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ELEMENTS OF SITE AND ITS IMPORTANCE IN ARCHITECTURAL DESIGN

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Abstract: Architects can achieve energy efficiency in the building they design by studying the macro and micro climate of the site, applying bioclimatic architectural principles to combat the adverse conditions and taking advantage of the desirable conditions. This Paper includes the site elements, Proper site planning criteria's, influence of site elements in design and the importance of implementation of site elements.

Index Terms - site elements, micro climate, macro climate ,importance of site elements..

I. INTRODUCTION

Site planning is the art and science of arranging the structures on the land and shaping the spaces between, an arts of arranging **USES** of land linked to architecture, engineering, landscape architecture, and city planning.

Site plans locate objects and activities in **SPACE** and **TIME**. These plans may concern a small cluster of houses, a single building and its grounds, or something as extensive as a small community built in a single operation.

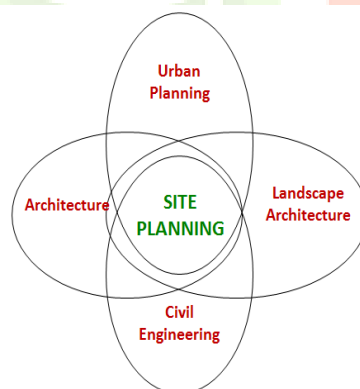


Fig 1. Interdisciplinary- Site planning

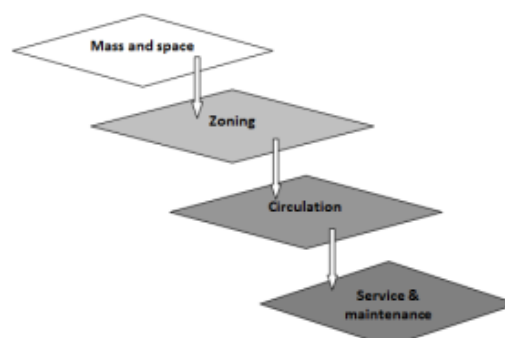


Fig 2. Process of Site planning

Site planning is the organization of the external physical environment to accommodate human behavior. It deals with the qualities and locations of structures, land, activities and living things. It creates a pattern of those elements in space and time, which will be subject to continuous future management and change.

- **Spirit of place**
- **Character of the place**
- **Nature of the project**
- **Behavioral studies**

Four basic models of site planning in history

- Fixing the place
- Defining the enclosure
- Sense of order
- Form of axial

Identifying the site elements and proper integration of site elements with design plays a vital role. Common elements that directly or indirectly affect thermal comfort conditions and thereby the energy consumptions in a building are listed below:

- Proper site Planning.
- Landscaping
- Location of water bodies
- Proper building orientation
- Apt Plan form
- Ratio of built forms to open spaces
- Building Envelope & Fenestrations

II. SITE

Careful selection of site helps in saving considerable amount of energy and provide satisfactory indoor environment throughout the year. Proper site planning can modify the microclimate of the site.

Micro climate of the site is affected by the following factors-

- Landform
- Vegetation
- Water bodies
- Street width and orientation

III. LANDFORM

Landform may be flat, undulating or sloping. Each may have a varying effect on the microclimate and may have to be planned accordingly.

- Wind flow is higher along the direction of the valley than across it.
- On slopes the air speed increases as it moves up the windward side, reaching a maximum at the crest and minimum on the leeward side.
- Thus position of the building with respect to the landform should be carefully studied.

IV. LANDSCAPING

Landscaping is an important element in altering the microclimate of a place. Proper landscaping reduces direct sun from striking and heating up building surfaces.

It prevents reflected light carrying heat into a building from the ground or other surfaces.

Landscaping creates different airflow patterns and can be used to direct or divert the wind advantageously by causing a pressure difference.

Additionally, the shade created by trees and effect of grass and shrubs reduce air temperatures adjoining the building and provide evaporative cooling.

Properly designed roof gardens help to reduce heat loads in a building.

A study shows that the ambient air under a tree adjacent to the wall is about 2 °C to 2.5 °C lower than that for un shaded areas.

