CHAPTER

1 Site Selection and Planning

INTRODUCTION

All architectural projects have their origin in the sites they are located, and their conceptualisation, planning, designing and construction are site specific. Every site is unique and distinct, comprising numerous complex elements that include varying topography, flora and fauna, biodiversity, climate, physical, social, environmental features, culture, etc. which largely influence, impact, and guide design process and decision making.

Site is crucial in positioning and orienting the building, determining the footprints, form, shape, fabric, material, structure, sustainability, and typology of the building, and its relation with the neighbourhood buildings. Finding and locating an appropriate site for any project and analysing the site is vital for a project to be rational, effective, and relevant.

Architectural site analysis involves evaluating a particular location physically, environmentally, and socially. The aim is to develop an architectural solution of merit to achieve the project's objective. Appropriate site is a pre-requisite that's vital to developing a project of merit because all good architectural solutions have their genesis in understanding, appreciating and utilising the maximum out of the site.

Site is a major determinant of success and failure of a project, hence sourcing appropriate site is vital for the owner, project managers, and architects. Broad guidelines and principles must be kept in mind while defining/selecting sites for any sustainable architectural project. Since all human settlements are unique, defining precise site selection is complex. Important factors in searching for an appropriate site, the broad methodology, guideline and approach, are:

1. Site selection
2. Site ecology and ecological survey
3. Site planning
    - A. Analysis
    - B. Minimising disturbances to the site
    - C. Microclimate
    - D. Heat island effect
    - E. Erosion and sedimentation control

F. Exterior lighting
G. Facilities for differently able

1.1 SITE SELECTION

Site selection and planning affects decisions about the surrounding facilities and emphasises on relationships between built environment, ecosystems, and ecosystem services. It focuses on restoring project site elements, integrating the site with local and regional ecosystems, and preserving the biodiversity that natural systems rely on. Selecting sites that have low ecological impact i.e., brownfield sites/contaminated land, urban infill can save the farmlands and greenfield locations.

The aim of ideal site selection and planning is to minimise ecological degradation by designing buildings and systems that reduce the impact of earthworks, runoffs, construction pollution and ongoing operations.

1.1.1 LOCATION

Environmental and public health experts warn that an explosion in the number of motorised vehicles on India's roads is threatening the health and economic security of its population. Vehicular emissions significantly contribute towards air pollution and greenhouse gas emissions.

Availability of water, sewerage, road network, storm water drains, communication network, etc. are vital for any project, institution, and user. While evaluating sites, these essentials must not be ignored. The absence of these services and infrastructures could delay the project and the initial, operational and maintenance costs could increase and make the project unaffordable. Only developed areas, where municipal services are available, must be considered for location of the project. Besides physical infrastructures, availability of social infrastructures in the close vicinity also need detailed evaluation. Success and failure of a project is largely governed by the availability of quality supportive infrastructure within and in the proximity.

1.1.2 BASIC AMENITIES

Basic amenities are essential for enhanced quality of life because they provide comfort, convenience and pleasure. Therefore, select a site for the project that is close to varied amenities or services such as schools, pharmacy, grocery/supermarket, post office. as listed in the compliance. To encourage the occupants to walk, there should be pedestrian access to these amenities without highways, walls, or other barriers blocking them.

Avoiding environmentally sensitive areas helps protect features that make many areas so special—creeks, lakes, aquifers, tree-covered hills, wildlife, native wildflowers and plants.

Fig. 1.1 Example – A project site with basic amenities in proximity

1.1.3 ACCESS TO PUBLIC TRANSPORTATION

India's National Action Plan for Climate Change (NAPCC) recognises that GHG emissions from transport can be reduced by adopting a sustainability approach through a combination of measures, such as increased use of public transport, higher penetration of biofuels and enhanced energy efficiency of transport vehicles (NAPCC, GoI, 2008).

(a) **Increasing the proximity of occupants to public transport during site selection:** To reduce the impact of fossil fuel-based transportation, promote public transport and ensure that at least one mode of public transport is at a walkable distance (800m) to the building occupants.

(b) **Provision of access to public transport:** If public transport is not accessible, provision of shared vehicles (preferably alternate fuel vehicles like CNG and e-vehicles) from/to the nearest mode of public transport should be made available. Carpooling should be encouraged by providing incentives to the occupants, besides mass transit use.

(c) **Encourage alternative modes of transport:** To encourage the use of bicycles and alternative fuel vehicles, associated facilities like bicycle racks, e-charging facilities, reserved parking for e-vehicles, showers and lockers should be encouraged.

(d) **Planning considerations:** Service, pedestrian, and automobile paths need consolidated planning to minimise pavement costs, improve efficiencies, and centralised runoffs. Besides these, while planning road infrastructure, the roads, walkways and parking areas should be as compact as possible so that the ratio of impermeable surfaces to the gross site area can be reduced.

1.2 SITE ECOLOGY AND SURVEYS

Most of the developments impact the habitat and the local biodiversity of the site. Some of those impacts cause loss of habitats, reduction in the value of habitat or the ability of the habitat to support the species that depend on them.

An ecological site is a distinctive land with specific soil and physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and its ability to respond similarly to management actions and natural disturbances. Ecological surveys are carried out to identify species or habitats that exist on a particular site. They identify potential constraints to the development because of important habitats or species.

Early identification of ecological constraints ensures timely development of proposals and incorporation of mitigation measures into the design phase.

Purpose of ecological surveys

The purpose of undertaking ecological surveys is to:

- Assess under EIA Regulations
- Identify ecological constraints, if any, at an early stage
- Minimise impact on biodiversity
- Identify endangered or legally protected species and minimise or avoid any impact on them
- Appropriately design mitigation measures as per the site and the surrounding areas

1.3 SITE PLANNING

1.3.1 SITE AND CLIMATE ANALYSIS

Site analysis is an activity usually performed prior to the commencement of design, to determine site characteristics and develop the project design with minimum disturbance to the site features. The purpose of performing the analysis is to understand the prevailing site conditions and gather thorough information about the positive and negative factors affecting the site before starting the design. The information helps in developing design concepts, which further help in shaping a good relationship between the building and the site.

Site analysis involves study of the climate by analysing the sun path and wind patterns to locate the buildings at an ideal orientation on the site. The analysis further includes study of existing soil, topography, underground water levels, vegetation, etc.

