

BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA



CLIMATIC AND ENVIRONMENTAL ZONES FOR INDIA SIMPLIFIED ADVICE FOR BUILDING DESIGN

For purpose of design of buildings based on climatic and environmental considerations, India can broadly be divided into six zones. Essential characteristics of each of these zones, requirements for human comfort and design guidelines are outlined in this Building Digest.

This data is presented as simplified information on climatic conditions in different parts of the country. Factors relevant to the achievement of comfort conditions indoors are indicated.

The geographical confines of India are 8° to 36° N latitude and 68° to 97° E longitude. The peninsular region is in the tropical zone and the rest in the temperate zone. The entire country may broadly be divided into six zones for environmental design. These are: 1. West Coastal Tropical, 2. East Coastal Tropical, 3. Peninsular plains, 4. Gangetic Plains, 5. Desert Areas and 6. Eastern Hill areas. Each of these has its own special environmental physical characteristics and these should be considered in the planning of buildings. These are listed separately. However, since the information is applicable to large areas, the need for a critical examination of site condition should not be overlooked.

The average daily maximum and minimum temperatures for the entire subcontinent lie around 28° and 18° C respectively with a swing of 10° C respectively and do not, therefore, indicate the extremes reached in summer or winter. To emphasise the possible extremes expectable during these periods, only these maxima and minima are shown in the following sections. Indian climate does not generally pose problems connected with extremes of heat coupled with extremes of humidity.

The main problems requiring solution in the designing for comfort are summer heat and monsoon humidity coupled with the failure of air movement when most required. There is need to avoid excessive heat gains in summer and heat losses in winter (wherever required) and for taking advantage of prevalent winds. Inclinations of apertures up to 30° with the expectable wind

direction do not result in large changes in internal air motion. Therefore, in situations where there is a conflict between solar heat gain and air motion, the actual site requirement should be the deciding factor for orientation.

Design should take into account: (a) the worst or near worst conditions for heat gains or losses and (b) the optima for natural lighting, since these are well defined entities depending only on solar position.

In warm climates 'Ventilation' has to serve two purposes: (a) for health and (b) for comfort. The former is taken care of by processes of infiltration, modes of living and our fenestration designs which do not make shutters for doors and windows air-tight, while the latter only by a generous provision for air-movement by natural or artificial means. Air-movement outdoors, with its wellknown vagaries, does not lend itself as a dependable design parameter for comfort ventilation. Heat gains (and heat losses) by ventilation should also be taken into consideration.

The above mentioned facts have added significance in the planning of buildings for high density areas.

Hill stations at elevations of 1000 m or more above M.S.L. need special design considerations. Here buildings should be designed to keep interiors warm at optimal comfort. To this end the building should be oriented NE-SW to get maximum solar radiation in the worst period of the year. Walls should be thick and insulative. Windows should be large (up to 30 per cent of floor area), double glazed and provided with air-tight shutters to prevent infiltration of cold outside air. Roofs should be thick and insulative and sloping. Outside colouring should be dark and absorptive. A court-yard to provide wind shelter and solar radiation trap would be an added advantage.

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For purpose of design of buildings based on climatic and environmental considerations, India can broadly be divided into six zones. Essential characteristics of each of these zones, requirements for human comfort and design guidelines are outlined in this Building Digest.

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need this Institute is bringing out a series of Building Digests from time to time and the present one is the 114th in the series. Readers are requested to send to the Institute their experience of adopting the suggestions given in this Digest.

In warm climates, ventilation has to serve two purposes: (a) for health and (b) for comfort. The former is taken care of by processes of infiltration, modes of living and our ventilation designs which do not make shutters for doors and windows (light) while the latter only by a generous provision for air-movement by natural or artificial means. Air-movement outdoors, with least well-down vegetation, does not lead itself as a dependable design parameter for comfort ventilation. Heat gains (and heat losses) by ventilation should also be taken into consideration.

The above mentioned facts have added significance in the planning of buildings for high density areas. High rise buildings at elevations of 1000 m. or more above M.S.L. need special design considerations. Here buildings should be designed to keep interiors warm at optimal comfort. To this end the building should be oriented N-E-W to get maximum solar radiation in the worst period of the year. Walls should be thick and insulative. Windows should be large (up to 30 per cent of floor area), double glazed and provided with air-tight shutters.

