BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE INDIA

CLIMATIC DESIGN DATA AND ITS APPLICATION (HOT & DRY REGION)

Introduction

The term climate embraces such meteorological elements as temperature, humidity, sunshine and rainfall. The physical environment in which men live and work are largely determined by these elements. The type of house or shelter required for attaining good livability is dependent on these climatic factors. Thus to design a building or to plan a site a knowledge of the climate and its variations is necessary. This digest aims to present the climatic data prevailing in most parts of Northern India in concise scientific form for direct utilisation by engineers and architects.

Climatic Data

Tropical climates, as prevailing in Northern India, are characterised by significant hourly variations and large diurnal variations in temperatures and sunshine. They also vary considerably over the year. The state

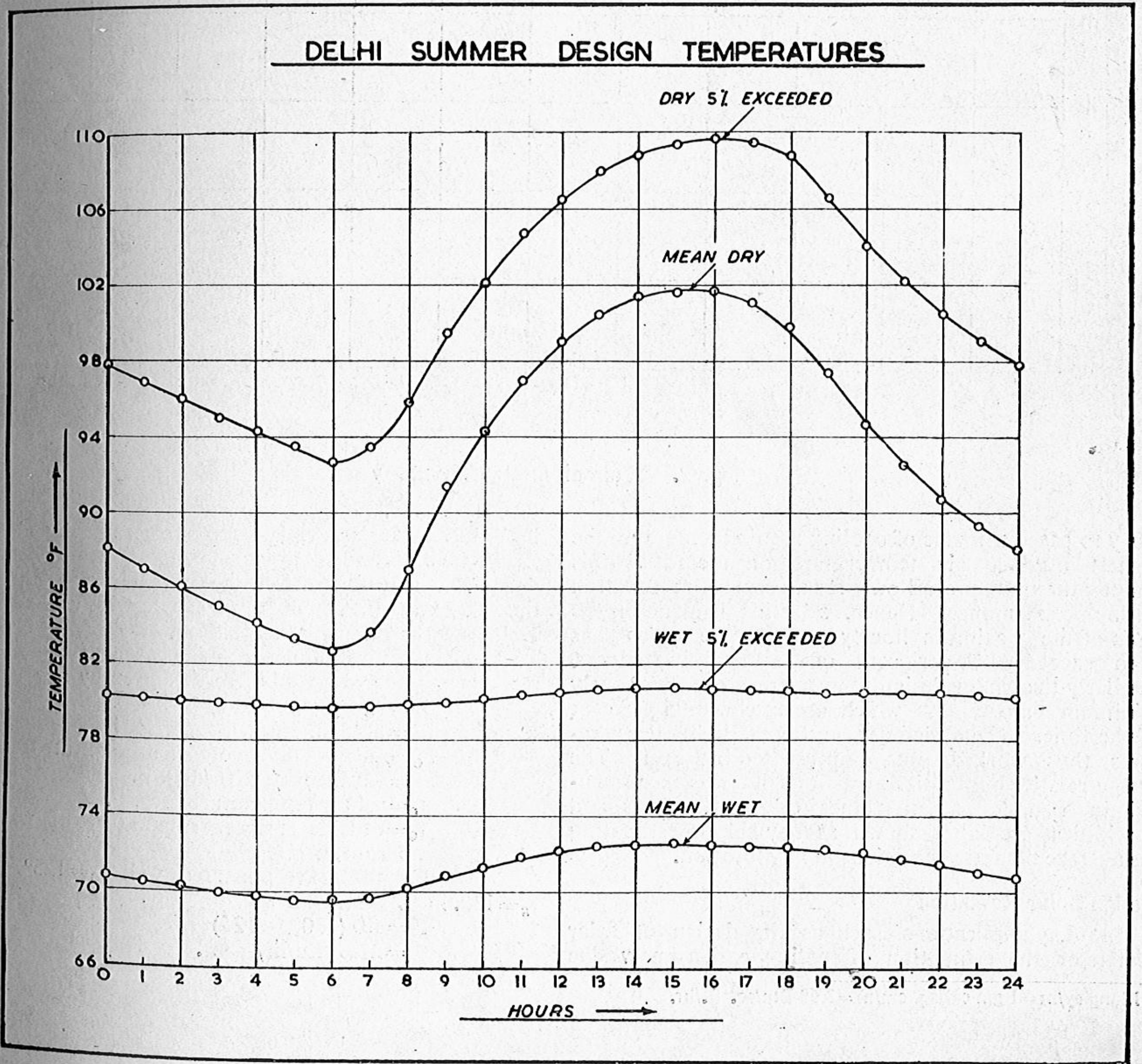

Fig. 1. Summer Design Temperatures

of the weather all over India is continuously recorded by the India Meteorological Observatories. The data collected by them at New Delhi has been processed statistically and is here presented as Climatic Design data.

