8 class rooms and other administrative blocks in a total of 900 square meter.



Typical Municipality housing designs

CLIMATE REVIEW

The ASHRAE 90.1 climate classes are based around the Koeppen Geiger classification system, but provide better definition in temperate and maritime zones. we can See also Koeppen Geiger and Kottek, Greiser,Beck, Rudolf and Rubel. Both the climate zone defined by ASHRAE and the climate zone calculated from the assigned weather data are given. The analysis in this report is based on the calculated climate zone.

CHARACTERISTICS

Rainfall location: Kabul, Afghanistan
Winter is potentially most dominant so the design must minimise heating energy and Latitude is mid so solar radiation on south/east/west walls is significant. While solar radiation on roofs is significant. Summer is cool Summer also has a moderate diurnal range and Summer also has cool summer nights ,Winter is mild with prevailing winds typically from the north, Summer prevailing winds typically from south.

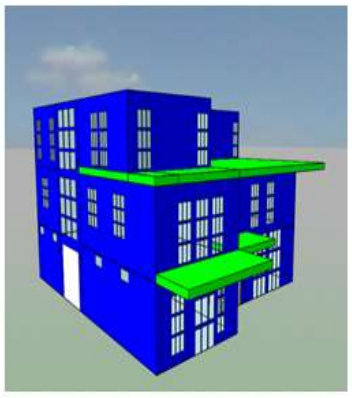
BUILDING - INTERNAL FORM

Heat production zoning is like, place heat gains to benefit north facing spaces. Heat and segregate heat gains and people and place highest internal gain spaces in north facing positions. While Stratification is place occupied spaces or activities to benefit from heat rising and place occupied spaces or activities to

avoid heat rising causing overheating. Thermal migration (seasonal use of semi-heated spaces). Buffer zones (tolerate wider temps and/or at certain times of the day) the semi-heated spaces (garages, winter gardens), stores, bathrooms. [10]

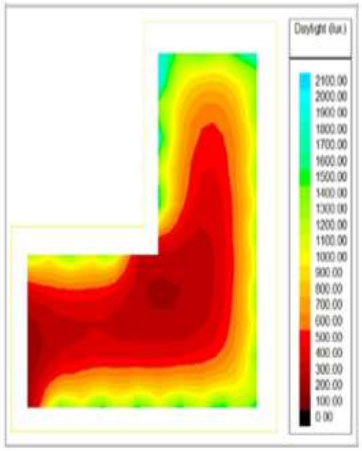
MODELING AND SIMULATION BY IESVE

Integrated Environmental Solutions Virtual Environment is an energy analysis and performance modeling software that offers several models customized designed to indicate various building performances work flows. It can help incorporate in sustainable building approaches and analysis into any BIM projects which is active since 1985. IES supports the approach taken by the USGBC and LEED, as it recognizes that, given a suitable set of tools for modeling, the greatest variables are user skill, inputs, and assumptions, and how the tools are used to support the design process. Model IT: To create a Virtual Environment project , To create basic room shapes, To create a sample building



study Model drawn in IESVE

Model IT: To create a <Virtual Environment> project,, to create basic room shapes, To create a sample building



ARTIFICIAL LIGHTING DESIGN CALCULATION
Flucs Pro: to perform an artificial lighting design calculation.
to perform daylight or artificial/daylight analyses for rooms with windows

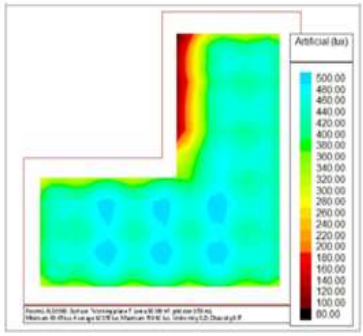
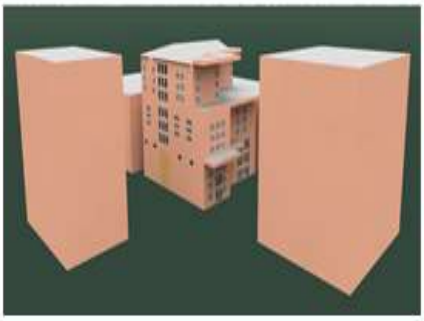


Fig 3.4.2b *daylight analyses for rooms with windows*

Radiance:3D lighting simulation tool to perform luminance lighting simulations, to perform external and internal luminance lighting simulations



Radiance:3D lighting simulation tool to perform luminance lighting simulations to perform external and internal luminance lighting simulations. Fig 3.4.3 a *luminance lighting simulations*

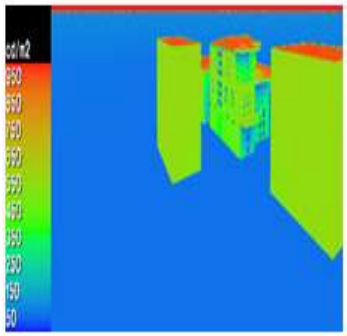
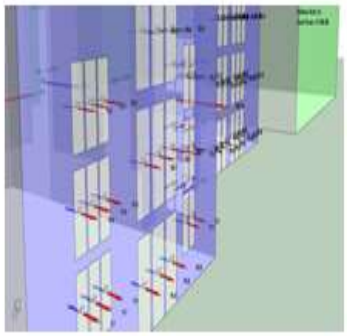


Fig 3.4.3 a *External and internal luminance lighting simulations*



macro flow: Simulate air flow driven by, Wind, Pressure, Buoyancy force

Macro flow: Simulate air flow driven by Wind, Pressure, Buoyancy force

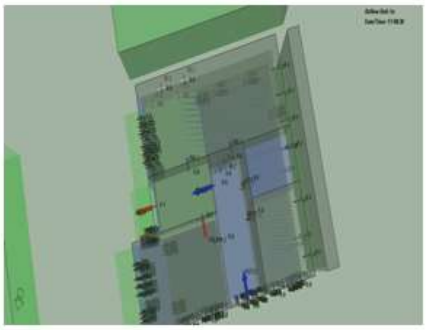


Fig 3.4.4 a and b *Air flow Simulation in l/s of air*

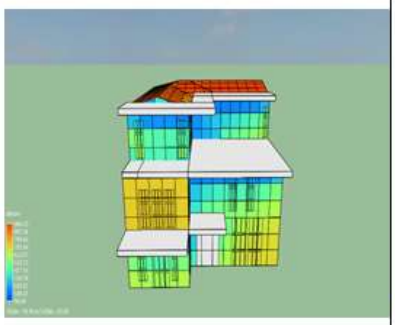


Fig 3.4.5 *Solar Irradiance simulations*. Sun Cast to perform solar shading studies, to create shading images and movies