The general design objectives for each climatic region are:

- Cold – The warming effect of solar radiation should be maximised and impact of winter wind minimised.
- Temperate – The warming effect of solar radiation should be maximised in winter and circulation of winter wind minimised. At the same time, shade should be maximised in summer while allowing air circulation.
- Hot-Arid – The design should focus on maximising shade and minimising the hot, dust-laden winds.
- Hot-Humid – The design should focus on maximising shade and wind to reduce humidity.

1.3.2 SUN PATH

The sun path diagram helps determine the position of the sun at different times of the day throughout the year. It helps to understand if the sun is available on the site, on any orientation, during a particular time. The sun path analysis also helps understand the shading patterns on the site by the existing trees or buildings around the site, which would help in determining the building location and orientation.

Elements of Sun Path Diagram

The sun path diagram shows the path of the sun in the sky-dome as projected onto a horizontal surface.

- There is a different sun path diagram from every latitude.
- The lines running from east to west represent the path of the sun on 21st day of each month of the year.
- Lines running perpendicular to the sun path lines indicate hours of the day.
- The lines radiating from the centre indicate the sun’s azimuth, i.e., the direction/angle of the sun.
- The concentric lines indicate the sun’s altitude. For example, at sunrise and sunset the sun’s altitude is zero, while it is maximum at 12 noon.

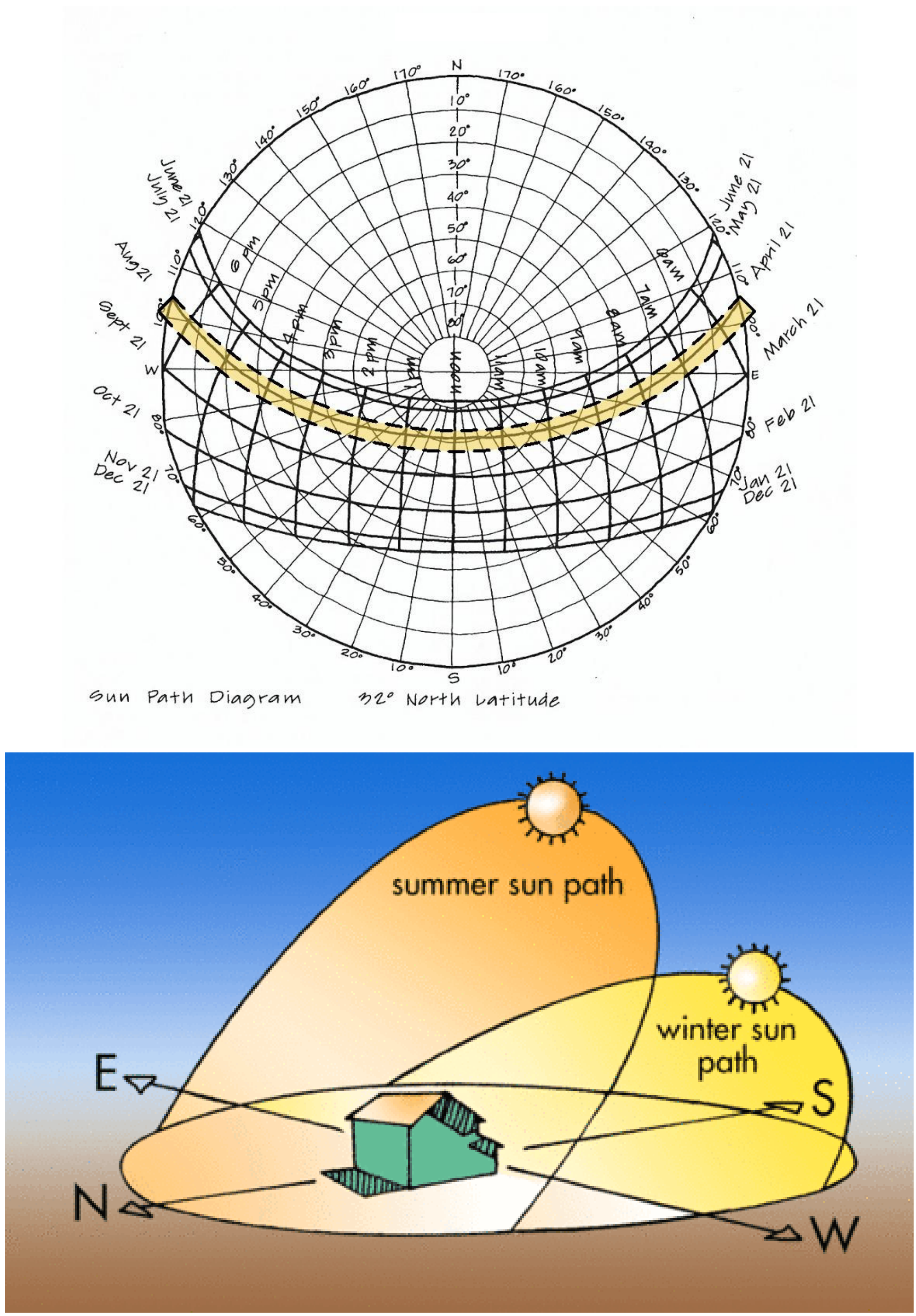


Fig. 1.2 Sun Path Diagram – Latitude 28^{o}

How to read sun path diagram

To determine the sun's position at 28°N latitude at 3pm in April,

1. Identify the month and time – Find the intersection of 3pm line and April line.
2. Find the azimuth – Follow the radial line that runs through the intersection and read azimuth of 260° west of south
3. Find the altitude – Finally, follow the concentric ring that runs through the intersection and read the sun altitude of 45°.

Dates, time, altitude and azimuth may all be interpolated between the values given.

1.3.3 WIND ROSE

It is important to locate the building in a particular orientation for continuous wind flow in the common areas and cross ventilation in the building. For this, wind direction and wind patterns on the site must be understood. This is possible through a wind rose diagram. Wind rose graphically represents the wind condition, direction and speed, at a given time and location. It shows the frequency of winds blowing from a particular direction.