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divided into six zones for environmental design. Zone I, West Tropical, Zone II, East Tropical, Zone III, Sub-tropical, Zone IV, Semi-arid, Zone V, Arid, and Zone VI, Desert. Each of these has its own special environmental characteristics and these should be considered in the planning of buildings. These are listed separately. However, since the information applicable to each zone is great, the need for a critical examination of the condition should not be overlooked.

The average daily maximum and minimum temperatures for the entire subcontinent are around 28°C and 18°C respectively with a swing of 10°C respectively. It does not, therefore, indicate the extremes reached in summer or winter. To bridge the gap, the climatic conditions during these periods are shown in the following table. Indian climate does not generally pose problems connected with extremes of heat coupled with excessive humidity.

Prepared by : Dr. V. Narasimhan
and M.R. Sharma
Published by : S. Srinivasan
Central Building Research Institute,
Roorkee, India.
August, 1975.

ZONE I
West Coastal Tropical

This is a narrow strip of land varying in width from about 20 to 150 km. west of the Western Hills extending from Trivendrum in the south to the north of Daman, elevations can be from sea level to 150 m above M.S.L.

CLIMATE

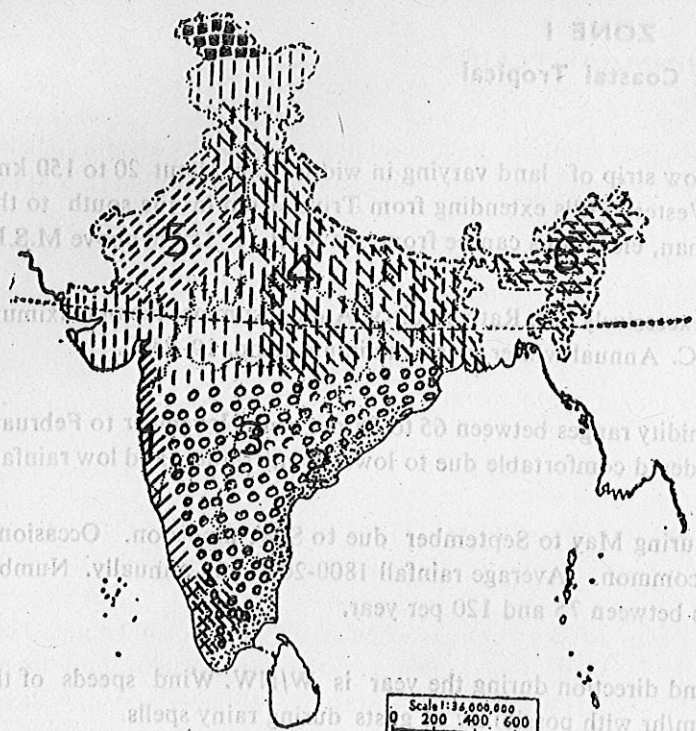
- Temperature** Climate not excessively hot. Rather sultry. Annual summer mean maximum temp. 30–33°C. Annual winter mean minimum temp. 19–23°C.
- Humidity** Relative Humidity ranges between 65 to 88 per cent. November to February may be considered comfortable due to lower temperatures and low rainfall.
- Rainfall** Principally during May to September due to S.W. monsoon. Occasional rains not uncommon. Average rainfall 1800-2000 mm annually. Number of rainy days between 75 and 120 per year.
- Wind** Principal wind direction during the year is W/NW. Wind speeds of the order 5/10 km/hr with possibility of gusts during rainy spells.
- Daylight** Adequate for most purposes during 0800-1600 hrs. During rainy spells there may be need for supplemental artificial lighting.

COMFORT

- Comfort** Sun exclusion between 0900 and 1700 hours. Generous provision for ventilation and air movement.
- Requirements** Fans essential almost any time and necessarily during periods of calm between spells of rains.

DESIGN REQUIREMENTS

- Site** Good rain water drainage essential.
- Layout** Building to be on the E-W to NE-SW axis to reduce solar heat gains and improve wind movements.
- Air-movements** Good arrangements for cross ventilation. Fans essential.
- Opening** 15 per cent of floor area and up to a maximum of 20 per cent for ventilation, air movement and daylighting, low sill heights, windows horizontal.
- Roofs** May be light weight but should be insulative. False ceiling is helpful. Protection against heavy rainfall necessary.
- External walls** Light weight, if possible, short time lag for heat transfer. Light external colours, W. Wall rain protected.
- Out door sleeping space** Not necessary, because of high precipitation.
- Lightning Protection** Yes : in the southern areas of this zone. See map.