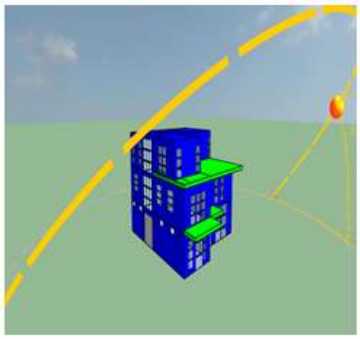
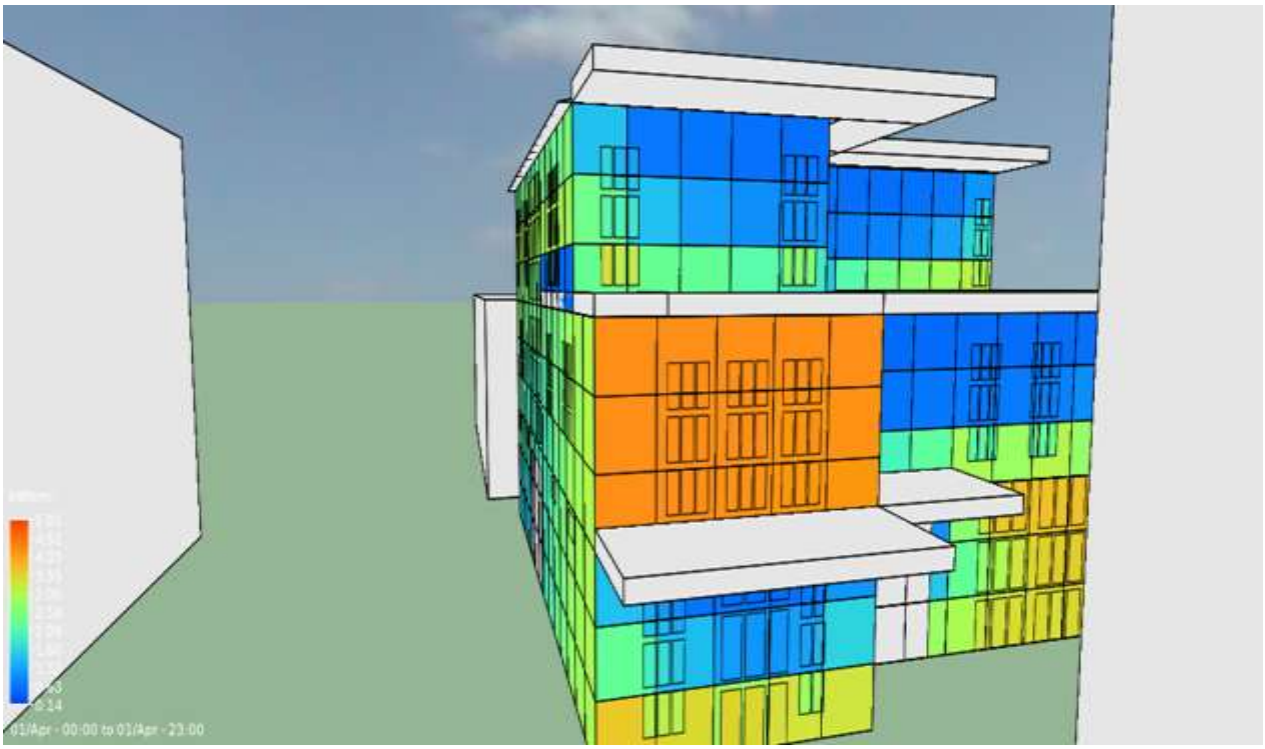


Fig 4.2 *Sun Cast Simulation*

Modeling & Simulation: In order to find out different aspects of a building regarding its energy and performance by using the Model IT function of the IES-VE a model resembling all the necessary elements of the building is created which indicates the envelope, openings, and shading, oriented exactly like the existing building which in this particular case is North-South facing as shown in Fig 4.2 SunCast Simulation. The building is subjected to incident solar radiations in different angles throughout the year , considering the fact that one of the major factors behind the heat gain of the building is the solar radiated heat which plays a vital role in overall heat gain of the building throughout the year so for this purpose by using the SunCast Function of the software certain iterations of simulations are performed in three trails so that the ultimate design elements could be selected and proposed for all the seasons throughout the year.

Sun Cast: To perform solar shading studies, to create shading images and movies

Fig 3.4.6 solar shading studies



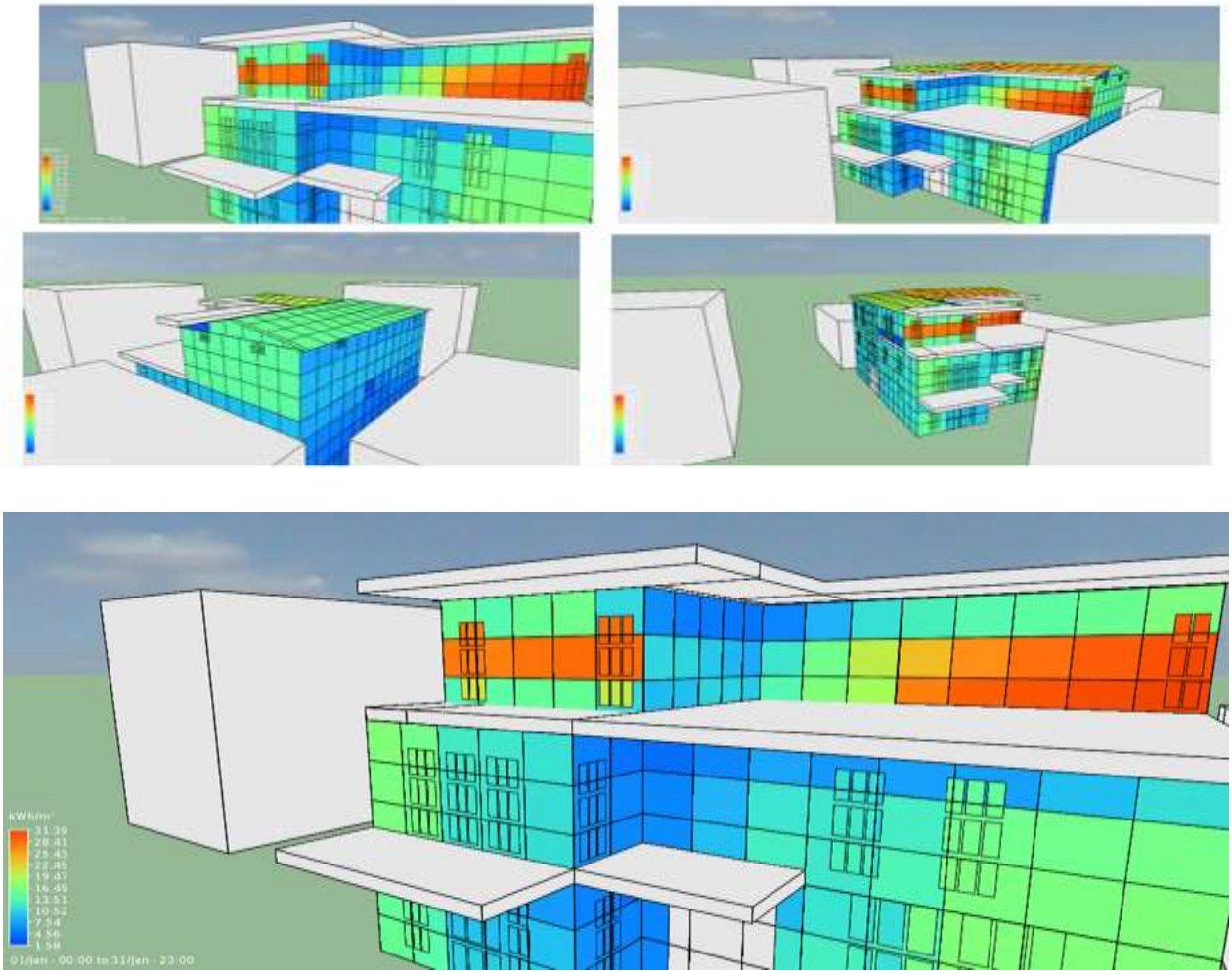
Summary: The case which is about to be studied is located in Kabul, Afghanistan and the type of building is an individual residential house which has been designed by the countries municipality as a stereotype multi-storey building design .By using IESVE the selected case study model will be simulated and consequent results and data will be analyzed and used as a major step towards making the residential case study as affordable and sustainable as possible.