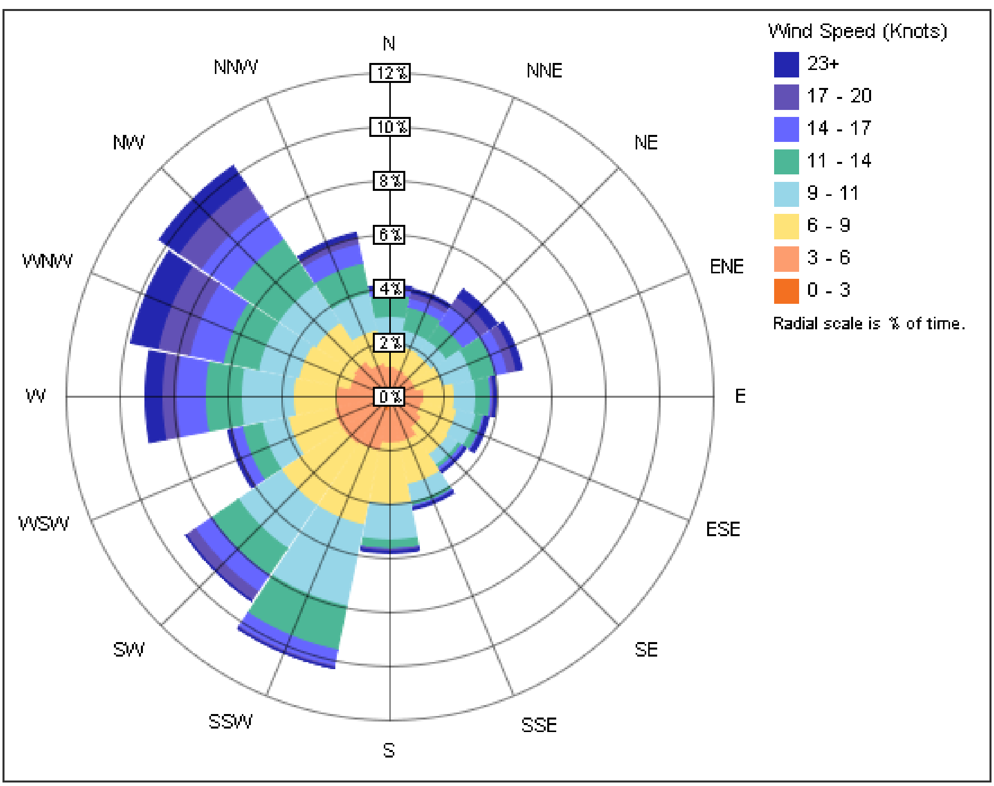


Fig. 1.3 Wind rose plot of Chennai 1 January 2020 – 31 January 2020

- The wind rose diagram normally comprises 8 or 16 radiating spokes that represent the cardinal wind directions (north, east, south, west) and their intermediate directions.
- The concentric circles and thickness of the lines represent the frequency of the wind.

How to read wind rose diagram

1. **Location –** The location of the wind rose is mentioned at the top of the diagram along with time duration.
2. **Legend –** The coloured boxes represent the wind speeds listed next to it. These colours correspond to the colours on the spokes and tell the wind speed. Check the unit to see if it's given in m/s, km/s, m/h, knots, etc.
3. **Concentric circles –** The concentric circles represent the duration for which the wind blows at certain speeds. Most often, the numbers are presented as percentages of the overall time, however, sometimes they are presented as hours or days.

1.4 MINIMISE DISTURBANCES TO SITE

India has become one of the fastest growing construction sectors in the world. New construction spending has grown by as much as 10% in the last ten years and built floor area has more than doubled. This increase in construction activity is being driven by rapid urbanisation.

Infrastructure developments restructure and modify a site, impacting its topography and landscape. Development of new buildings is often seen to be associated with disturbing the existing topography and vegetation. This can lead to the loss of native species and biodiversity.

To address these challenges, it is recommended to adopt a master plan for the development of the project site, minimise disruption to existing ecosystems and design the building to minimise its footprint. The type of soils on-site will influence where buildings are placed, where infiltration facilities are located, an[-d even the areas that must be preserved for natural vegetation. A comprehensive soil profile must be performed for efficient layout of the site and the specific activities to be followed must be understood.

Site disturbance can be avoided by maintaining at least 15% of the site area with natural topography and/or vegetated spaces. This can be achieved by reducing the development footprint. The project team should survey the project site, study the existing vegetation, ecosystems, and topography, such as rocks, and water bodies. Consider consequences of proposed development on existing features and develop strategies to minimise this impact.

Strategies for reducing disturbances in site include:

- Preserving the natural features
- Designing landscapes with multi-culture plant species to promote biodiversity and native or adaptive vegetation

If project site area is less or already disturbed, design the site with more vegetated spaces on built structures such as parking, footpaths, walkways, roads, grass medians and pavers, or consider vertical landscaping on external walls.

Maintaining existing topography and vegetation helps in:

- Preserving existing biodiversity on the campus
- Maintaining microclimate conditions of the site
- Improving site air quality
- Prevailing drainage patterns, existing vegetation and saving on energy usage
- Lessening the construction cost by working with the site contours rather than mass grading, which creates air pollution, erosion potential, and ecosystem loss

Preservation of existing trees and transplantation

Infrastructure development reforms and modifies the landscape. Trees are often subject to the potential impact of new development. This leads to the loss of native species and biodiversity. Preserving the right trees and protecting them from damage can maintain greenery and minimise subsequent cost of rehabilitation of a tree. Trees are carbon sinks and CO2 levels could increase due to deforestation.