Trees are the primary elements of energy –conserving landscape. Climatic requirements govern the type of trees to be planted.

For Eg: Planting deciduous trees on the southern side of a building is beneficial in a composite climate, Deciduous plants such as mulberry or champa cut off direct sun during summer and as these trees shed leaves in winter they allow the sun to heat the buildings in winter.

Plants shrubs and trees cool the environment as they absorb radiation for photosynthesis.

Vegetation also creates different air patterns and can be used to direct or divert the prevailing wind advantageously by causing minor pressure differences.

V. WATERBODIES

Water is a good modifier of microclimate. It takes up a large amount of heat in evaporation and causes significant cooling especially in a hot and dry climate.

Since water has a relatively high latent heat of vaporization, it uses up a large amount of heat in evaporation and causes significant cooling effect.

It also raises the humidity level. Hence should be avoided in humid climates. The wind flow pattern at a site is influenced by the presence of a large water body.

VI. BUILDING ORIENTATION

Building orientation is to be done with regard to solar radiation and wind. With careful design, shading and deflecting devices can be incorporated to exclude the sun or redirect it into the building, just as wind can be diverted or directed to the extent desired.

The buildings on one side of the street tend to cast a shadow on the street and opposite building, if they block the sun's radiation.

VII. OPEN SPACES AND BUILT FORM

7.1 OPEN SPACES

Open spaces such as courtyards can be designed such that the solar radiation incident on them during day time can be reflected on to the building facades for augmenting solar heat. This is possible if surface finish of the courtyard is reflective in nature. Courtyards can also be designed to act as heat sinks. It provides cooler environment if covered by grass and other vegetation. Water body in the courtyard gives cooling effect.

7.2 BUILDING FORM

The volume of space inside a building that needs to be heated or cooled and its relationship with the area of the envelope enclosing the volume affect the thermal performance of the building. This parameter, known as the S/V (Surface to volume) ratio, is determined by the building form.

Surface to volume ratio: A compact building gains less heat during daytime and loses less heat at night. The compactness of the building is the ratio of its surface area to its volume, that is, Compactness = S/V (surface area/volume). In hot-dry climates the S/V ratio should be as low as possible to minimize heat gain. In warm humid climates the prime concern is creating airy spaces. This would require a higher S/V ratio.

- The parameter surface to volume ratio is determined by the building form.
- For any given building the more compact the shape, the less wasteful it is in gaining or losing heat. Hence in hot and dry regions and cold climates, buildings are compact in form with a low S/V ratio to reduce heat gain and losses respectively.
- Also the building form determines the air flow pattern around the building, directly affecting its ventilation.

The depth also determines the requirement of artificial lighting – greater the depth higher the need for artificial lighting and higher the energy consumption.

- The building envelope and its components are key determinants of the amount of heat gain and loss and wind that enters inside. The primary elements affecting the performance of a building envelope are:
 - Materials and Construction techniques
 - Roof
 - Walls
 - Fenestrations and shading
 - Finishes

VIII. MATERIAL WITH LOW EMBODIED ENERGY

Choice of building materials is important in reducing the energy content of buildings. Strain on conventional energy can be reduced by use of low-energy materials, efficient structural design and reduction in transportation energy.

8.1 THERMAL INSULATION

Insulation is of great value when a building requires mechanical heating or cooling insulation helps reduce the space conditioning loads. Location of insulation and its optimum thickness are important. In hot climates, insulation is placed on the outer face (facing interior) of the wall so that thermal mass of the wall is weakly coupled with the external source and strongly coupled with interior.

8.1.1 ROOF

The roof receives significant solar radiation and plays an important role in heat gain/losses, day lighting and ventilation. Depending on the climatic needs proper roof treatment is essential. In hot regions, the roof should have enough insulating properties to minimize heat gains.

A massive roof of RCC tends to delay the transmission of heat into the interior when compared to lighter roofs such as asbestos cement sheet roofing.