METHODOLOGY & PRELIMINARY HOUSE DESIGN

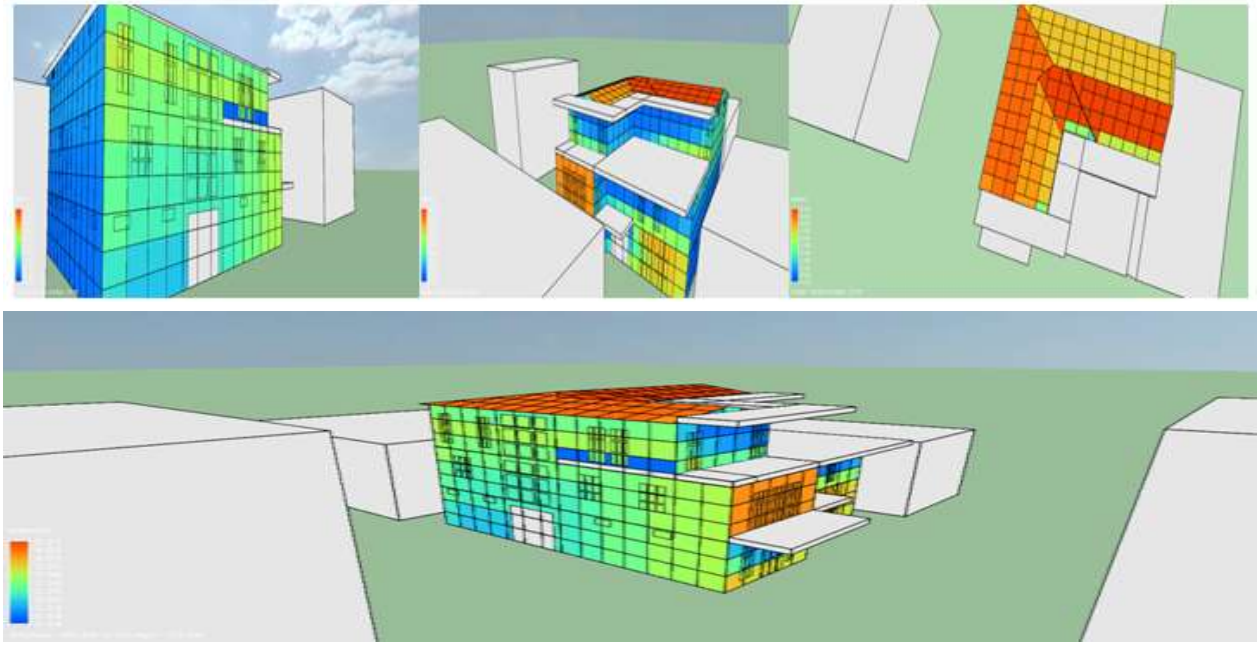
Introduction: The basic methodology for this project is to accumulate and acquire the best suitable design and approach for a construction which is supposed to be Cost effective and affordable, Self sustaining, Environmentally friendly and Energy efficient in composite climate and to collect optimum data necessary to achieve the above then analyze, differentiate and select the best alternatives to set Benchmarks for further developmental studies and to contribute in the Sustainable Development of the country, to be specific, this project's aim is to create a Model and run simulations on it and analyze the data acquired from Simulations to find out relations between variety of data and to Select the most feasible housing design .

Modeling & Simulation : In order to find out different aspects of a building regarding its energy and performance by using the Model IT function of the IES-VE a model resembling all the necessary elements of the building is created which indicates the envelope, openings, and shading, oriented exactly like the existing building which in this particular case is North-South facing as shown below .The building is subjected to incident solar radiations in different angles throughout the year , considering the fact that one of the major factors behind the heat gain of the building is the solar radiated heat which plays a vital role in overall heat gain of the building throughout the year so for this purpose by using the Sun Cast Function of the software certain iterations of simulations are performed in three trails so that the ultimate design elements could be selected and proposed for all the seasons throughout the year.

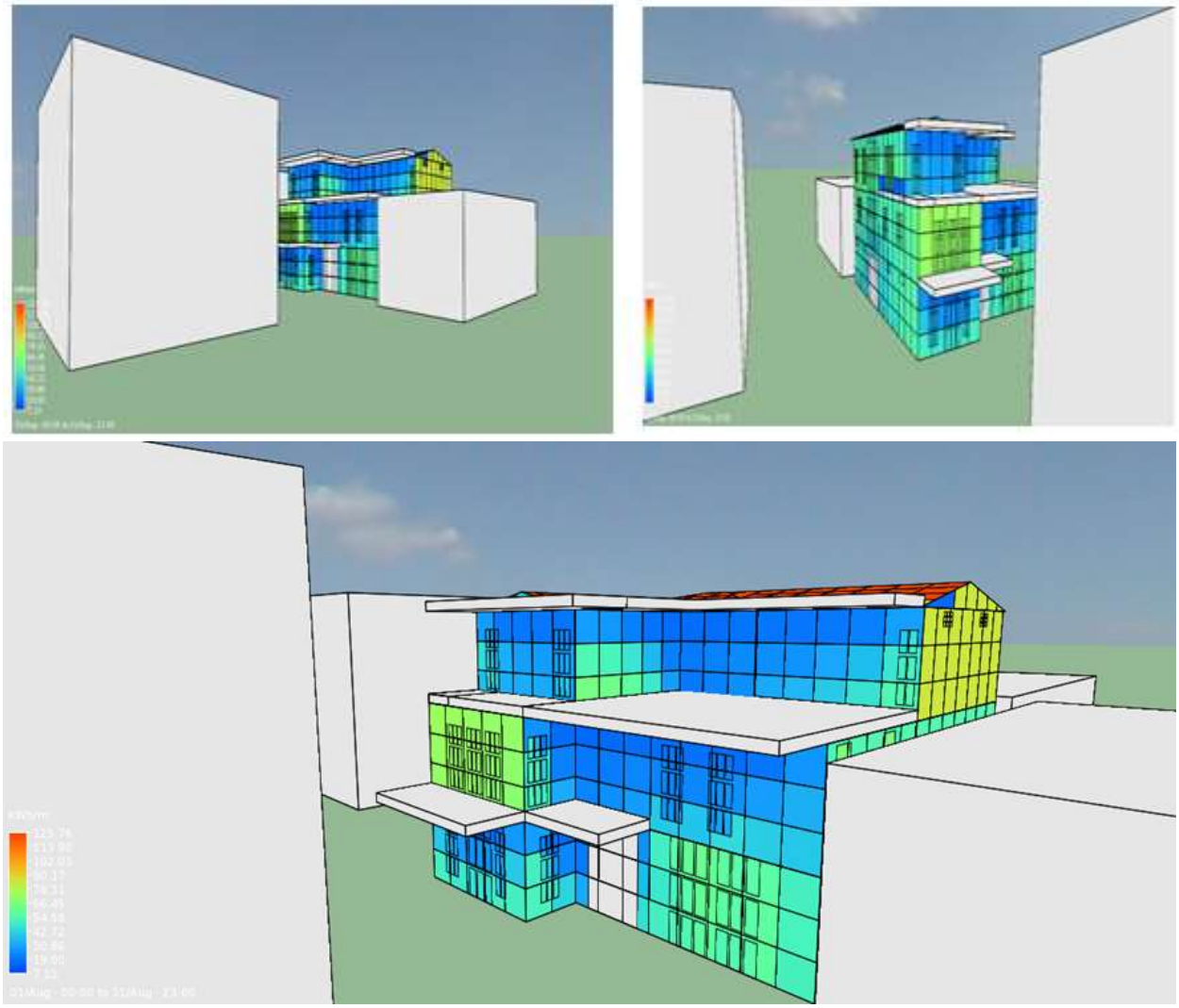
Trail 1: This trail is a Sun Cast simulation performed for the month of January as follows:



