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Integrated Approach Utilizing Passive Design Principles for Construction of Affordable Housing

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Abstract: ***Around the world populace in urban communities has been expanding in multifold because of fast urbanization also, movement of town people. The evil impact of urbanization is making destruction nature of life, clog, and natural contamination further, it additionally affects abiding units in the city having a gigantic interest because of this the expense of development per square feet has been expanding quickly alongside the land cost subsequently it is thing to get done reasonable houses then, at that point, just be the viable answer for residing. An endeavor is made in the current review resort to development of reasonable lodging consolidating inactive plan boundaries. Hence, feasible materials and procedures of development have been considered out of various variables, the work has been achieved in three phases: Sustainable materials are recognized to shorten ecological debasement and financial effect by utilizing relative list and insightful ordered progression strategies for positioning of the material in stage one out of sixty materials the initial ten position materials were utilized while in stage two, it is created in light of different to assemble model uninvolved plan factors to upgraded the warm solace and day lighting in lodging framework and examination of burdens is completed in STAAD Pro, utilizing supportable materials in view of positioning and in the wake of applying filler piece strategy for development of the rooftop. In the last stage, life cycle costing is assessed coming about in the all-out cost decrease by practically 20% and further upkeep cost is likewise saved due to energy saving by manageable materials and aloof plan rules.***

Keywords: Sustainable materials, Affordable housing, Relative index method, AHP, Ranking, Passive design and LCA of cost.

I. INTRODUCTION

Housing is one of the most basic needs the mankind desires for their well-being and living under different environmental conditions. It is also felt that during the pandemic situations that are prevailing across the world and the progress of IT facilitates workforce to work from their respective homes. On the other hand, as the population is increasing due to the rapid urbanisation and migration of people from fringe areas and villages to the core centre areas of the cities, thus the small and medium cities are being getting transformed into megalopolises as a result. More the urbanisation more the demand for dwelling units, as a result of this the building activity has been boomed in cities in the recent past. In view of the core areas are getting densely populated, demand for construction of building has been increased in leaps and bounds. Mediocre people though dwelling in city areas cannot go for the construction of their own building owing to the high cost of construction, hence affordable housing is warranted for catering to the needs of such a segment of population. While adopting the affordable housing in different locations, it is learnt that it is associated with a variety of environmental issues. More so, the climate changes and other related construction problems and availability of natural resources, energy consumption inside the dwelling units as well as in the production of materials along with the rationing of land uses pave a way against the development. On the contrary, the current and future impact caused by climate change is becoming a serious threat to human activities and people's well-being. Thus, this emerging threat requires housing design to strengthen the function of shelter by resorting to construction utilising sustainable materials.

Passive design is a major part of an environmental aspect, and approaches utilizing several techniques and strategies that can be employed to the buildings in all types of climates around the world. With regard to the local environmental conditions in the present context, passive design strategies encompassing climate and comfort to provide a soothing conditions for the inhabitants has been considered, in line with urban sustainable design, policies and strategies. The key to designing a passive building is by taking advantage of 2 the local climate (micro-climate) and therefore, climate characteristics and classification can help with identifying approaches as early as site planning and analysis. Therefore, climate and comfort are the two fundamental measures in passive design that require attention. These techniques and strategies can also be supported by various other parameters such as using technologies (passive and/or active) and customizable controls as well as enhanced by patterns of biophilic design for improving health and well-being in the built environment.