- 1 West Coastal Tropical
 - 2 East Coastal Tropical
 - 3 Peninsular Plains
 - 4 Gangetic Plains
 - 5 Desert Areas
 - 6 Eastern Hill Areas
- Areas where lightning protection is necessary
- Data is not available

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The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Areas (Reorganisation) Act 1971, but has yet to be verified.

ZONE 3 PENINSULAR PLAINS

This region is roughly south of the line joining Surat and Calcutta. This area is topologically undulatory. Altitude ranging from 100 m to 900 m above M.S.L.

CLIMATE

Temperature	Hot during summer and relatively warm during the year. Winter pleasant.
	Annual summer maximum temperature 34-41° C
	Annual winter minimum temperature 14-19° C
Humidity	The relative humidity ranges between 25 per cent to 80 during the monsoon season, generally between June to November. Nights are generally cool.
Rainfall	500 to 900 mm with a few exceptions when it may go to 1300 mm. The period of rainfall is mostly June to Sept. in the western half and June-November in the easterly areas of the peninsula. Number of rainy days in the year 40 to 75 days.
Wind	The principal wind direction is W and NW and the wind speed between 3 to 10 km/hr.
Daylight	Adequate for most purposes during 0800-1600 hrs except when the rains are on.

COMFORT

Comfort requirements Sun exclusion during 0900 to 1700 hrs. in summer. Reasonable provision for ventilation and air motion. Fans essential. Air conditioning desirable.

Site Good rain water drainage essential.

Layout Building on E-W axis to reduce solar heat gains in summer and most part of winter.

Air-movement Single banked rooms for good cross ventilation.

Openings Upto 15 per cent of floor area for ventilation, air motion, and daylighting. To be shielded during 0900 to 1700 hrs during summer. Winter sunshine may not be desirable either.

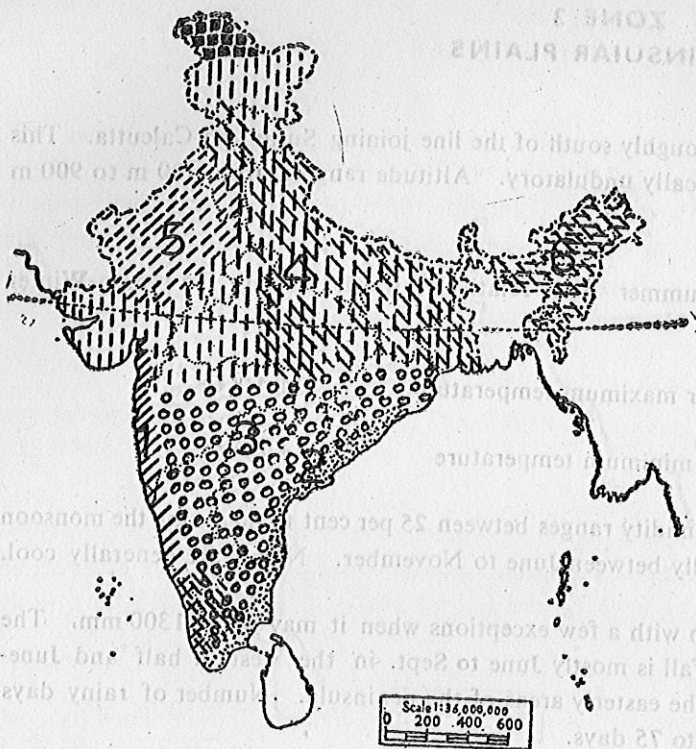
Roofs Light weight insulative or medium heavy with short time lags may be sufficient. Design for moderate rains. False ceiling and attic ventilation may be useful. Northern positions may need heavy roofs also.

External walls Light weight with short time lags will suffice. Local conditions may dictate heavy walls. Light colour on walls.

Outdoor sleeping space Not essential, but may be required in some specified places. Depends on local climate and practice.

Lightning protection Yes : in some parts of the southern end and N. E. end of the region. See map.

DESIGN REQUIREMENTS



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DESIGN REQUIREMENTS

Roofs

Heavy with a eight hour time lag.* This will help keep interior at equitable temperature levels. Roofs should be designed for moderate rains. Should be white washed for additional comfort, just before onset of summer, to reduce heat gains.