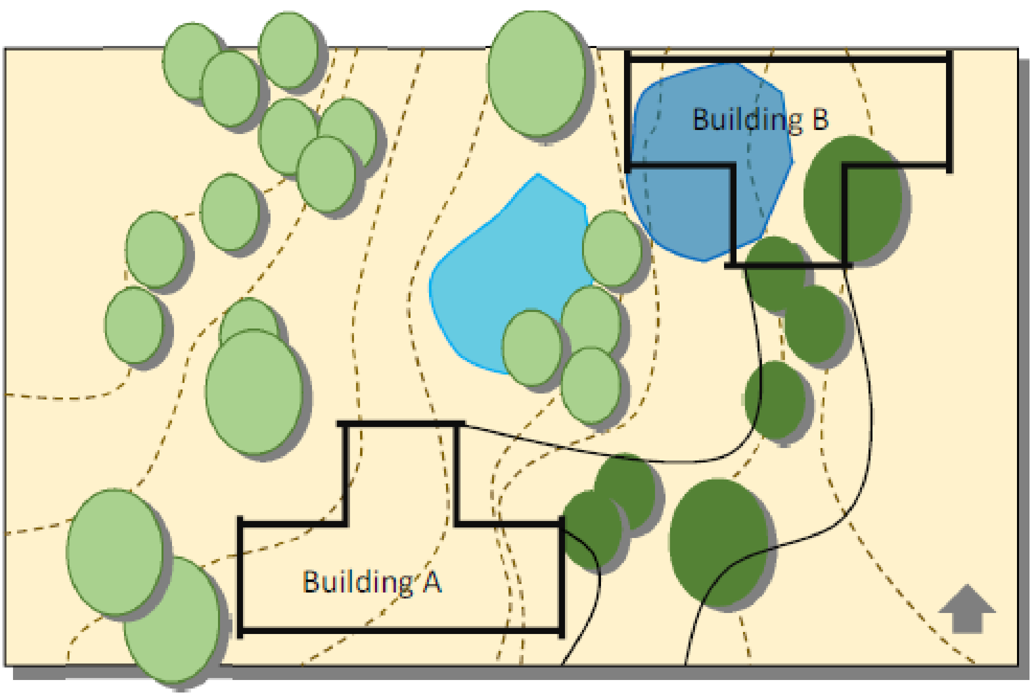


Fig. 1.4 Example – Site planning with existing trees

Site planning with existing trees

If trees are present onsite, the project team should plan the building design around the trees rather than cutting them down. Existing vegetation should be marked on the site survey plan.

Design must integrate trees with the new development to preserve the maximum number of existing trees. Fully grown trees falling under the area earmarked for the construction must be preserved in the existing landscape plan.

In the example below, 7 trees out of the 25 are impacted by the proposed development. Pathway can be altered to save trees. Alternatively, footprint of the building can be modified to preserve the existing trees. After marking the location of the existing trees, the project team can start planning the utilities, roads, design of the buildings around the existing trees, and protect the habitat and biodiversity.

Trees must be retained on the project site and protected by taking the following measures:

Tree survey in a prescribed format should be carried out, as indicated in the table below. The landscape plan should show trees that have been preserved, and those which had to be transplanted or removed.

Table 1.1 Tree survey schedule format

Tree Survey Schedule Format						
Tree No.	**Botanical Name**	**Common Name**	**Girth**	**Height**	**Spread**	**Condition**

Transplantation of existing trees

If the project cannot preserve the existing trees, tree transplantation must be carried out. Transplantation is the latest method to conserve trees and facilitates infrastructure development in cities without felling of trees.

Any healthy tree can be transplanted in any season. The survival rate of trees while transplanting is about 80%. Transplantation can be done up to a distance of about 1500km. Considering the extrinsic and intrinsic factors, transplantation is a proven economical process.

Transplantation process

Following is a step-by-step approach to transplant a tree from one location to another:

- **Planning:** The first step is to collect the details of the tree species to be transplanted. The team should evaluate whether the tree can be retained/removed and the analysis should include the sun and water requirement, type of soil, and approximate height, girth, root ball diameter, etc. Assessment of the site of relocation should be done and details mentioned on spacing of existing trees, soil pH, etc.

Botanical name: *Couroupitaguianensis*

Common name: Cannon ball tree

Approxht.: 7ft

Sun requirement: Full Sun

Water requirement: Moderate

Fig. 1.5 Example – Transplantation process

- **Pit Preparation:** The pit should be dug in advance and its size be at least 1.5 times the root ball diameter. The root ball diameter should be ten times the diameter of the stem, six inches from above the ground and the depth of pit should be approximately the same as the root ball.

Fig. 1.6 Preparation of pit

Fig. 1.7 Preparation of tree

- **Preparation of tree:** The area of the root ball should be marked, and the branches pruned and the excavation done outside the demarcated line.
- **Root ball excavation:** The circular shape should be maintained while excavating the root ball and cutting be done without damaging the roots. By using a rooting hormone, clone a new plant from a fresh plant cutting, ensuring that the cloned

plant grows fast and strong while being protected from fungus and disease. Root hormone is a mixture of plant hormones that stimulate the growth of a plant cutting and should be sprayed on fresh cuts.

Fig. 1.8 Example – Root ball excavation

- **Burlap/packing of root ball:** While packing the root ball, wrap the root ball with gunny sacks, which help retain moisture, protect the root ball and ensure easy installation.
- **Lifting and packing:** The tree and root ball must be firmly secured and leaves of the tree removed to reduce evaporation loss. Few leaves should be retained to

understand the growth pattern of the tree after transplantation. The lifting should not take place from the trunk. It should be done from an inch above the root ball.

Fig. 1.9 Example – Root Ball excavation and Burlap, and lifting and moving

- **Post-plantation care:** The tree support systems need to be provided post plantation. After placing the tree, the pit should be filled with topsoil followed by excavated soil. The plant/tree must be irrigated depending upon the season and requirement and the root/shoot hormones be applied periodically.

Fig. 1.10 Example – Post-plantation care

Some key aspects related to operation and maintenance during and post transplantation are:

- Provided with proper support, trees can be left without plantation for 4–5 days.
- Trees can be stored in tree banks for 2–4 years.
- Trees can be transported and translocated from 40km to 1500km distance.

- Tree survival after transplantation depends on proper trimming of roots, sunlight, watering of plants and support for adaptation. Water logging must be avoided and care be taken to ensure roots do not rot.
- Time required for the process to establish the tree is 6–8 months, depending upon the height and girth of the tree.

1.5 TOPOGRAPHIC MICROCLIMATE

Every site has its own climate characteristics. This local set of atmospheric conditions that differ from those in the surrounding areas is called microclimate.

Buildings can be located with the use of these microclimates. Microclimate makes a location on the site more desirable than the other locations. Microclimate can get affected by buildings and landscapings around the site too. For example, the tree in the figure below is acting as a windbreak that protects the house against the winter winds and changes the microclimate of the site significantly.