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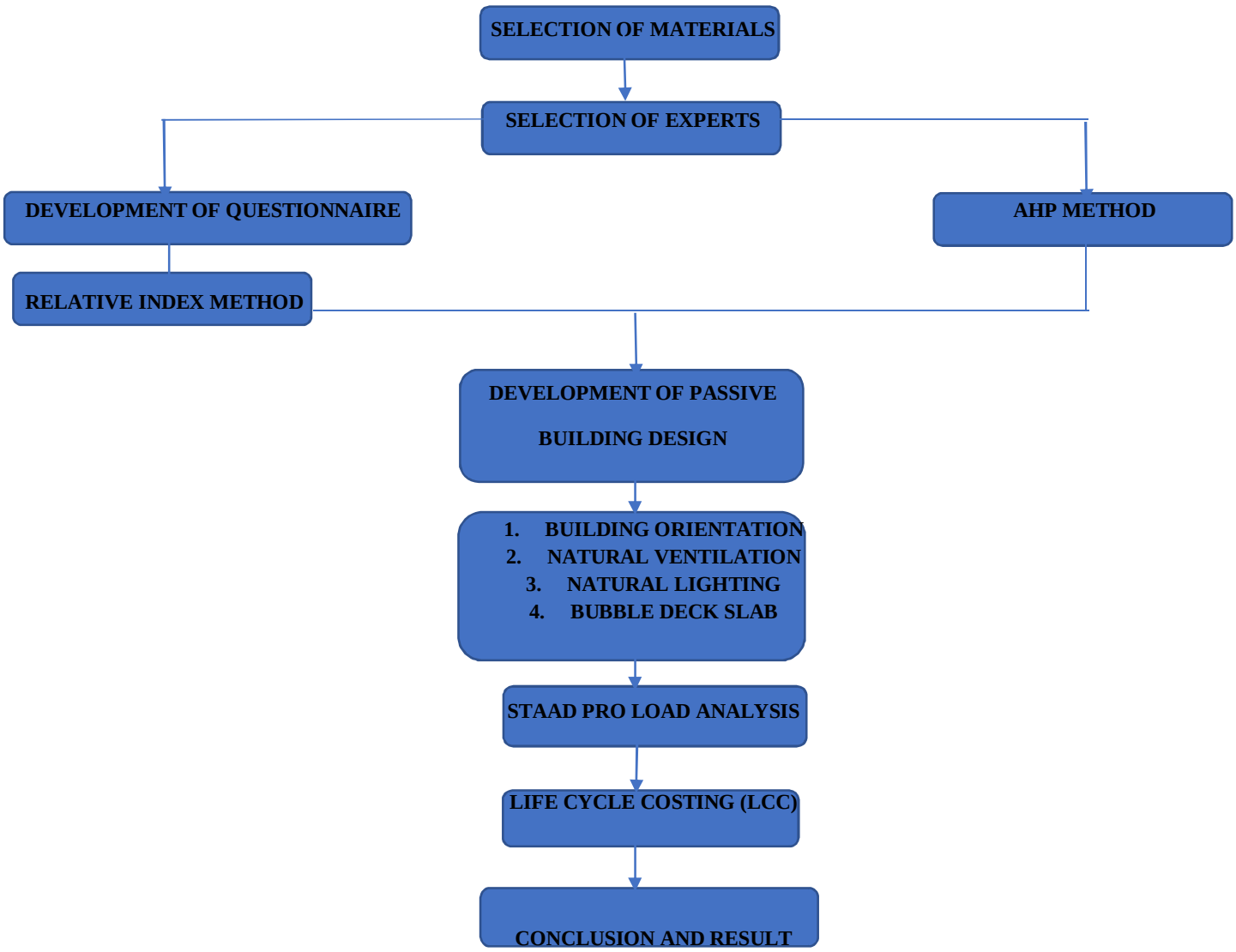
In designing building envelope conditions, there are various factors that need to be kept in mind. The factors that affect the indoor thermal quality include radiant temperature, humidity, air movement, air temperatures, and human physiological aspects like body metabolic rate, level of activity and clothing of the occupants which affect the microclimatic condition within the indoor environment. A good indoor thermal condition is essential for providing comfortable (primarily without heat stress or thermal strain for the occupants) and healthy environmental conditions to sustain occupants living quality.

II. AIMS AND OBJECTIVES

To configuration building envelope by involving uninvolved plan standards for minimal expense lodging to conquer bothersome warm condition looked by inhabitants.

1) Investigation of materials utilized in reasonable lodging.
2) Recognizing practical materials to defeat issues connected with traditional structure materials.
3) Improvement of recognized materials utilizing AHP and Relative file strategy.
4) Planning of minimal expense building utilizing aloof standards.
5) Examination of latent plan building utilizing STAAD PRO ace.
6) Correlation of traditional structure with minimal expense working by LCC.

III.METHODOLOGY



IV. RESULTS AND CONCLUSION

A. *Data Collection*

In planning building envelope conditions, there are different elements that should be remembered. The variables that influence the indoor warm quality incorporate brilliant temperature, moistness, air development, air temperatures, and human physiological viewpoints like body metabolic rate, level of action and attire of the tenants which influence the microclimatic condition inside the indoor climate. A decent indoor warm condition is fundamental for giving agreeable (principally without heat pressure or warm strain for the inhabitants) and solid ecological circumstances to upgrade tenants living quality depending on development using feasible materials. Subsequently, as an issue of this, a bunch of 60 practical structure materials were recognized and exposing to an organized survey through a Google structure. Study was directed. Then later, 10 practical materials were distinguished by utilizing an overall file procedure that depended on the reaction got from the respondents. To demonstrate the positioning of materials by relative record, another strategy Analytical Hierarchy technique has been applied and checked.