Walls

Massive with 8 hour time lag.** If possible should be shielded with deciduous trees especially on the West and North West in summer. Careful consideration should be given to plan internal occupancy during hot summer months.

Outdoor sleeping area

Essential and most desirable. The possibility of re-radiation to the clear sky at night and consequent reduction of body temperature outdoor is great as compared to reradiation to the hot indoor ceiling and possible discomfort.

Special needs

Desert coolers in summer and room heaters in winter.

Lightning protection

Yes : in most parts of this zone See map.

* Equivalent to a roof consisting of 10 cm RCC + 10 cm lime concrete + water proof ng treatment.

** Equivalent to a wall consisting of 20 cm bric' work + 1.25 cm lime plaster on either side.

ZONE 5
THE RAJASTHAN DESERT

This desert area includes parts of Rajasthan. Lying north of Gujrat, West of U.P. and South of Haryana. The elevations are between 200 to 400 m above MSL. Large tracts with little rainfall, absence of green vegetation and abundance of cacti and populations clustered around lakes and water spots are main characteristics of this region. The ground water table is more than 50 metres below ground level.

CLIMATE

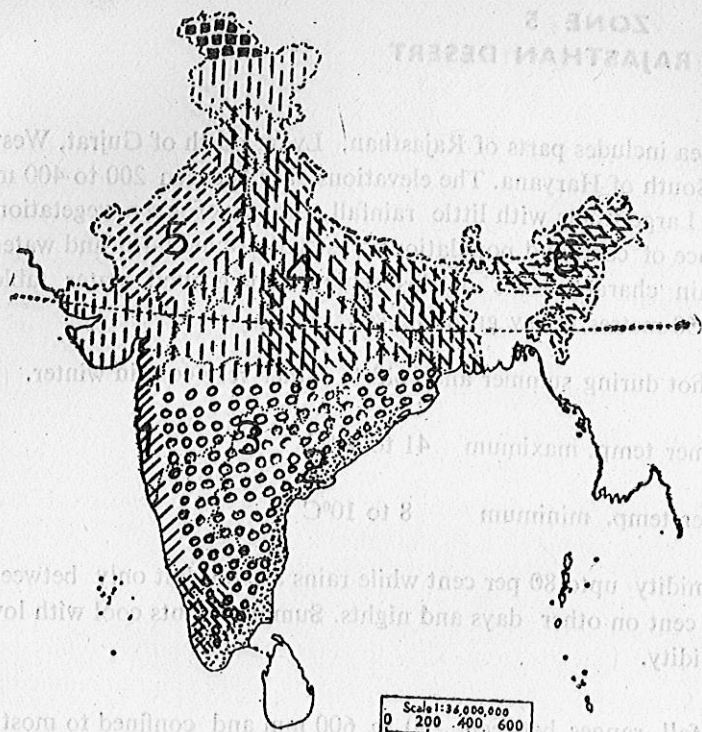
Temperature	Hot to very hot during summer and cold to rather very cold in winter. Annual summer temp. maximum 41 to 44°C Annual winter temp. minimum 8 to 10°C
Humidity	Relative humidity upto 80 per cent while rains are on but only between 10 to 25 per cent on other days and nights. Summer nights cool with low relative humidity.
Rainfall	Annual rainfall ranges between 250 to 600 mm and confined to mostly July-August with number of rainy days between 20 to 35.
Wind	Principal directions W, NW, SW and in that order. Summer winds dust laden. Speeds range between 10-15 Km/hr. Summer atmosphere dusty.
Daylight	Adequate during between 0800 to 1600 hrs. Slightly less during winter afternoons due to low solar position and shortness of day time when supplemental lighting may be needed.

COMFORT

Comfort requirements	Sun exclusion during summer between 0800 hrs and 1700 hrs later. Sunlight entry in winter during day time preferred. Protection against hot, dusty, cold winds. Roof and walls need shading. Desert coolers are useful in summer. Fans at low speed provide relief during hot summer daytime indoor.
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DESIGN REQUIREMENTS

Site	Nothing specially required.
Layout	Building axis East-West to avoid solar heat gain in summer and receive it in winter. Compact planning to avoid exposure to sun.
Air-movement	Not critical but desirable and hence compact planning.
Openings	Minimum 12 per cent of floor area but should be limited to 15 per cent in the N and S exposed walls. Should be provided with close fitting shutters to cut off hot and cold winds as well as dust.
Roofs	Heavy with a eight hour time lag.* This will help keep interior at equiatable temperature levels. Should be white washed for additional comfort, just before onset of summer, to reduce heat gains.
Walls	Massive with 8 hour time lag.** If possible should be shielded with deciduous trees especially on the West and North West in summer. Careful consideration should be given to plan internal occupancy during hot summer months. Shielding is essential.