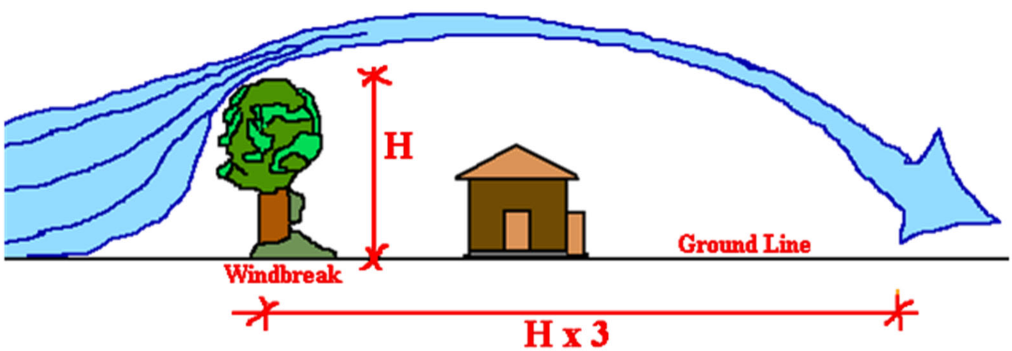


Fig. 1.11 Example – Topographic microclimate

According to the Indian Meteorological Department, the critical months of each season are January, May, August, and November, representing winter, summer, monsoon, and post monsoon respectively.

Several principles to predict the microclimate to design a building on a site are:

- **Air movement is driven by density:** In valleys, the less dense warm wind moves uphill during the day and the denser cool air flows downhill. At night, when temperatures are cool, the area near the ground forms a cool layer by collecting the cool air, while a warm layer of air collects in the higher elevation landforms. Thus, in such areas designing the buildings at higher landforms is suitable for the microclimate created in the valleys.

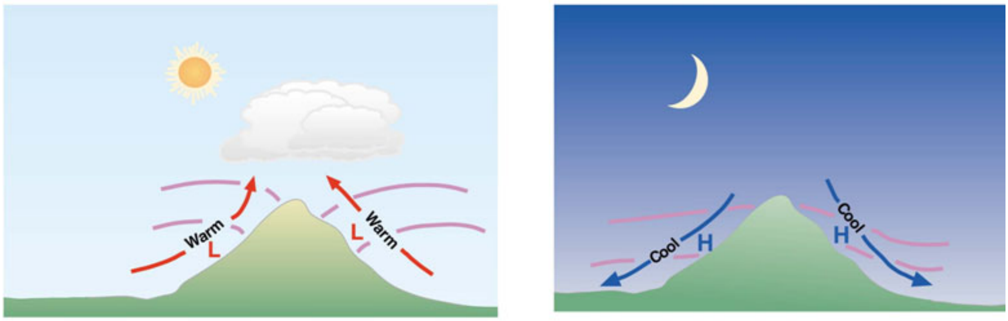
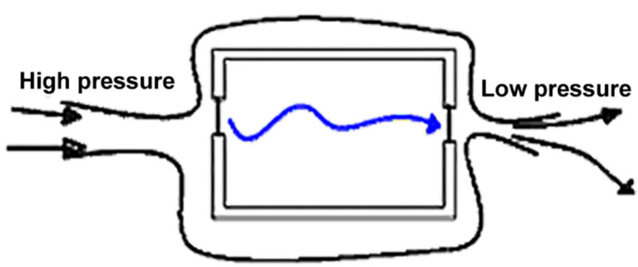


Fig. 1.12 Example – Air movement driven by density

- **Solar radiation varies with the terrain:** In tropical climatic conditions, the sun moves from east to west from the south and faces south for the maximum time of the day. South-facing slopes/flat surfaces receive more radiation of the sun than other orientations. Designing buffer spaces or locating the renewable energy towards the south directions result in maximum generation.

  However, in cold climates, designing regularly occupied spaces towards the southern direction result in heating the space naturally. The easterly slopes/orientation receive more morning sun, and western slopes/orientation receive more afternoon/evening sun. The projects can choose to locate their regularly occupied spaces in these orientations as the impact on daily radiation for east-west orientation is not huge. North orientation is the idealistic location to plan the regularly occupied spaces as there are no direct radiations, rather only diffused daylight.

- **Air flows from high-pressure to low-pressure areas:** Natural ventilation is caused by the pressure difference created naturally because of the temperature difference between outside and inside of the building. The windward side of the building creates a positive/ high pressure, whereas the leeward side of the building has a negative pressure, thus creating a suction region. This results in a large flow of wind from the high pressure areas to the low pressure areas through the building openings/windows and is commonly termed cross ventilation.



Cross Ventilation

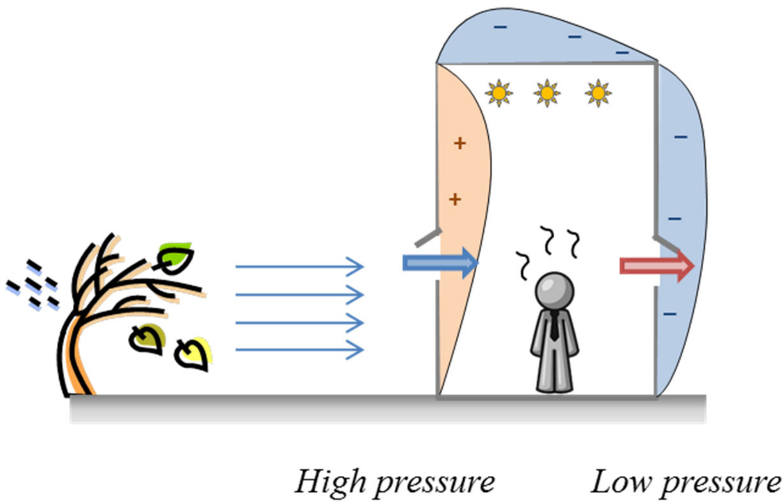


Fig. 1.13 Example – Air flow from high-pressure to low-pressure areas

- **Venturi effect:** When the air flow is channelled and restricted, it creates a pressure drop, and its velocity increases. This phenomenon is termed as venturi effect. Venturi effect is utilised in buildings for passive cooling and natural ventilation. Buildings can be designed with bigger positive and smaller negative air pressure zones, thus creating increased air flow in the buildings. The venturi effect can be utilised while designing the street networking to increase airflow on the streets.