Table No. 1: Sustainable Material

S.NO	MATERIALS	THICKNESS (m)	SPECIFIC HEAT CAPACITY (J/KGK)	THERMAL CONDUCTIVITY (W/MK)	DENSITY (KG/M^3)	THERMAL RESISTIVITY (M^3K/W)	THERMAL DEFFUSIVITY (M^2/S)	THERMAL EFFUSIVITY	COST INRS /Sqft	REFERENCE
1	Cork	0.08	1900	0.04	240	2.0	8.77E-08	135-056	104	S.Khatun & A Rauth (2019)
2	Gypsum Board	0.01	1090	0.17	668	0.074	2.33E-07	351.824	12	S.Khatun & A Rauth(2019)
3	Cement plaster	0.01	780	0.72	2162	0.014	4.27E-07	1101.898	24-31	S.Khatun & A Rauth(2019)
4	Expended Polystyrene	0.07	1200	0.033	1040	2.121	2.64E-08	202.93	10	S.Khatun & A Rauth (2019)
5	Suspended Sealing	0.04	840	0.045	1000	0.889	5.36E-08	194.422	15	S.Khatun & A Rauth (2019)
6	Fibre Glass	0.08	700	0.04	1500	2.0	3.81E-08	204.93	45	S.Khatun & A Rauth (2019)
7	Pvc Mesh	0.03	1250	0.25	1400	0.120	1.43E-07	661.438	8	S.Khatun & A Rauth (2019)
8	Poluyrethane	0.03	0.03	0.02	500	1.500	1.33E-03	0.548	35	S.Khatun & A Rauth (2019)
9	Concrete	0.15	1000	0.16-1.4	2400	0.8-1.28	0.75×10-6	0.1	40-60	S.Khatun & A Rauth (2019)
10	Zinc	0.003 - 0.004	390	112.2	7135	8.62	14.13	0.31	50	Zinc (Zn) - Properties, Applications (azom.com)
11	Copper	0.03	377-389	385.0	8940	7.5×10-10	1.11×10-4	0.04-40	500	https://matmatch.com/learn/material/copper-properties
12	Clay	0.015 - 0.020	878	0.15-1.8	1600	0.85	0.78×10-7	0.23	100-150	Thermal Conductivity of some selected Materials and Gases (engineeringtoolbox.com)
13	Polyurethane	0.001 - 0.012	1000	0.02-0.03	961	3.6	5.2	0.035	90	Polyurethane Foam - Thermal Insulation (nuclear-power.net)
14	Asphalt	0.15	900	0.8-2	2243	0.44	0.74	0.2	80-150	Bin Zhao, 2019
15	Wood		2380	0.12-0.04	960	0.97	0.13×10-6	0.31	150-250	Thermal Conductivity (gsu.edu)
16	Slate	0.04-0.05	760	0.143-0.179	2691	0.05	4.2	0.1	85	Thermal parameters of roofing slates from Czech Republic | SpringerLink
17	Coffe husk	0.304	18.34	1.62	260	1390	0.19	95.14	12/kg	Robert koppen,2010
18	COB	0.457 -0.61	-891	0.6	1.400	0.505	5.9×107	674.4	7/kg	Bouwens.D,1997
19	Plastic Brick	0.08	0.08	0153	900 - 1800	0.153	9.23	936.49	75	Achel G.N Tiwari,2009

B. Data Analysis

1) Selection of Materials Using Relative Index Method (RI): Relative index is used in this selection of material process; Relative importance index analysis allows identifying most of the important criteria dependent on participants' replies and it is also an appropriate tool to prioritize indicators rated on Likers- type scales. The info had been analyzed through formula of relative index analysis method from previous related studies.

Table No.2: Evaluating of Result of Surveying (Relative Index)

S.NO	Materia ls	Durability	Thermal Transmission	Thermal Conductivity (W/Mk)	Cost (Rs/Sqft)	MaterialsUsed In DifferentPart Of Building	Sustainable criteria
1	Cork	1.26	0.26	0.04	104	used in flooringand wall covering	Socio- econom ic criteria
2	Gypsum Board	5.52	2	0.17	12	Used in ceiling, roof andfloor	Environmentally sustaina ble
3	Expand ed polysty rene	0.41	0.2	0.033	10	used in floor, walls and roof	Socio- econom ic criteria
4	Fiber glass	4.12	0.34	0.04	45	used in doors and windows	Environ mentall y & technic ally sustaina ble
5	PVC mesh	3.4	0.25	0.25	8	Used in ventilatio n and window	Environ mentall y & technic ally sustaina ble
6	Polyure thane	15	0.149	0.02	35	used in vapour retarders, windows films & roof	Environ mentall y & technic ally sustaina ble
7	Plastic blocks	33.7	0.47	0.18	45/pi ece	used in walls	Environ mentall y & technic ally sustaina ble