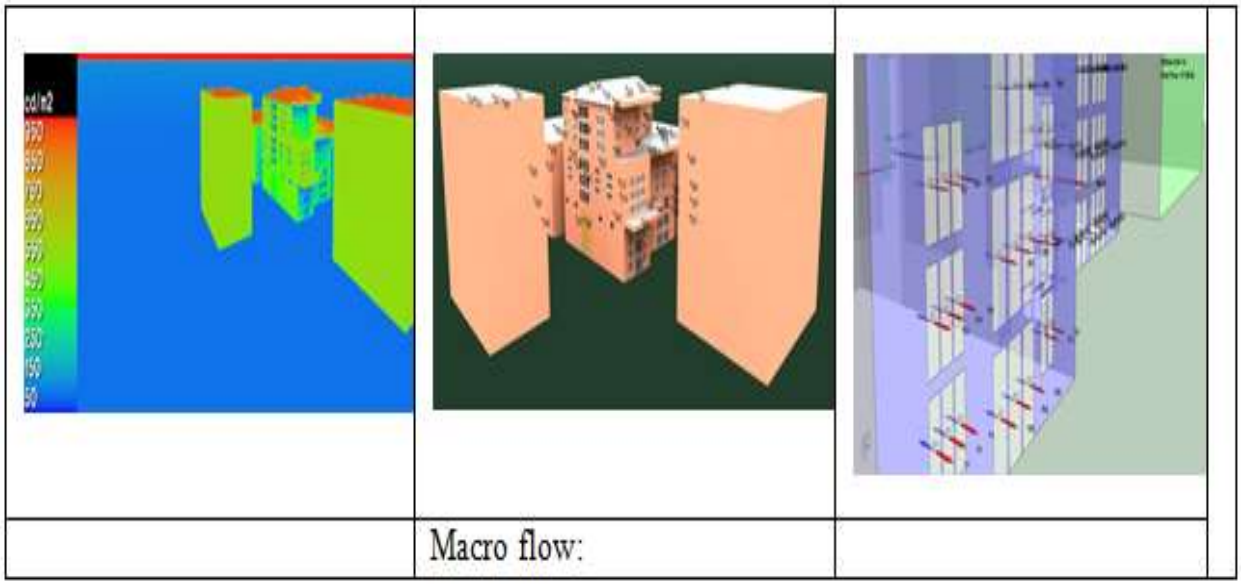
Trial 2:This trail is SunCast simulation performed for the month of April as follows



Trail 3: This trail is a SunCast simulation performed for the month of August as follows:



Radiance



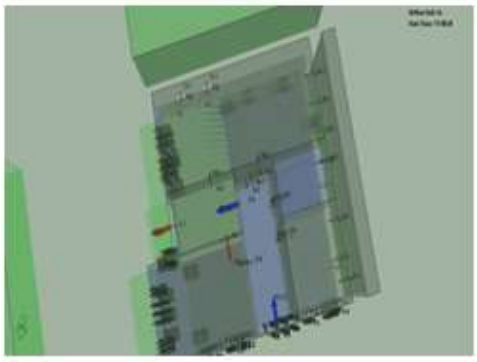


Fig 4.2.5 *Macro Flow Simulation*

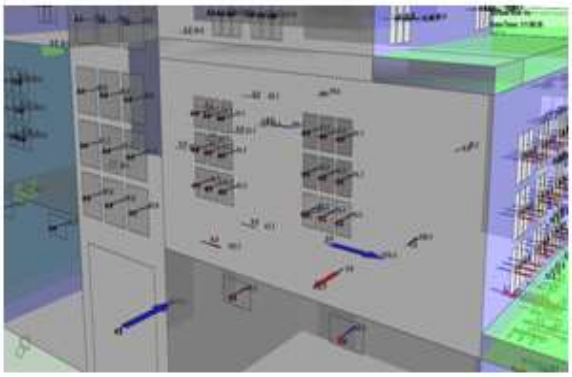


Fig 4.2.6 Shading *Simulation throughout the year*

SunCast Simulation Analysis: As witnessed in the simulations performed on the building for different time scenarios in three different intervals of the year, in the month of January due to the incident sun radiation's angle being low, only the top portion of the building is subjected to solar irradiance which includes third floor and front portion of the roof as shown in figure 4.3.

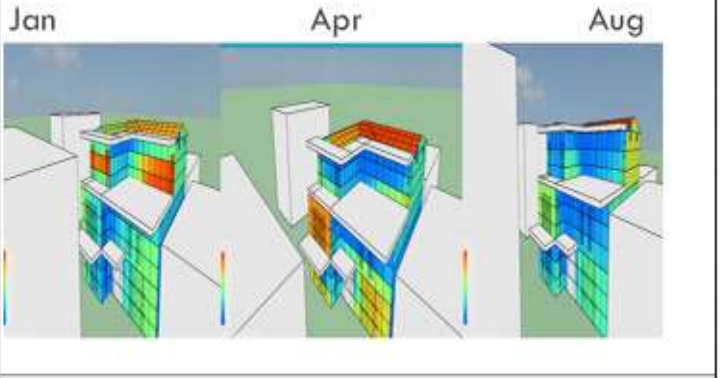


Fig 4.3 comparison *of solar irradiance for the months of January, April and August*

When the angle of solar radiation incident on the building increases in the month of April a transitional shift is observed , now third floor front walls are not subjected to the incident radiations due to provision of shading hangers but as the angle increases distance of the sun decreases with respect to the building and more intense irradiance is recorded on to roof and there is a shift of radiation subjection to second floor exposed external walls and finally in the month of august which is believed to be the warmest months of the year in the region solar radiations are incident in a more closer distance than the rest of the year and that is why more intense irradiance is observed on the roof of the building .