In the tropics, where the natural climates are warm to hot, the problem of comfortable living is to keep cool rather than to keep warm. Building design is therefore shaped largely by the summer maximum temperatures, sunshine and humidity. The summer design data here presented may be considered as representative for the warm and dry climates of North India.

Design Dry and Wet bulb Temperatures

Outdoor-air temperatures vary considerably over a period of hours in any location at any season. In the design of buildings or cooling plants, it is not customary to base estimates of cooling requirements on the highest outdoor air temperature on record as this temperature may prevail only for a very short duration during peak summer. Hence, selection is made on the basis of the maximum hourly temperature which has been exceeded 5 per cent of the time in summer. Similarly the winter design temperatures are the hourly minimum temperatures which are exceeded 95 per cent of the time. The design dry and wet bulb temperatures thus worked out are presented in Fig. 1. The design relative humidities at various hours are presented in Fig. 2. Mean values of temperatures and humidities are also shown as they help in estimating the average climatic conditions at any location.

Design Solar Radiation

In many applications, such as the design of solar heaters or the estimation of cooling load, a knowledge of the intensity of solar radiation incident on a surface becomes necessary. The summer design total radiation* on a horizontal roof and on differently oriented walls at New Delhi are shown in Fig. 3.

Application

A very important application of design temperatures and design solar radiation is in the computation of "Sol-air Temperature" and Equivalent Temperature Differential". Sol-air temperature is the temperature of the outdoor air which would cause the same rate of heat entry into the weather side of a building material as exists with the actual combination of total radiation and outdoor air temperature. The sol-air temperature concept gives a convenient and accurate method of estimating heat gain through sunlit wall and roof surfaces. The summer design sol-air temperatures for New Delhi (and most places in North India) are given in Table 1 for grey plastered surfaces having absorptivity $\alpha=0.65$ and film coefficient 4.0 Btu./hr./sq. ft./deg. F. As an illustration, the heat entering through the exposed surface of a plastered west wall at New Delhi may be calculated as follows.

The instantaneous rate of heat entry into the weather surface of a wall or roof is given by :

$$H = h_o (t_s - t_o)$$

where H = heat entering, Btu/hr/sq. ft.

h_o = outside film coefficient of heat transfer = 4 0 Btu/hr/sq. ft./deg. F.

t_s = sol-air temperature, deg. F.

t_o = outside surface temperature of wall or roof, deg. F.