2) Calculation: Relative Importance Index (RII)

Table No.3: Relative Index

S.NO	STATEMENT	STRON GLY AGREE	AGREE	NEUTR AL	DISAG REE	STRONGL Y DISAGREE
	Scale values	1	2	3	4	5
1	Cork	14	43	41	22	20
2	Gypsum board	9	39	10	37	45
3	Expanded polystyrene	5	10	51	37	37
4	Fiberglass	7	10	40	42	41
5	PVC mesh	0	16	31	66	27
6	Polyurethane	11	57	40	15	13
7	Plastic blocks	25	58	42	13	2
8	Interlocking bricks	12	58	44	15	11
9	Fired clay bricks	11	57	44	16	12
10	Hollow RCC blocks	14	57	40	14	15
11	Earthen bags	10	40	48	22	20
12	Porotherm claybricks	27	66	31	12	4

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$$\text{Relative Importance Index} = \frac{5*n5 + 4*n4 + 3*n3 + 2*n2 + 1*n1}{A*N}$$

n5= Number of respondents for Strongly Agreen
n4= Number of respondents for Agree
n3= Number of respondents for Neutral
n2= Number of respondents for Disagree
n1= Number of respondents for Strongly Disagree
A (Highest Weight) = 5
N (Total number of respondents) = 140

C. Optimising materials using AHP Method

1) *Introduction:* By utilizing the AHP technique the gained materials are considerably further short recorded or chosen to acquire the best practical material, it is a strategy which is utilized to decide a solitary item from a troublesome or dubious rundown of items. The AHP strategy thinks about the significant factors and required factors and gives the best item among the given show; it depends on a recipe presented by "Thomas Saaty" (1980).
2) *The Analytic Hierarchy Process:* The Analytic Hierarchy Process (AHP), presented by Thomas Saaty (1980), is a successful device for managing complex independent direction, and may help the leader to lay out boundaries and pursue the most ideal choice. By lessening complex choices to a progression of pairwise examinations, and afterward blending the outcomes, the AHP assists with catching both abstract and objective parts of a choice. Likewise, the AHP consolidates a valuable strategy for checking the consistency of the leader's assessments, hence diminishing the inclination in the dynamic interaction

.

D. How AHP Works

The AHP thinks about a bunch of assessment models, and a bunch of elective choices among which the best choice is to be made. It is critical to take note of that, since a portion of the models could be differentiating, it isn't correct overall that the most ideal choice is the one which upgrades each single measure, rather the one which accomplishes the most appropriate compromise among the various standards.

The AHP produces a load for every assessment measure as per the chief's pairwise examinations of the rules. The higher the weight, the more significant the relating measure.

Then, for a decent measure, the AHP allots a score to every choice as indicated by the chief's pairwise examinations of the choices in light of that basis. The higher the score, the better the presentation of the choice as for the thought about model. At last, the AHP consolidates the models loads and the choices scores, in this way deciding a worldwide score for every choice, and a resulting positioning.

E. Passive Design

1) *Introduction:* The plan of the structure which keeps up with the agreeable temperature inside the structure utilizing the regular components and environment to use the advantages and to dispose of the power age and autonomy on hardware for warming lighting and cooling is called latent plan there are two significant measures that ought to be consider for uninvolved plan for helpful that are environment and solace. The uninvolved plan of the structure and its advantages are made sense of in the papers as well as the advantages of the detached plan on human wellbeing and prosperity is examined. Numerous natural qualities influence human wellbeing, prosperity public activity.
2) *Passive Design, Strategies and Site Planning:* The detached in light of taking benefits from environment and normal energy which streams to keep up with warm solace. It is tied in with utilizing the fitting structure material and building direction and finishing the direction of the structure ought to be appropriately organized and the texture of the structure envelope ought to be organized to forestall heat gain While planning a home structure envelope go about as a hindrance between virtual environment and regular environment for human solace level for accomplishing wanted degree of solace, building encompass assumes an imperative part alongside specific advances utilized. The mix of both dynamic and aloof nature helps in accomplishing solace as displayed in the figure 9