Summary: Air flow Simulation and SunCast Simulation can lead us to methods of reducing Solar Irradiance intake by the building and respective heat gain during summer times which eventually will lead us to be able to reduce energy used to keep the house cool and trigger cooling stress and in the same manner during the winter times enables us to improve air tightness and insulation of the house and increase energy efficiency and act as a remedy to heating stress.

LCCA LIFE CYCLE COST ASSESSMENT

5.1 Introductions

This chapter is comprised of all the necessary data needed to calculate the life cycle cost of the building with respect to energy utilization and keeping in mind that our ultimate aim is to be able to select the best affordable designs of housings; LCCA appears to be playing a vital role.

As we will find about the expenses endured by a household of LIG throughout the year and subsequent years in the future, this particular data can help in comparing the efforts taken by this project and its efficiency and the remedial measures and their efficiency towards reducing energy and resource deterioration.

5.2 Conducting Survey

A Survey is conducted in the site where the case study is located and contains information regarding the heating and cooling techniques commonly practiced in the region, the sources of energy to fulfil the same and respective expenses endured on monthly and annual basis.

A total of at least 100 houses were surveyed for the same purpose and as observed satisfying data had been acquired which will help in analysing the facts and trigger the solutions to it.

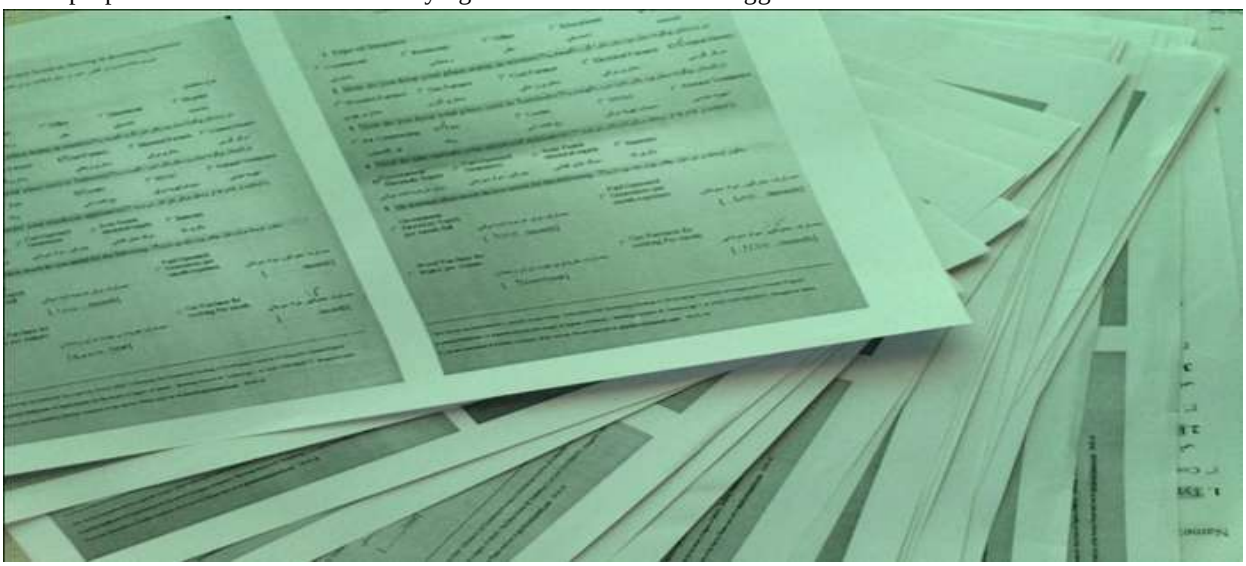


Fig 5.2 a survey sheets

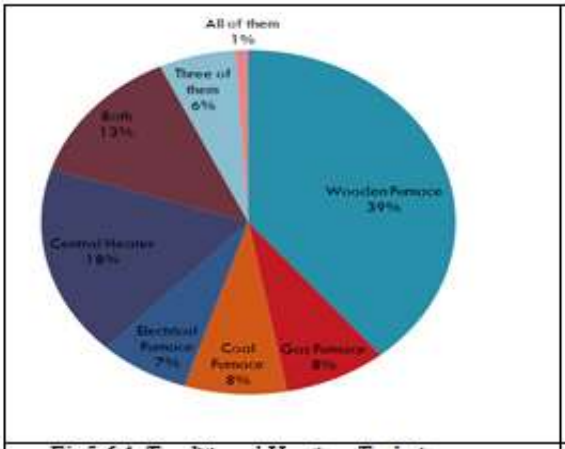


Fig5.6.1 *Traditional Heating Techniques*

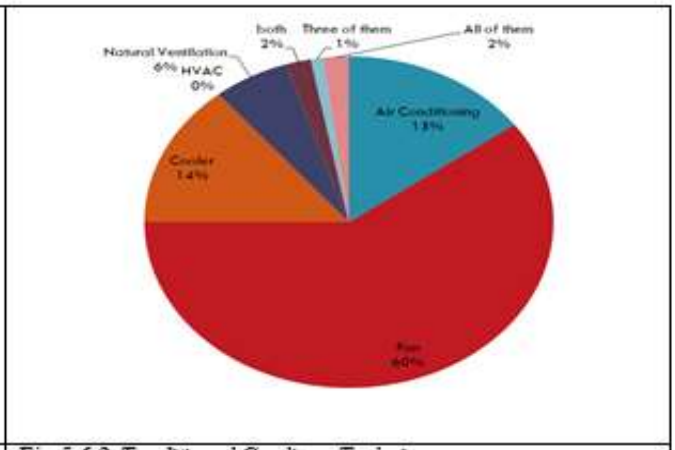
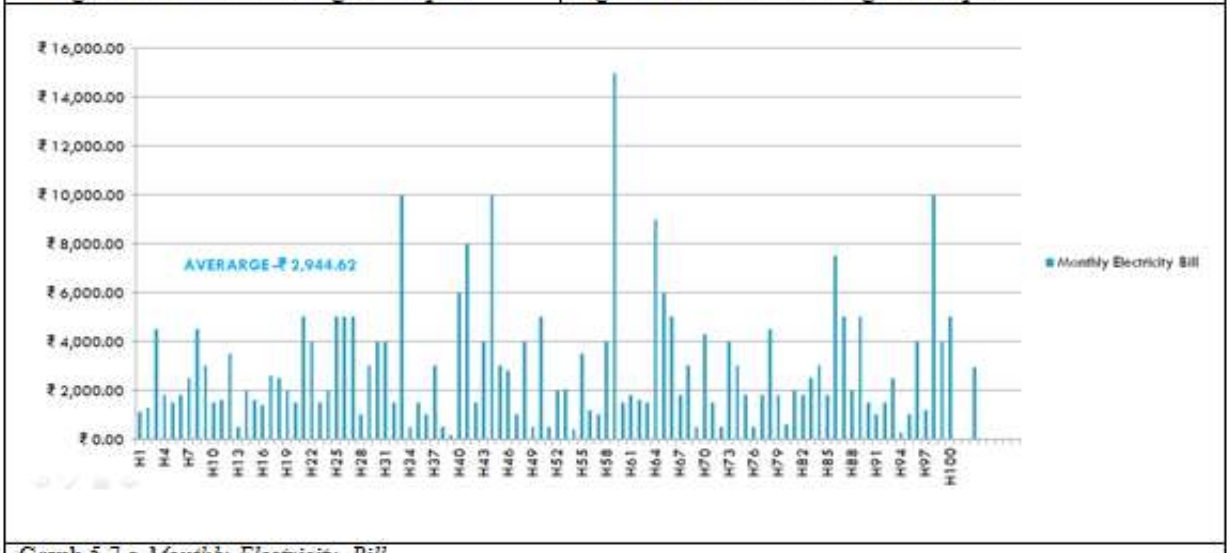
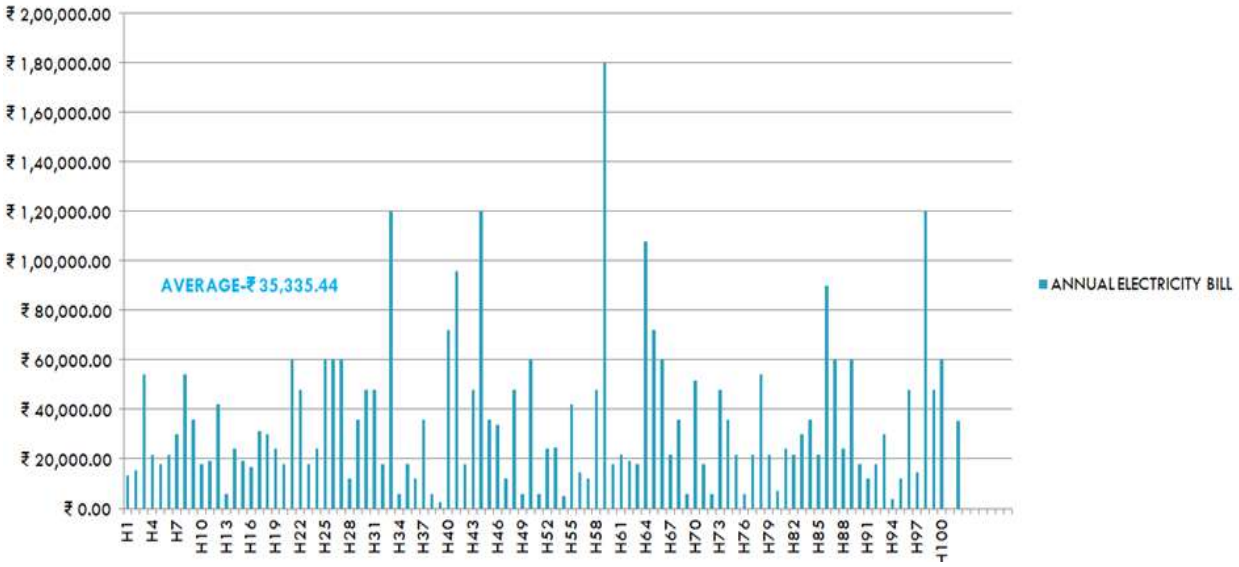


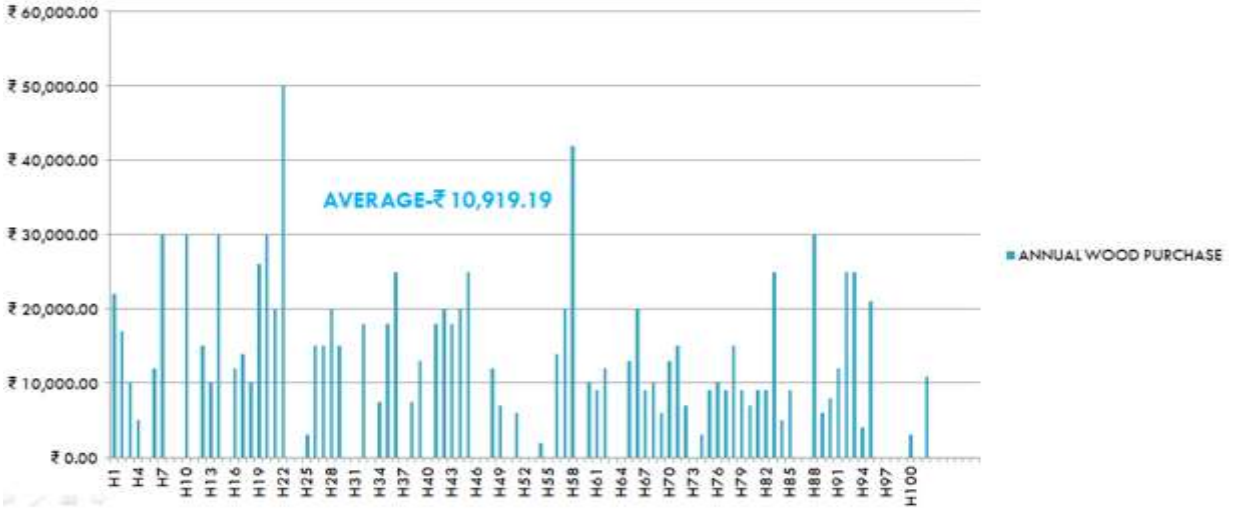
Fig 5.6.2 *Traditional Cooling Techniques*