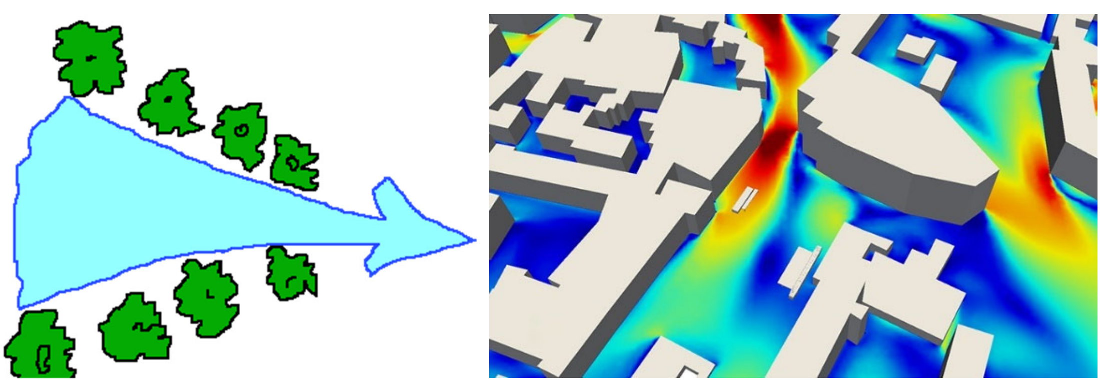


Fig. 1.14 Venturi effect

1.6 HEAT ISLAND EFFECT

Heat island effect occurs when urban landscapes experience warmer temperatures, when compared to the adjacent rural areas, because of solar energy retention on constructed surfaces.

Research shows that Indian cities are becoming 'urban heat islands'. The ongoing study, based on NASA satellite readings, shows cities would be warmer by 5–7°C than the surrounding rural areas on summer nights. Artificial urban surfaces, such as concrete and asphalt, act as a giant reservoir of heat, absorbing it in the day and releasing it at night. Traffic pollutants also add to the heat and people turn to air conditioning, which causes more heat and pollutants, and increases climate changing emissions and that leads to warmer global conditions. The two important strategies to mitigate this problem are reflective roofs and vegetated roofs.

Dark, non-reflective surfaces used for parking, roads, roofs, walkways, and other hardscapes absorb the sun's warmth and radiate heat, creating heat islands. Urban areas can be 1.8–5.4ºF (1–3ºC) warmer than the surrounding suburban and undeveloped areas, and as much as 22ºF (12ºC) warmer in the evenings. These heat islands may contribute to regional average warming trends.

Urban heat island effects have numerous negative consequences. Plants and animals sensitive to temperature fluctuations may find habitat affected by heat islands inhospitable. Human health may suffer because exposure to ground-level pollution is often worse in places affected by heat islands. Additionally, heat islands increase cooling loads in summers, necessitating larger, more powerful air-conditioners that use more electricity. This increases cooling cost, produces more greenhouse gases, and generates pollution.

A few strategies to reduce the negative impact of heat island effect are:

- Limiting the amount of impervious hardscape areas on the site to limit heat island effect. Using open grid pavement systems for parking lots, roads, and walkways, which stay cooler due to reduction of impervious surface area and increased evaporation from the open cell vegetation. Using light coloured paving surfaces, and shade paved areas with landscaping.
- Darker paving materials generally have low SRI values. Grey or white concrete has a higher reflectance and a higher SRI. Micro surfaces and coatings over asphalt pavement can be used to attain the required SRI value.

Solar Reflectance – It is the ratio of the reflected solar energy to the incoming solar energy wavelengths of approximately 0.3–2.5 micrometres.

Solar Reflectance Index (SRI) – It is the measure of a material's ability to reject solar heat, as shown by a small temperature rise. It is defined such that a standard black (reflectance 0.05, emittance 0.9) is 0 and a standard white (reflectance 0.8, emittance 0.9) is 100.

Some of the typical solar reflective index of paving and roofing materials are given in Table 1 and 2.

- Vegetation can be used to shade buildings and pavements from solar radiation. This can be achieved by providing shade using trees, large shrubs of native or adaptive species.
- Parking under cover can also help reduce heat island effect. Parking can be multi-storied, or have subterranean structure, or be a shade providing structure. Roof of structured parking must also meet SRI requirements.

Elevated temperatures from urban heat islands, particularly during the summers, can affect a community's environment and quality of life. Reduction in urban heat island leads to the following benefits:

- **Energy consumption** – Elevated summertime temperatures in cities increase energy demand for cooling and add pressure to the electricity grid during peak periods of demand. A reduction in heat island helps control energy demand.
- **Air quality and greenhouse gases** – Higher temperatures increase energy demand for cooling, which causes higher levels of air pollution and greenhouse gas emissions. Reduced urban heat island reduces cooling demand.
- **Human health and comfort** – Increased daytime surface temperatures, reduced night time cooling, and higher air pollution levels associated with urban heat islands can affect human health by contributing to general discomfort, respiratory difficulties, etc. Reduced temperatures enhance comfortable living conditions.

Table 1.2 Solar Reflectance Index (SRI) for Standard paving materials

Material	Emissivity	Reflectance	SRI
Typical new grey concrete	0.9	0.35	35
Typical weathered* grey concrete	0.9	0.20	19
Typical new white concrete	0.9	0.7	86
Typical weathered* white concrete	0.9	0.4	45
New asphalt	0.9	.05	0
Weathered asphalt	0.9	.10	6
*Reflectance of surfaces can be maintained with cleaning. Typical pressure washing of cementitious materials can restore reflectance close to original value. Weathered values are based on no cleaning.			

Table 1.3 Solar Reflectance Index (SRI) for typical roofing materials

Example of SRI Values for Generic Roofing Materials	Solar Reflectance	Infrared Emittance	Temperature Rise	Solar Reflectance Index (SRI)
Gray EPDM	0.23	0.87	68°F	21
Gray asphalt shingle	0.22	0.91	67°F	22
Unpainted cement tile	0.25	0.90	65°F	25
White granular surface bitumen	0.26	0.92	63°F	28

Contd...