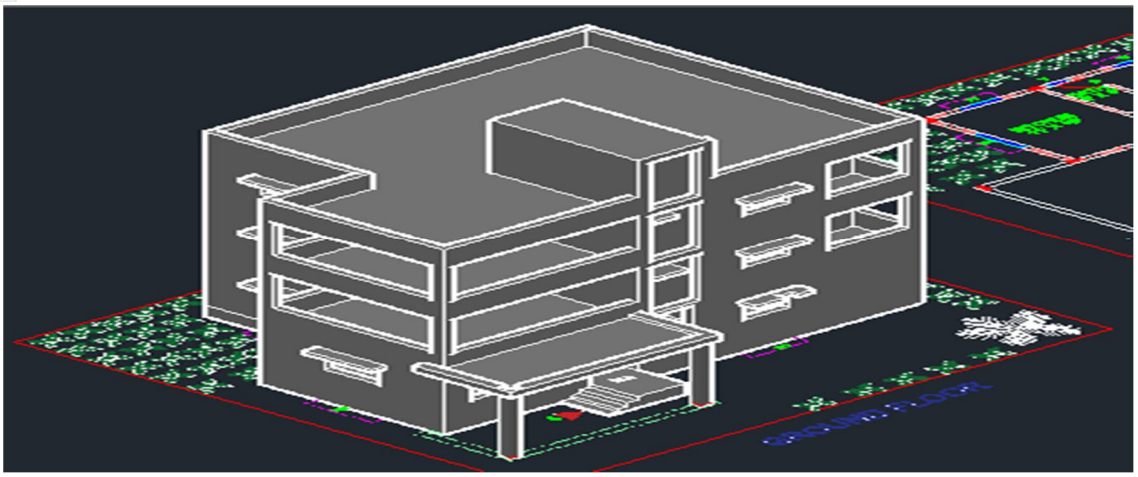


Figure 1: Building Design

F. Orientation

The structure plan ought to be so that advantages ought to be gotten from the encompassed environment assuming the idea of the weather conditions is blistering or bright the indoor and the outside of the structure should got less measure of hotness and assuming the weather conditions is cold it ought to be furnished with the breeze insurance this kind of direction ought to be consider with in the plan the spans of the window ought to be kept up with and the course of action of the windows ought to be so that the windows ought to be orchestrate the other way of the entryways so the breeze which go through the window ought to circle all through that floor with great structure wrap and the windows ought to be organize so that the sun beams which has a vitamin d which is interesting and great for human wellbeing ought to come inside the house. Well plan building ought to be situated and which has great organized space so that most of the room ought to be face towards equator in this manner the eastern and the western sides are presented to the low point summer sun in the first part of the day and the evening. Assuming most of windows are planned into the equator-confronting divider, sun infiltration into the it be boosted to assemble will. Living regions ought to be sited to acquire most extreme advantage from cooling breezes in warm climate and asylum from bothersome breezes in winter. This doesn't imply that the direction of the structure ought to be fluctuated from north towards winning breezes, as it doesn't need to confront straightforwardly into the breeze to accomplish great cross-ventilation (Mingfang 2002).

1) *Building Shape:* A decent refined latent structure produce less measure of air contamination and nursery gasses and it additionally give to a more practical climate. A decent inactive structure save energy as well as give great natural advantage in the event that we will construct a better reasonable future for this planet than conquer this representation engineers necessities to learn new apparatuses