Roof covered by inverted earthen pots with a layer of earth over them provides good insulation. The earth and the air inside the pots provides good insulation for heat.

- Broken China mosaic tiles can be used as the topmost layer in roof for reflection of incident radiation.
- A cover of deciduous plants or creepers can be provided. Evaporation from leaf surfaces will keep the rooms cool.
- A removable cover is an effective roof shading device. This can be mounted close to the roof in the day and rolled up to permit radiative cooling at night. The upper surface of the canvas should be painted white to minimize the radiation absorbed by the canvas and consequent conductive heat gain through it.

- Effective roof insulation can be provided by using vermiculite concrete as used in RETREAT building at Gual Pahari (near New Delhi) and has reduced roof conduction by 60%.
- Incorporating vents and skylights for effective ventilation and day lighting.

8.1.2 WALLS

- The wall thickness, material, and finishes can be chosen based on heating and cooling needs of the building.
- Appropriate thermal insulation and air cavities in the walls reduce heat transmission into the buildings.

8.1.3 AIR CAVITIES

Air cavities within walls or an attic space in the roof ceiling combination reduce the solar heat gain factor, thereby reducing space-conditions loads.

The performance improves if the void is ventilated. Heat is transmitted through the air cavity by convection and radiation.

8.1.4 FENESTRATIONS AND SHADING

- Of all the elements in the building envelope, windows and other glazed areas are most vulnerable to heat gain or losses.
- Proper location, sizing and detailing of windows and shading form an important part of bioclimatic design as they help to keep the sun and wind out of a building or allow them when needed.
- Appropriate design of openings and shading devices helps to keep out the sun and wind or allow them into the building.
- The location of openings for ventilation is determined by prevalent wind direction.
- Openings at higher levels naturally aid in venting out hot air.
- Size, shape and orientation of openings moderate air velocity and flow in the room.
- Fenestrations having 15%- 20% of floor area are found adequate for both ventilation and day lighting in hot and dry and hot and humid regions.
- The important components of window that govern the comfort are the glazing systems and the shading devices.

8.1.5 SHADING DEVICES

Heat gain through windows is determined by the overall heat loss coefficient U-value (W/mk) and the solar energy gain factor and is much higher as compared to that through solid wall.

Shading devices for windows and walls moderate heat gains into the building.

In a low rise residential building in Ahmedabad, shading a window by a horizontal 0.76 m deep chajja can reduce the maximum room temperature by 4.6 C.

Moreover the number of uncomfortable hours in a year with temperatures exceeding 30 C can be reduced by 14%.

Shading devices are of various types-

- Movable blinds or curtains.
- Louvers.
- Fixed overhangs

A. Movable blinds or curtains:

- Block the transmission of solar radiation through glazed windows, especially on the east and west walls.
- In hot and dry climates, when ambient air is hotter than room air, they help to reduce convective heat gain.
- In warm, humid climates, where the airflow is desirable, they impede ventilation.
- For air conditioned buildings, where the flow of outside air is to be blocked, they can reduce cooling load.

B. Overhangs and louvers

- Blocks the part of sky through which sunlight passes.
- Overhangs on the south oriented windows provide effective shading from the high-altitude sun.
- An extended roof shades the entire north or south wall from the noon sun.
- East and west openings need much bigger overhangs, which may not be possible and can be achieved by porticos or verandahs on these sides or by specially designed louvers to suit the building requirements.

C. Glazing systems

- Natural light enters into the buildings thro glazed openings, skylights, light shelves, clerestories etc. Special types of glazing may also be used to reduce the transmission of heat and glare.
- The window size should be kept minimum in hot & dry regions.

8.1.6. FINISHES:

The External finish of a surface determines the amount of heat absorbed or rejected by it.

A smooth and light colour surface reflects more light and heat in comparison to a dark colour surface.

Lighter colour surfaces have higher emissivity and should be ideally used for warm climate.

IX. CONCLUSION

Site Planning is the interdisciplinary, considering the process of planning, study of micro and macro climate, knowing the importance of site elements and implementation of site elements in design process will give the sustainable design output..

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