Scale: 1:36,000,000
0 200 400 600

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- Data is not available

DESIGN REQUIREMENTS

ZONE 6 THE EASTERN HILLS

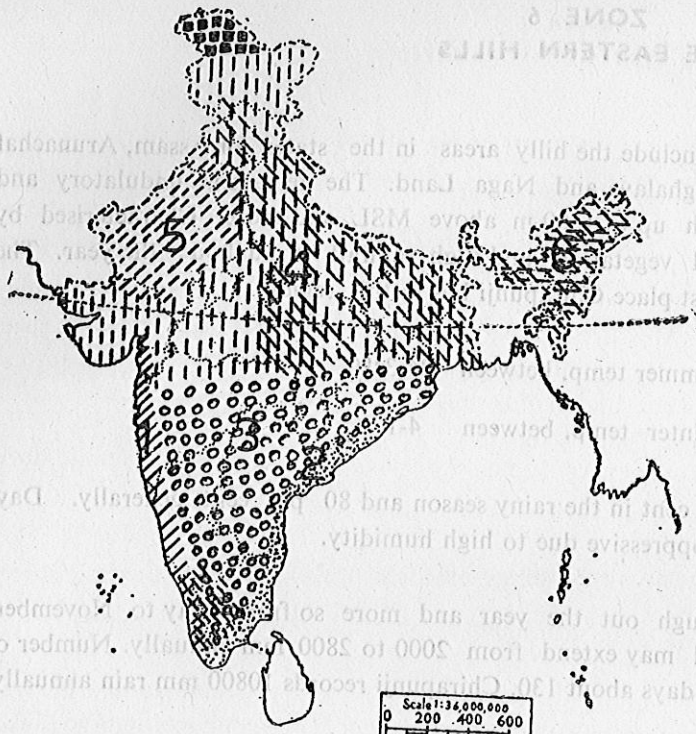
This would include the hilly areas in the states of Assam, Arunachal Pradesh, Meghalaya and Naga Land. The terrain is undulatory and altitudes reach up to 1500 m above MSL and more. Characterised by dense tropical vegetation and high rainfall throughout the year. The world's wettest place Chirapunji lies in this region.

Temperature	Maximum summer temp. between 24-31°C Minimum winter temp. between 4-10°C
Humidity	Up to 95 per cent in the rainy season and 80 per cent generally. Days and nights oppressive due to high humidity.
Rainfall	Almost through out the year and more so from May to November. Total rainfall may extend from 2000 to 2800 mm annually. Number of annual rainy days about 130. Chirapunji records 10800 mm rain annually.
Wind	Principal direction S or SW. Possibility of driving rains.
Daylight	Adequate during 0800 to 1600 hrs. except when obstructed by tall vegetation or during short daytime hours in winter.
Comfort requirement	Adequate provision for ventilation in summer. Rain and fungus protection and control desirable.
Site	Adequate rain water drainage essential.
Layout	Orientation of longitudinal axis of building E-W desirable but not critical in hills.
Air-movement	Cross ventilation essential and controls to prevent penetration of wind borne rain indoors.
Openings	May be up to 25 per cent of floor area subject to adequate control of wind borne rain.
Walls	Light or heavy but should have sufficient insulation. Vapour barrier should be considered depending on location. Wind pressure on walls to be considered.
Roofs	Light or heavy but with sufficient insulation and designed for quick drainage, Vapour barrier should be considered based on location and possible wind pressures.
Outdoor sleeping space	Not necessary due to high precipitation.
Lightning protection	Yes : throughout this zone.

CLIMATE

COMFORT

DESIGN REQUIREMENT



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DESIGN REQUIREMENTS

Outdoor sleeping spaces.	Essential hence the recommended courtyard type compact planning.
Lightning protection	NIL

* Equivalent to a roof consisting of 10 cm RCC + 10 cm lime concrete + water proofing treatment.