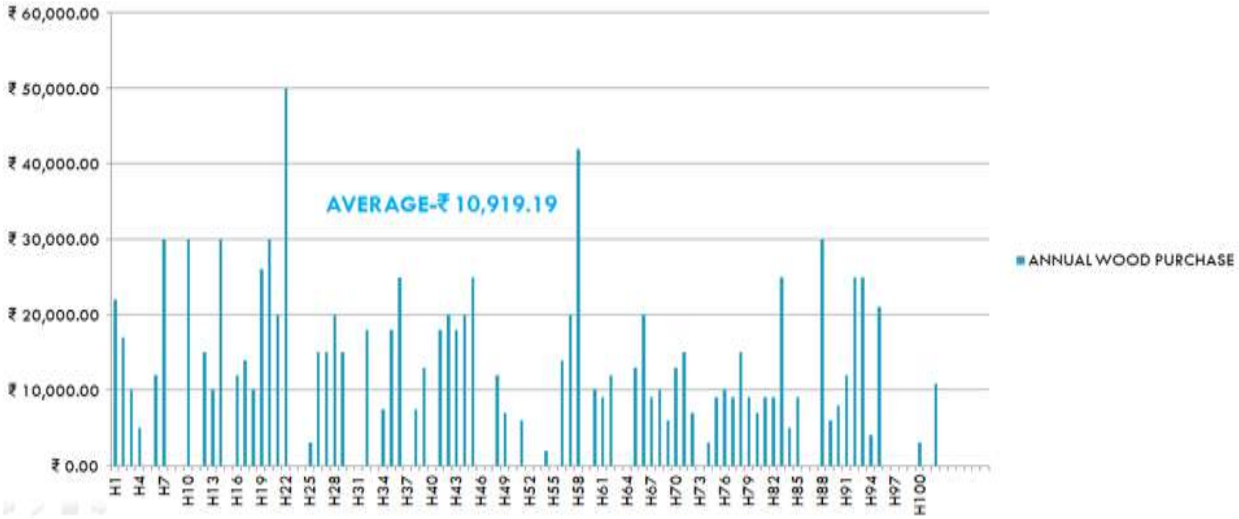
Graph 5.7 a *Monthly Electricity Bill*



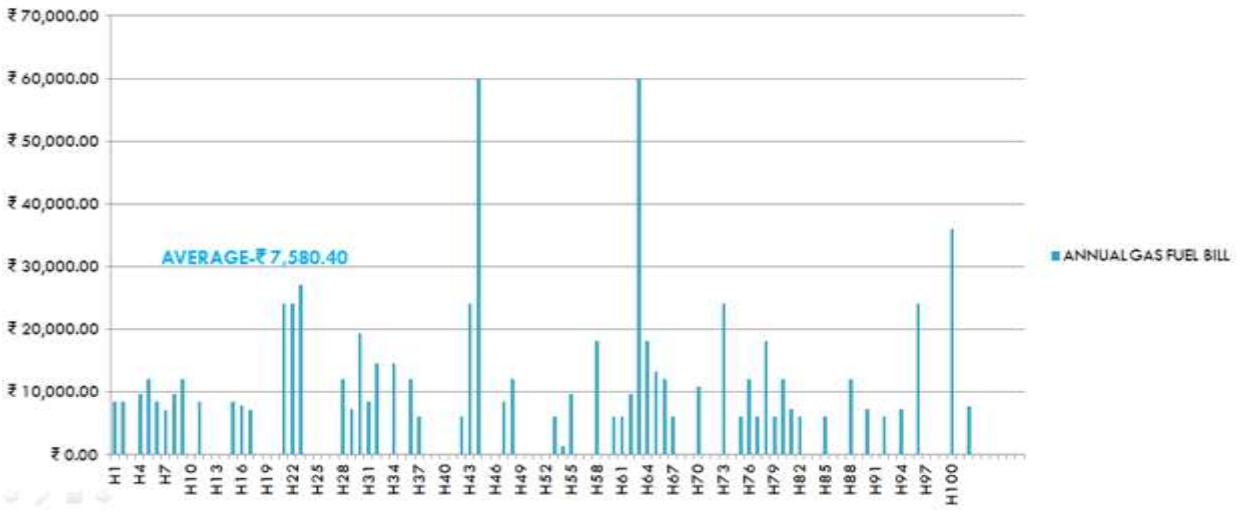
Graph 5.7 b Annual Electricity Bill

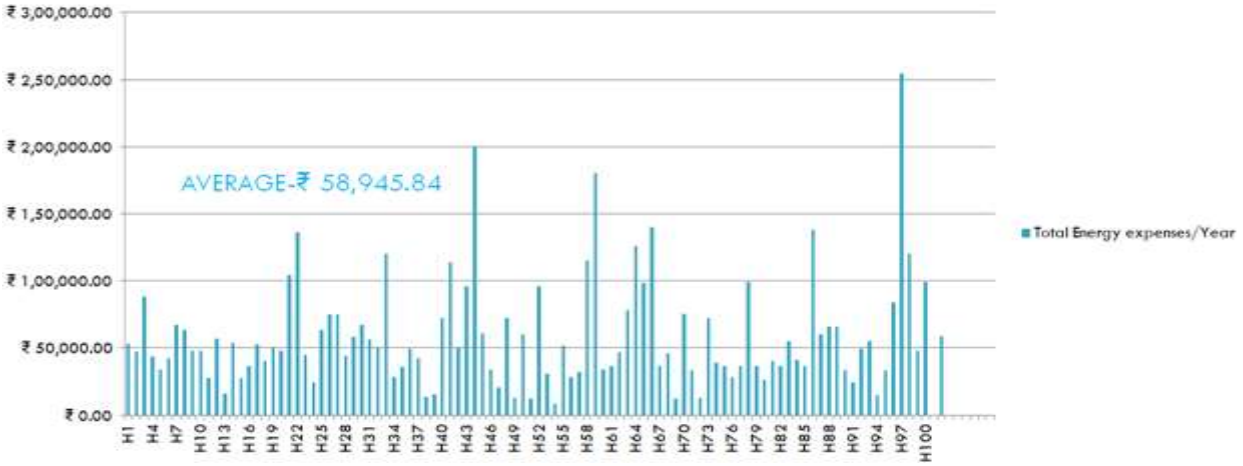


Graph 5.7 b Annual Electricity Bill



Graph 5.7 c Annual wood





Items	Average
Annual Wood Purchase Bill	₹10,919.19
ANUALL ELECTRICITY BILL	₹35,335.44
ANUALL POWER BACKUP	₹5,220.00
ANUALL GAS FUEL BILL	₹7,580.40
Total Energy expenses/Year	₹58,945.84
Cost for 5 Years	₹2,94,729.20
Cost for 10 Years	₹5,89,458.40
Cost of 20 years	₹11,78,916.80
Cost for 30 years	₹17,68,375.20

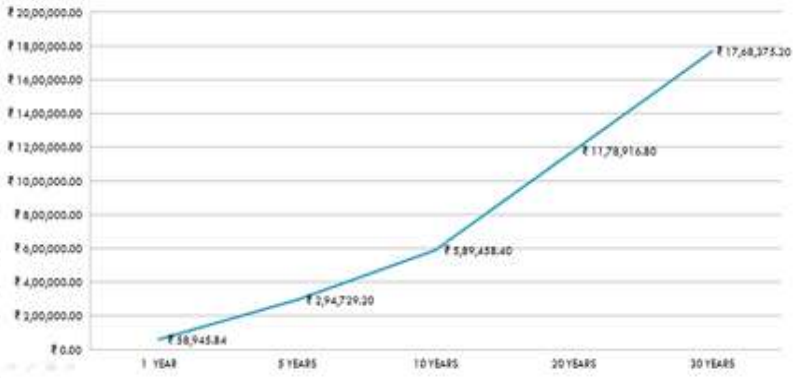


Table 5.8 Life Cycle Cost Assessment

FINDINGS AND ANALYSIS

As a result of collection of necessary data available for Affordable and Self sustained housing, study of a case located in a developing region which has composite climate, its respective modeling and simulations and Survey data collection and analysis and the subsequent results this project has been able to find numerous facts and criteria regarding the design of affordable and self sustained housing in developing countries of composite climate region.

Construction: Findings with respect to the initial construction of the dwelling are as follows:

High levels of insulation is required and has to be Super-insulated. Air tightness is important in heat loss. Airlock entrances with Double glazing required. Reflective insulation (summer radiant heat control, especially roofs). More glazing to southerly aspects (northerly in southern hemisphere), but with appropriate summer sun protection. Limit northerly (southerly in southern hemisphere) facades to 15% of total window area, but sufficient for good Day lighting. A Double/multi-height interior voids - south orientated for daylight penetration and to minimise northerly windows. Include thermal mass where diurnal range is significant and building type would benefit. Lightweight walls, Lightweight roof, well insulated. Comfort can possibly be achieved without extensive night vent. Light external finishes (in humid climates these are difficult to effectively maintain).