Example of SRI Values for Generic Roofing Materials	Solar Reflectance	Infrared Emittance	Temperature Rise	Solar Reflectance Index (SRI)
Red clay tile	0.33	0.90	58°F	36
Light gravel on built-up roof	0.34	0.90	57°F	37
Aluminium	0.61	0.25	48°F	56
White–coated gravel on built-up roof	0.65	0.90	28°F	79
White coating on metal roof	0.67	0.85	28°F	82
White EPDM	0.69	0.87	25°F	84
White cement tile	0.73	0.90	21°F	90
White Coating – 1 coat, 8mils	0.8	0.91	14°F	100
PVC White	0.83	0.92	11°F	104
White Coating – 2 coats, 20mils	0.85	0.91	9°F	107

Source: LBNL Cool Roofing Materials Database. These values are for reference only and are not for use as substitute for actual manufacturer data.

Case Study

Building information –

Typology : Factory building

Structure : Ground + Mezzanine

Conditioned area : 20,000 sq. ft

WWR : 32%

Solar Reflectance Index –

Conventional roofing sheet : 45

GreenPro certified roofing sheet : 85

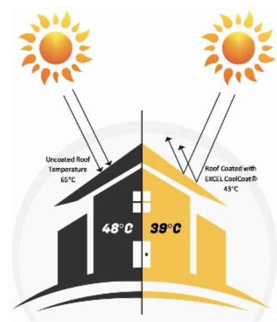


Table 1.4 Energy saving as per conventional roof and roof with GreenPro certified roofing sheet

S. No.	Parameter	Conventional Roof	Roof with GreenPro Certified Roofing Sheet	Savings
1	Cooling load	91 TR	84 TR	**8.1%**
2	Annual building energy consumption	249070 kWh	238361 kWh	**4.3%**

1.7 SOIL EROSION CONTROL

A naturally occurring process, soil erosion is a phenomenon that affects all landforms. Soil erosion refers to the wear and tear of topsoil by the natural physical forces of water and wind or through forces associated with construction activities. Erosion, whether by water, wind or tillage, involves three distinct actions—soil detachment, movement and deposition.

In soil erosion, the topsoil, high in organic matter, fertility, and soil life, is shifted elsewhere ‘on-site’, where it builds up over time or is carried ‘off-site’ where it may fill in drainage channels. Soil erosion contributes to the pollution of adjacent watercourses, wetlands, and lakes, and reduces cropland productivity.

Soil erosion can be a slow process that continues relatively unnoticed, or can occur at a rapid rate, causing serious loss of topsoil. Soil compaction, loss of soil structure, poor internal drainage, salinisation, low organic matter and soil acidity problems are other serious soil degradation conditions that can accelerate soil erosion.

The erosion potential of any surface is determined by four basic factors—soil characteristics, vegetative cover, topography, and climate. Detachment, transportation, and deposition are basic processes that occur on upland areas. Detachment of soil particles is a function of the erosive forces of raindrop impact and flowing water. Hydrology, topography, soil erodibility, soil transportability, soil surface cover, incorporated residue, residual land use, subsurface effects, tillage, roughness, and tillage marks are the major factors that affect upland erosion processes.

Types of Soil Erosion

(a) **Mechanism of erosion –** When rain falls on exposed soil particles, the particles dislodge and splash into the air. The dislodged particles can become suspended in the water and can easily be transported to great distances by surface water runoff.

(b) **Sheet and rill erosion –** Sheet erosion is the uniform movement of a thin layer of soil from sloping, bare, and unprotected land. Falling raindrops detach soil particles, which go into solution as runoff occurs. Detached particles are transported down slope/grade to a point of deposition. Rills form with longer, harder rains when runoff volumes accelerate. Erosion increases as slope/grade becomes steeper and develops longer slope length.

(c) **Gully erosion –** Rill erosion evolves into gully erosion as runoff increases, from one heavy rain or a series of storms over time. A gully is generally defined as a scoured-out area that is not crossable with tillage or grading equipment.

(d) **Streambank and streambed erosion –** This type of erosion is the scouring away of stream banks. Degrading or downcutting streambeds and/or repeated high flows for extended duration causes bank erosion. Streambank and streambed erosion are a significant contributor of sediment loads to surface water resources.

(e) **Wind erosion –** Wind erosion is similar to sheet erosion in detachment, transport, and deposition of soil particles. But here the transportation mechanism is wind instead of water.

Here are the factors to be considered before strategising the required soil erosion control:

- Existing topographic features of the project site and the immediate surrounding area
- Location of all surface waters, which may receive runoff within or from the project site
- Types, depth, slope, locations and limitations of the soils
- Characteristics of the earth disturbance activity, including the past, present and proposed land uses and the proposed alteration to the project site
- Volume and rate of runoff from the project site and its upstream watershed area

Strategies to mitigate soil erosion

Reducing the volume of runoff and preventing the detachment of soil particles are two key approaches involved in mitigating soil erosion. Establishing a protective cover such as mulching, temporary or permanent seeding, applying a compost blanket, or installing rolled erosion control products (mats or blankets) can help control erosion.

➢ **Grading Strategies:** Grading strategies, such as minimising the area exposed at any given time, are the most effective way to reduce the potential of erosion. Minimising grading reduces the amount of land exposed to erosion and saves cost. Developments can be designed to fit the existing landscape which help minimise the amount of required grading. The suggested techniques are:

- Phased grading minimises the amount of disturbed land at any given time and helps maintain vegetative cover at strategic locations.
- Phasing divides essential grading into distinct parts. Grading of each phase is started, completed and stabilised in sequence.
- Most often, it is best to start grading activities at the highest point of a site and gradually move down the gradient.
- To reduce soil compaction, deep tillage should be done as the final step of grading activity at each phase. This helps increased infiltration, decreases runoff, and improves rooting depth.
- Use temporary or permanent stabilisation techniques as soon as the site grading is completed.

➢ **Dust Control:** Dust control is most often a temporary control from exposed soil surfaces on roads and construction sites. The suggested techniques are:

- Mulching – Considering environmental aspects, mulch materials, chemical or wood cellulose fibre binders can be used instead of emulsified asphalt. Mulching conserves moisture for seedlings and protects them from extreme temperatures. Mulching limits soil erosion and lessens the need to contain sediment. Mulches most often used are straw, fibre or wood chips.
- Utilise existing trees or large shrubs to offer protection.
- Sprinkle water until the surface is moist, to settle the dust.
- Provide barricades to control air currents and soil erosion.
- Utilise crushed stone or coarse gravel to control dust on roads or other areas during construction.