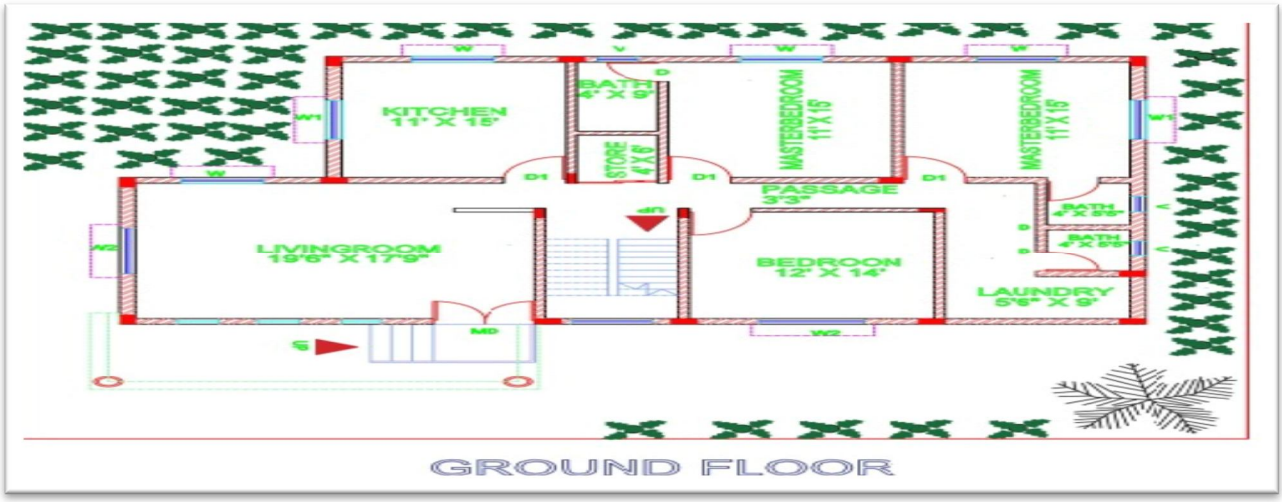


FIGURE 2: Ground Floor Plan

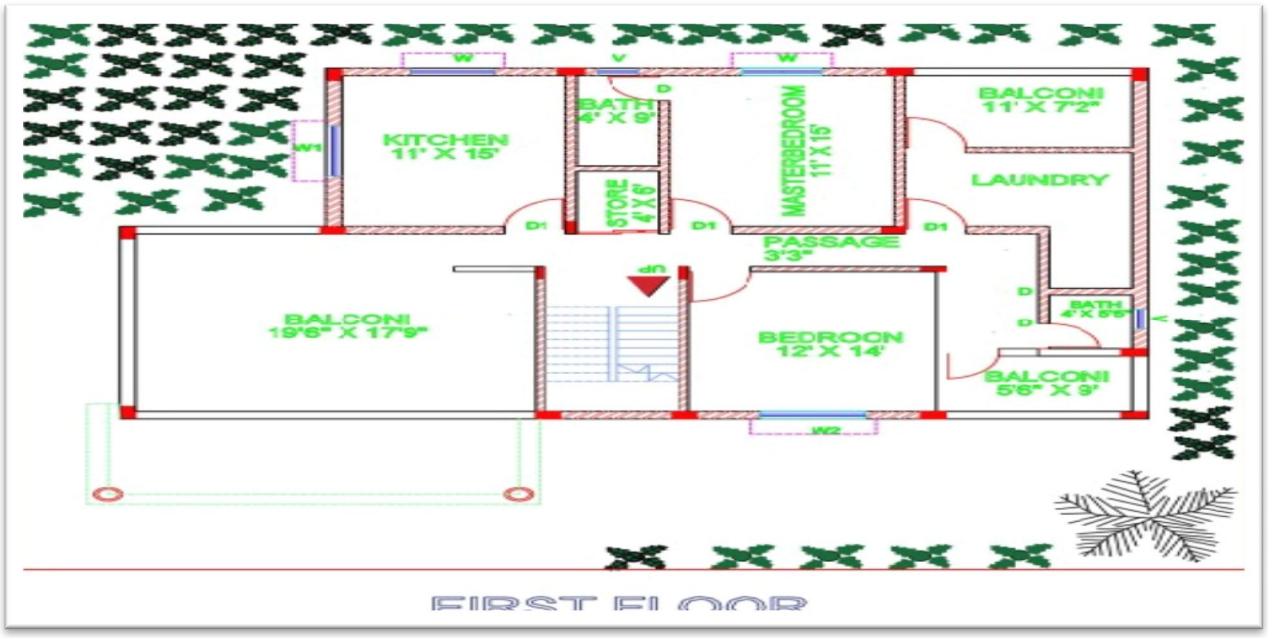


Figure 3: First Floor Plan

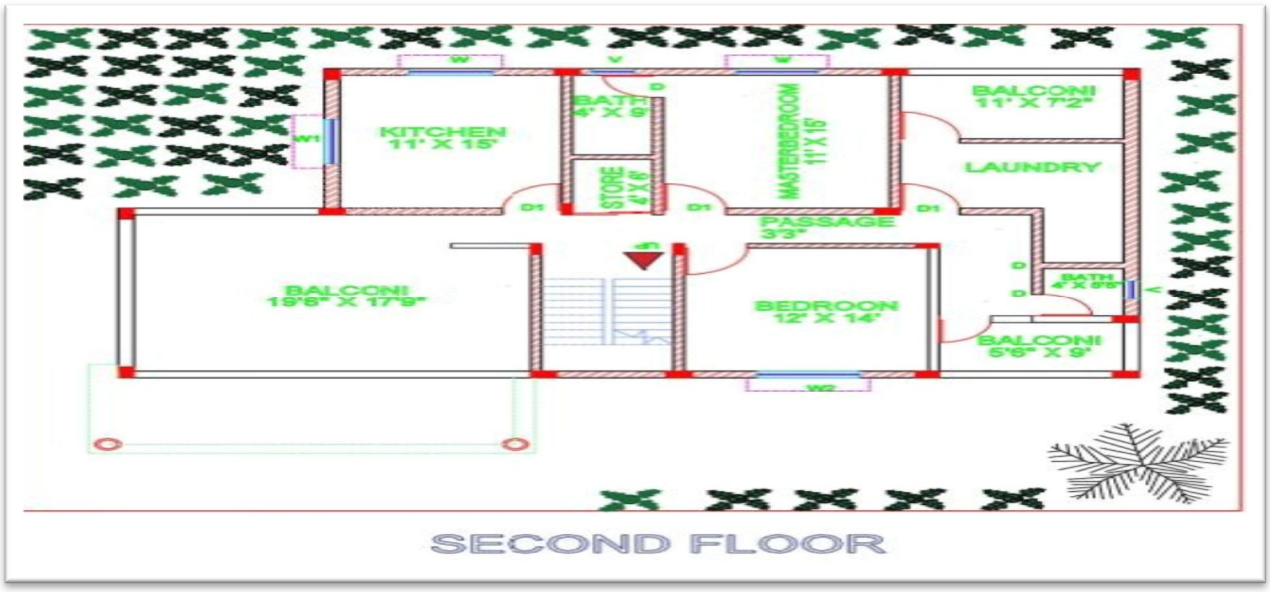
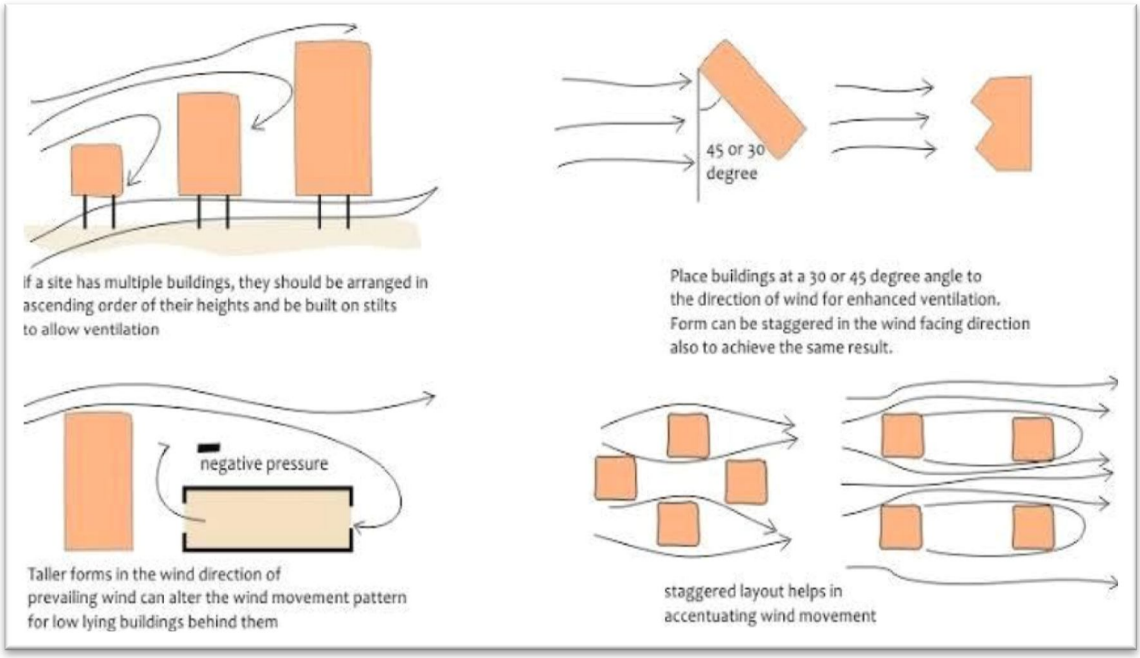


Figure 4: Second Floor Plan

The structure shape ought to be so that ought to give open space to course of wind and regular assets the plot size which we have consider while planning the aloof plan of the structure is 55'x 60' and the form size is 35'x 50' which give normal ventilation around the structure and a decent plan is one of the models for latent plan assembling yet additionally procuring regular assets like ranch and vegetation is one of the measures for good detached plan constructing the given figures 2,3,4 comprise of one arrangement with various floors. Ground floor comprise of 2 main room, 1 ordinary room, 1 store room, 1 parlor, 1 kitchen as displayed in the figure 2 First floor comprises of 1 expert bed room, 1 ordinary room, 1 kitchen, 1 washroom, 1 clothing and 3 galleries as displayed in the figure 3 and the subsequent floor is pretty much as same as 1 story as displayed in the figure 4

Site arranging is an indispensable piece of inactive planning. Every parts placement brings about the administering the microclimate created around the site. Drafting and massing help to accomplish wanted microclimate in various environments.