Windows/openings: Ventilation openings typically N and S (check prevailing winds and place on windward/leeward facades). Medium openings, 25-40% of walls (above sill height, body height but directed airflow, if at high level directed airflow). Prevent winter cold drafts causing discomfort (zoned windows, mixed mode etc). Effective zoned window design (all seasons and zoned functionality).User control of glare, direct sun and passive ventilation openings

Shading/protection: Shade glazing summer:- vegetation, overhangs, balconies, Consider adjustable shading.

Ventilation: Summer night cooling in conjunction with thermal mass (in hot climates comfort set point may be too low if air conditioned). Effective cross ventilation (windward and leeward openings), including suction zone forms - roof wind troughs, north lights (top floors). Stack ventilation (windless days or nights, most effective on taller buildings, esp. for hot humid- tropical) (Take care with winter leakage/volume control). Wind catchers (Malkaf) to capture breezes at roof level especially in dense urban patterns for summer cooling. Designed to match the degree of directional variability of local winds (number of opening sides). Some hot dry regions have strong night winds that are especially suited to wind catchers (take care with winter leakage/volume control). Taller spaces/raked ceilings (stratification and space for ceiling fans). Wing walls to improve single sided/two adjacent sided ventilation with wind angles down to 15 degrees.

Design priorities: Minimise radiant heat risk (via solar conduction). Minimise summer day heating rate. Maximise summer evening/night cooling rate. Address cold winter day comfort.
Address cold winter night comfort. Minimise heat loss. Minimise air infiltration. Maximise effective natural cross ventilation. Utilise good diurnal range potential. Use low humidity potential (evaporative cooling). Use solar energy potential (renewable). Prevent rain penetration (during summer vent).
Heating: As seen in the Air flow Simulation the cold air enters the building from bottom of the openings provided in the ground floor and then gets heated inside the building and tends to raise in the topmost of the building and during the winter season that air is supposed to stay in the building and to do so air tightness of the openings already existing is mandatory and the effect of the solar radiation will only be on the roofs so the top most floors will be warmer than the floors located below.
Cooling:As observed in the air flow simulation and SunCast simulation, due to exposition of the external walls and roof to the incident warm solar radiations, the building gets heated and to avoid overheating of the building certain factor have to be taken into care such as: Cross ventilation, Reflective roof , Double glazing ,Wall insulations, Controlled Exhaust System, Adjustable shadings, Overhangs, Balconies, Vegetation

CONCLUSION AND RECOMMENDATIONS

Achievements of objectives :The main Objective of this Project was to Combine Affordable Housing and self sustained housing and optimize the design for the most suitable type of housing in Developing Countries of composite climate region For succeeding the above some of the common objectives were outlined and are achieved as follows: Data accumulation, Optimum data collected for analyzing, differentiating and selecting the best alternatives and this particular type of analysis can act as a benchmark for further developmental studies which considerably

contributes in sustainable construction industry. Most suitable practices for affordable self sustaining housing have been selected . Heating Technique which best suits affordability and sustainability are Central Heating , Radiant Heating , Trombe Wall Passive design, Cooling Technique which best suits affordability and sustainability are: Radiant Cooling, Adjustable Shading, Natural Ventilation ,Green Roofs, Reflective Roofs, Pitched Roofs, Exhaust System , Energy sources which best suits Affordability and Sustainability are: Photovoltaic Panels for Electricity production, Solar water Heaters for hot water, Solar water Heaters for Radiant Heating, Solar water Heaters for Central Heating, Wind Turbine for Electricity production, Natural Day lighting should be adopted in the areas of the roof and walls least susceptible to solar irradiance in summers and as an alternative pitched skylight windows can suit the case the best. Water Footprint of dwellings are reviewed and the most suitable Rain water harvesting design has been obtained LCCA (Life cycle Cost Assessment) of the project is conducted and necessary data are obtained and analyzed. Initial Constructional design priorities have been obtained for affordable and sustainable housing.

CONCLUSION

Traditionally an average of 39%-48% of the residents in Kabul city use wooden furnaces or coal furnaces to heat their homes in the winters which is not advisable at all means not only because of the hazards towards environment due to carbon emissions but, is financially stressful as well to an extent that the combined annual electricity consumptions for heating, cooling and lighting is around 40000 Rs and the total energy expenses a household endures in a span of 20-30 years of time reaches 2 crores (20 million Rs) and for a household who comes under the Low income group division of the society affording this huge amount for a long run is out of question . In this thesis work efforts are put together to minimize operational costs regarding energy utilization of houses in developing countries and as the findings of the project work has been analysed, it is possible to achieve the same by certainly considering the initial house design and optimization and audit of the energy and compliance with the sustainable code of constructions and passive architecture.

RECOMMENDATIONS FOR FURTHER STUDIES

1. In Developing countries of composite climate region a system of housing should be developed and established in which all the mentioned design criteria shall include as a standard code of construction.
2. Solar energy as a renewable source has to become the major infrastructural assignment of a country where primary energy is outsourced.
3. Affordability and sustainability has to be promoted in a larger governmental scale.
4. Households are facing water scarcity and the only way of triggering the same is protection of water bodies in the country and Afghanistan as a developing dry country is liable to utilize every single drop of water available, whether it is water harvesting by means of catchment of different scales or directing the runoff water to recirculation and reusing and preventing water waste at a country level.

REFERENCES

[1] (Gabriel et al 2005, p6)[1]
[2] (Queensland Affordable Housing Consortium, Australia, 2012)[2
[3] (10th annual Demographia International housing affordability survey, 2014).[3]
[4] (Gabriel et al 2005, p7)[4]
[5] (Queensland Affordable Housing Consortium, Australia, 2012).[5]
[6] (10th annual Demographia International housing affordability survey, 2014).[6]
[7] (IFM/World bank/UN/DESA/Unicef/Transparency/International[7]
[8] Cambridge, Massachusette,June15, 1965,School of Architecture and Planning, Combridge institute of Technology, Thesis, A System of low income cost housing in india by Gautam Budhabhai shah p(3,39)[8
[9] ASHRAE 9.1 A s55 (p161) A s56 (p162) A s56 (p162) A s46 (p136)[9]

IESVE DATABASE AND REVIEWS

Other References

[1] Journal of Architectural Engineering Technology, Sustainable Housing and Building Materials for Low-income Households, Bredenoord J*, international urban planner/ housing Researcher, Housing Research Group, The Netherlands-2016, 5:1

[2] Government of India, Ministry of Housing & Urban Poverty Alleviation (JNNURM Mission Directorate), Guidelines for Affordable Housing in Partnership Affordable Housing in India, Jones Lang Lasalle, On.Point, an inclusive approach to sheltering the bottom of the pyramid

[3] CIB World Building Congress 2007-091, Low cost housing, a continues struggle (Overview, research, future), Peter A. Erkelens International Journal of constructive Research in Civil Engineering(IJCRCE), Volume 2, Issue 5, 2016, PP 21-25, ISSN 2454-8693, A critical Review on Making Low Cost Urban Housing in india. Housing Affordability Literature Review and Affordable Housing Program Audit, Urban Research Centre ,University of Western Sydney,July 2008