➢ **Temporary and Permanent Vegetation:** To reduce runoff and erosion during construction, temporary seeding methods are used. Permanent seeding stabilises disturbed or exposed areas and allows selection of the most appropriate plant materials for long-term erosion control.

➢ **Compost Blanket:** Compost blanket provides soil amendment, consisting of decomposed organic waste, with a consistency similar to high quality topsoil but with a much higher organic matter content. The impact of raindrops is absorbed by the high organic matter content of compost, which prevents detachment of soil particles. Organic matter also retains water on the site to reduce runoff and for potential transportation of sediment or other pollutants.

1.8 FACILITIES FOR DIFFERENTLY ABLED

Today, accessibility for all is recognised as a basic necessity, and attempts all over the world are ensuring that. Barrier-free features are now becoming fundamental to all design concepts. Universal design or barrier free environment is a design that makes any space accessible to everyone, irrespective of age, disability or other factors.

The 'Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1996' was enacted by the Government of India to ensure a barrier free environment and smooth, free, and safe movement of people regardless of age or disability of any kind. Designers/architects/planners must be taught to create universal designs right from the development stage and to consider the independence, convenience and safety of all people.

The main intent of barrier free environment is to design spaces that ensure every person can function independently without external assistance during their everyday activities like procurement of everyday essentials, communal living, employment, and leisure and relaxation. To be active, a differently abled person must commute freely and the building facility should be able to attend to his/her needs.

Design aspects according to human abilities

People with disabilities may include, but are not be limited to inability or difficulty to walk, reliance on walking/mobility aids, visual impairments, speech and hearing impairments, lacking in coordination of motor movements, reaching and manipulation, lack of stamina, difficulty in interpreting and reacting to sensory information, and extremes in physical sizes.

Key considerations

A well-designed environment that is safe, convenient, comfortable, and readily accessible benefits everyone. The movement of an individual or a group (which include people with disabilities) must be safe and easy for everyone. Here are the key considerations while designing such spaces:

1. Access to the site – Pedestrian and vehicular
2. Reserved parking close to the entrance of the building
3. At least one primary entrance to the building to be used (and indicated by a sign)by differently abled
4. Ramps, wherever required, to be designed with adequate gradients, width and proper landings
5. Adequate external and internal lighting
6. Accessible external furniture (seats, bins, etc.)
7. Detailed information signage at the entrance

8. Overall minimum travel distances
9. Smooth level differences providing adequate support – Raised thresholds to be avoided, but where this is not possible, their height should not exceed 25mm
10. Spacious elevators that allow traffic by wheelchairs. Audio and braille assistance in lifts for visually impaired people
11. Wide access doors, low height drinking water fountains, low height information desks, spacious lifts and easy operation of control switches

(a) To enable wheelchair users to pass through doors, the minimum clear door width must be 900mm and be operable by a single effort. To enable wheelchair users to approach doors, manoeuvring space is needed and so the corridor must have a width of at least 1200mm to allow a 90° turn to be made through a door.

(b) Door handles and locks must be easy to operate. To facilitate the closing of a door by wheelchair users, the door must have a horizontal handle approximately 800mm from the floor. To help people with impaired vision to see doors, the door and the frame should have a colour that contrasts the adjoining wall

Windows should be easy to open and close

1. Sanitary facilities, in accordance with the nature and use of a specific building or facility, should be made accessible and usable by the physically challenged. Sanitary facilities must to have space to allow individuals in wheelchairs, details of which can be found in NBC 2005
2. Safe stairs that are easy to use, and facilitate safe assisted evacuation/rescue in emergencies
3. Non slippery walking surfaces and tactile pathways if feasible. Floors on a given storey must be of a common level throughout or be connected by a ramp
4. Important information should be communicated via two senses or more (tactile, audible and visual)
5. Good visual contrast of walls, floors, doors and signage
6. Good acoustics and hearing enhancement systems

References and Source

- National Building Code 2005
- State of the Environment, Atlas of India
- Natural Resources Defense Council
- India Environment Portal
- The Nature Conservancy
- Wildlife Trust of India
- Environmental Impact Assessment in India
- Indian Institute of Human Settlement
- India's National Action Plan for Climate Change (NAPCC)
- Flowers of India

Site Selection and Analysis

- Contour Mapping: http://www.engineeringenotes.com/surveying/contouring/contour-definition-and-methods-contour-surveying/14030
- Climate and Site Analysis: The Role of Climate Factors on Designing and Constructing Buildings (From Urbanization Architecture Approach) by Sarieh Zareaian*, Khaled Aziz Zadeh2
- National Climate Change Adaptation Research Facility
- Tree Transplantation: Greening, Landscape and Tree Management Section; Development Bureau, The Government of the Hong Kong Special Administrative Region

Heat Island Reduction

- LBNL Cool Roofing Materials Database
- ASTM International Standards

Soil Erosion & Control

- National Bureau of Soil Survey and Land Use Planning
- Wasteland atlas of India by national remote sensing agency; NRSA
- NBSS & LUP and Indian Council of Agricultural Research (ICAR)
- Soil Degradation in India: Challenges and Potential Solutions, Ranjan Bhattacharyya
- Soil Erosion and Conservation in India, By Staff Reporter, August 2018
- Soil Erosion — Causes and Effects, J. Ritter, P.Eng
- Soil and Water Conservation Society
- Urban Soil Erosion and Sediment Control, USDA, March 2008
- Erosion and Sediment Control Guideline – December 2006
- Erosion Control Technology Council
- International Erosion Control Association

Facilities for Differently Abled

- Guidelines and Space Standards for Barrier Free Built Environment for Disabled and Elderly Persons – CPWD
- NZEB – Passive Design strategies, https://nzeb.in/knowledge-centre/passive-design/form-orientation/
- http://www.engineeringenotes.com/surveying/contouring/contour-definition-and-methods-contour-surveying/14030
- http://sustainablesources.com/site-selection-and-analysis/