2) *Cooling:* Massing of the structure blocks assist with accomplishing warm and visual solace levels whenever planned according to the climatological necessities. Building blocks channelize or discourage the breeze stream; they likewise go about as concealing gadgets for environmental elements. Building blocks plan and calculation can impact the breeze stream and speed. Massing of squares can assist with managing the late spring wind and accomplish ventilation, and impede wind stream in winter season.



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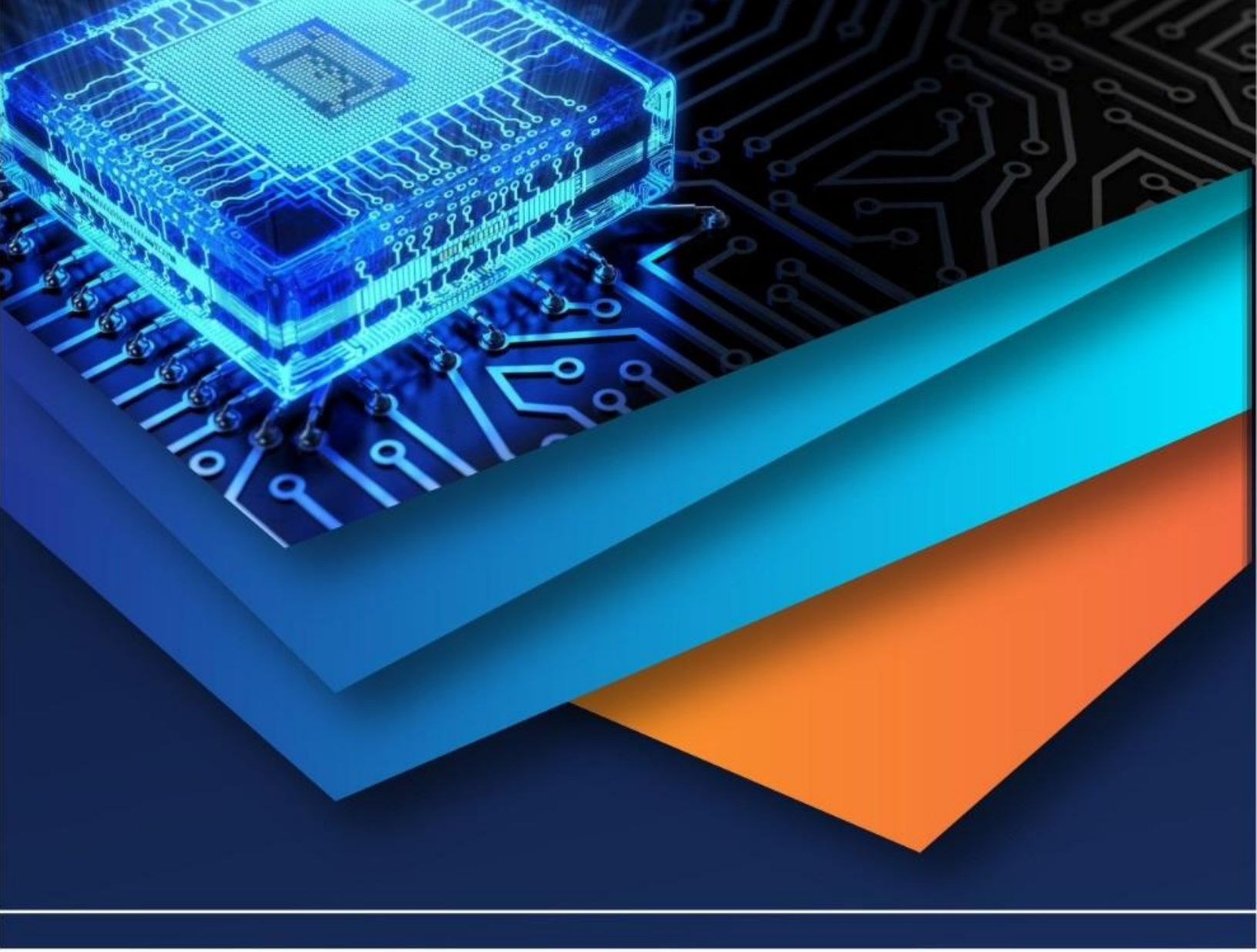

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