** Equivalent to a wall consisting of 20 cm brickwork + 1.25 cm lime plaster on either side.

ZONE 4 THE GANGETIC PLAINS

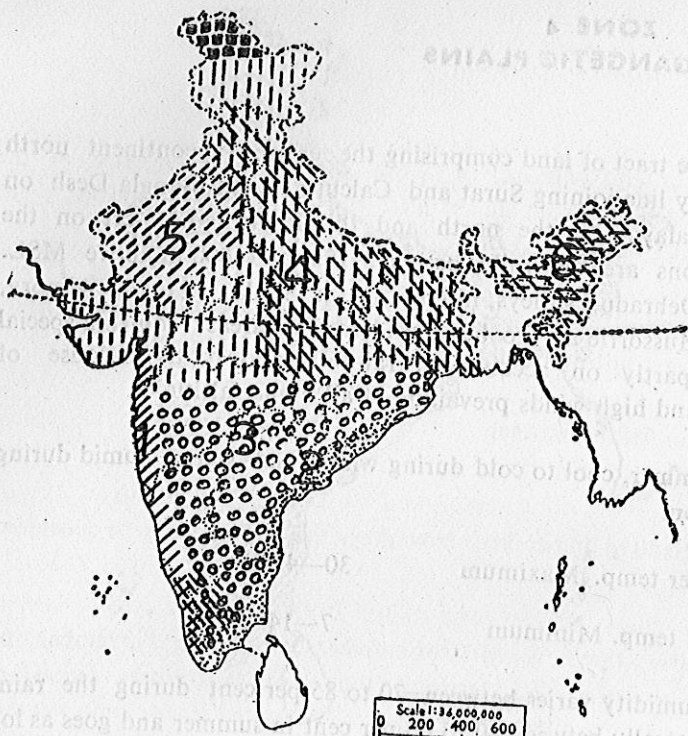
This is the large tract of land comprising the entire subcontinent north of an imaginary line joining Surat and Calcutta, with Bangla Desh on the east, Himalayas on the north and the Rajasthan desert on the west. Elevations are generally between 100 and 600 m above MSL. Srinagar and Dehradun valleys, hill resorts at Simla, Manali, Almora, Nainital and Mussorrie are to be considered as areas requiring special consideration partly on account of rainfalls and partly because of temperatures and high winds prevailing at all higher altitudes.

Temperature	Hot during summer, cool to cold during winter and warm humid during monsoon season.
	Annual summer temp. Maximum 30—42°C
	Annual winter temp. Minimum 7—14°C
Humidity	The relative humidity varies between 70 to 85 per cent during the rainy season and generally between 40 to 60 per cent in summer and goes as low as 25 per cent in winter. Summer nights outdoor are relatively cool except when atmospheric dustiness increases.
Rainfall	Rains are confined to the South West monsoon from mid July to mid September. Average rainfall is between 650 to 1400 mm and number of rainy days between 35 to 60 annually.
Wind	There is no specific wind direction but W. NW. and SW are most probable. Summer is characterised by hot dust raising winds with velocities going up to 15 km/hr. Atmosphere is dusty in May/June.
Daylight	Sufficient during 0800 to 1600 hrs. As one proceeds north the shorter duration of daylight hours in winter may require artificial supplemental lighting during the day.
Comfort requirements	Sun exclusion in summer during the day from 0800 to 1700 hrs. Sunlight penetration in winter desirable. Adequate provision for air change and comfort ventilation in monsoon period. Building requires cooling in summer by shading, roof treatments and/or air conditioning. Situation ideal to use desert coolers in summer. Winter heating required in most 1 laces.
Site	Good rain water drainage very essential in view of the flat terrain and possibility of water stagnation.
Layout	Building axis to be East-West to avoid heat gains in summer and receive the same in winter. Location of rooms to be judiciously determined.
Air-movement	Open spacing desirable to take advantage of external air motion for cross ventilation just to fit. Excessive air changes in summer or winter brings in heat or cold respectively from outside
Openings	Minimum 15 per cent and up to 20 of floor area for ventilation and daylighting. Should be capable of being tightly closed during summer days and winter nights.

CLIMATE

COMFORT

DESIGN REQUIREMENTS



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0 200 400 600

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DESIGN RECOMMENDATIONS
 COMFORT
 CLIMATE

ZONE 2
East Coastal Tropical

This is a strip of land varying in width from 20-200 km east of the Eastern Hills extending from Calcutta to the tip of the peninsula. The altitudes extend from sea level upto 250 or 300 m. above MSL.