For the above plastered wall $t_o = 125°F$ and $t_s = 130.4$ at 2 p.m. Hence

$$H = 4.0 (130.4 - 125)$$
$$= 21.6 \text{ Btu/hr/sq. ft.}$$

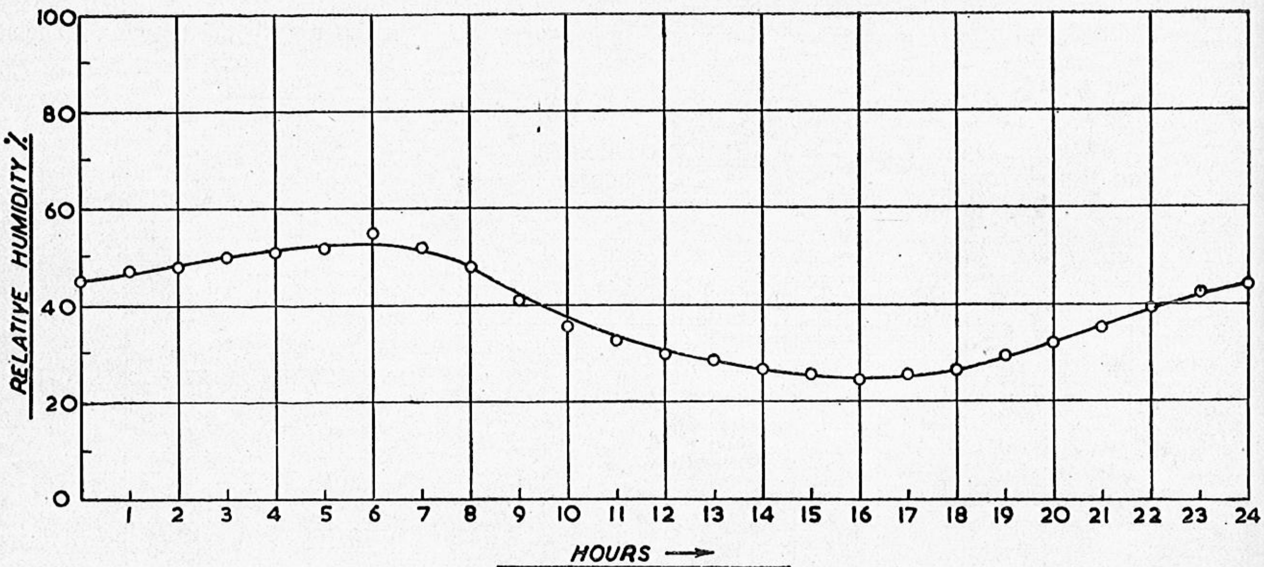

Fig. 2. Summer Design Humidity

*1 langley/hr=1 gm cal/sq. cm/hr=3.69 Btu/sq. ft./hr.

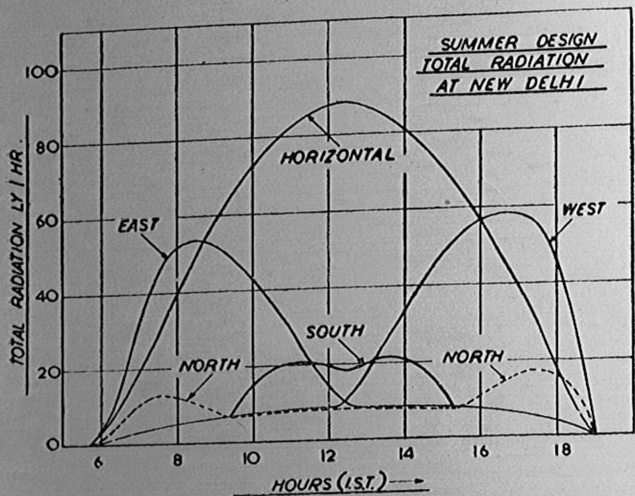

Fig. 3. Summer Design Total Radiation

The heat gain through a wall or roof depends not only on its thermophysical property but also on the intensity of solar radiation on the exposed surface, the outdoor and indoor temperatures and their hourly variations. These factors, as also the time lag i.e. the time taken by the heat to flow from outside to the inside air are taken into account by a term "Equivalent Temperature Differential" (ETD). Equivalent Temperature Differentials for roofs and differently oriented walls are given in Table 2.

The Equivalent Temperature Differentials are used (in place of the actual difference between outside and inside temperatures) with the overall heat transmission coefficient U. For example, the heat gain at 2.00 p.m. during summer through a horizontal roof consisting of 6 in. cement concrete and ½ in. plaster is $56.7 \times 0.7 = 39.7$ Btu/hr/sq. ft.

TABLE I

SUMMER DESIGN

Sol-Air Temperature °F for New Delhi

Time I.S.T	Roof	East Wall	West Wall	North Wall	South Wall
0	97.8	97.8	97.8	97.8	97.8
2	96.0	96.0	96.0	96.0	96.0
4	94.3	94.3	94.3	94.3	94.3
6	93.9	93.9	93.3	93.9	93.3
8	119.8	126.4	100.6	103.0	98.8
10	148.3	129.1	108.1	108.1	113.4
12	156.2	115.4	113.7	113.7	117.9
14	156.7	115.0	130.4	116.0	120.8
16	143.2	115.0	144.4	115.7	115.7
18	119.6	109.6	132.7	111.2	111.2
20	104.1	104.1	104.1	104.1	104.1
22	100.5	100.5	100.5	100.5	100.5

TABLE II

Equivalent Temperature Differentials for summer New Delhi 28° 35′ N 77° 12′ E

Time I.S.T.	Horizontal roof 6″ concrete ½″ plaster inside U=0.70 Btu/hr/Ft²/°F	Walls 9 inch brick plastered on both sides U=0.455 Btu/hr/Ft²/°F			
		East Wall	West Wall	North Wall	South Wall
2	26.8	23.9	24.4	22.8	22.8
4	24.7	22.2	22.7	21.1	21.1
6	24.1	20.4	20.9	19.3	19.3
8	22.0	19.1	19.6	18.0	18.0
10	21.7	18.4	18.9	17.3	16.8
12	37.0	29.1	20.6	20.0	19.9
14	56.7	42.2	26.1	25.5	23.5
16	64.2	40.8	30.6	29.0	30.7
18	64.9	32.9	37.1	31.8	34.2
20	57.4	32.9	49.6	32.4	33.1
22	48.5	31.5	50.3	31.1	31.1
24	29.5	27.0	36.8	26.9	26.9

Calculated for a room temperature of 80°F

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 twelfth in the series.

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