CLIMATE

Temperature Not excessively hot but warmer than the west coastal region. Some places tend to get hot in summer due to local conditions.

Annual summer mean max. temp. 32—35° C
Annual winter mean min. temp. 15—20° C

Humidity Ranges between 50 to 85 per cent. November to February may be considered comfortable.

Rainfall Principally during the N.W. Monsoon from October to November, but rainy spells during the S.W. Monsoon (June-Sept.) also likely. Occasional showers not uncommon. Coastal areas are subjected to cyclonic weather. Average rainfall 900-1300 mm. per annum. Number of rainy days 50-80 per year.

Wind The principal wind direction is S/SW and in coastal towns easterly in the afternoons. Wind speeds of the order of 5-10 km/hr.

Daylight Adequate for most purposes during 0800-1600 hrs. except during heavy rainfalls.

COMFORT

Comfort Requirements Sun exclusion during 0900-1700 hrs. essential. Generous provision for ventilation and air movement. Fans essential during summer and rainy days.

Site Good rain water drainage essential.

Layout Building to be on E-W axis to reduce solar heat gains.

Air-movements Single banked rooms with good arrangement for cross ventilation.

Openings Up to 15 per cent of floor area and up to 20 per cent for ventilation and for daylighting. To be shielded from sun 0900-1700 hrs.

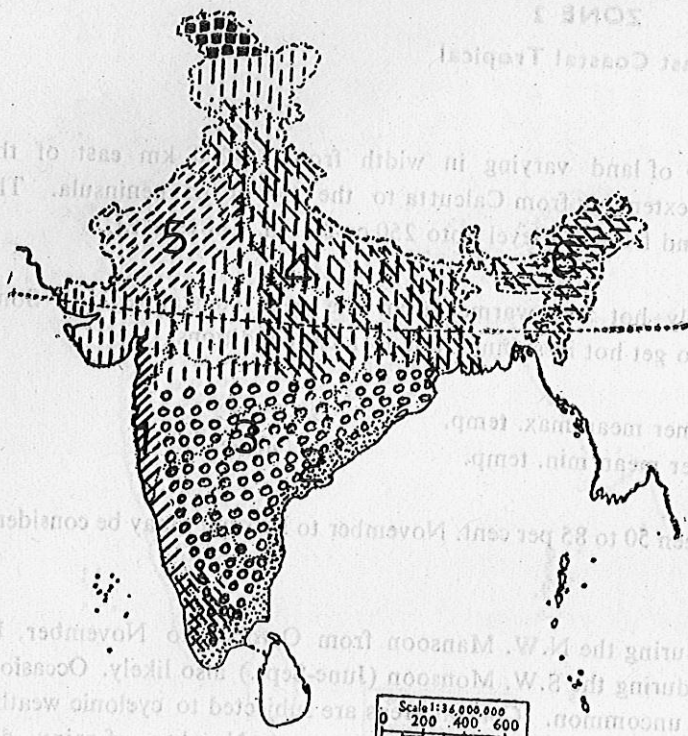
Roofs Light weight with short time lags may be sufficient. Design for moderate rains. False ceiling helps.

Walls Light weight if possible with short time lags for heat insulation. Light external colours, damp proofed.

Outdoor sleeping spaces Not essential.

Lighting protection Yes—in some portions of the south of the zone. See map.

DESIGN REQUIREMENTS



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CLIMATE DESIGN REQUIREMENTS

Lighting protection
 Yes—in some portions of the south of the zone. See map.
 Outdoor sleeping spaces—Not essential.
 Walls—Light weight if possible with short time lags for heat insulation. Light external colours, damp proofed.
 Roofs—Light weight with short time lags may be sufficient. Design for moderate rains. False ceiling helps.
 Openings—Up to 15 per cent of floor area and up to 20 per cent for ventilation and for daylighting. To be shielded from sun 0900-1700 hrs.
 Air-movements—Single banked rooms with good arrangement for cross ventilation.
 Layout—Building to be on E-W axis to reduce solar heat gains.
 Comfort Requirements—Good rain water drainage essential.
 Ventilation and air movement. Fans essential during summer and sun exclusion during 0900-1700 hrs. essential. Generous provision for rainy days.