

DESIGN RECOMMENDATIONS FOR BUILDINGS IN CHENNAI USING MAHONEY TABLE

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ABSTRACT

In the current scenario, the necessity of sustainable living environment is the essential need of the hour. The recent expansion of the Chennai metropolitan area as a Greater Chennai Corporation by inclusion of suburban zones makes it as one of the fastest growing cities. In addition to that Chennai city developed more infrastructure development in almost all areas that also includes “smart city” project. These types of infrastructure development lead to various climatic issues bringing negative impact on the environment leading to blocking of gifts of nature like air, wind, water. However, we cannot give up development of city since it is economically essential for the development of industries which totally depends on manual labour who are to be accommodated in these building structures. This does not mean that we can compromise with the natural environment. Even in the past, our earlier generations were aware of the benefits from certain climatic features by adopting appropriate building design. This paper gives an intuition into the design recommendations for climatic design approaches for the city of Chennai through Mahoney calculation.

Keywords: Climate parameters, Mahoney calculation, Design recommendations

INTRODUCTION

The Mahoney tables are very useful traditional tools to give design solution for buildings with a set of reference tables used as a guide for the climatic design.

CLIMATIC PARAMETERS

As per NBC (National Building Code) India can be divided into five climatic zones, namely, hot and dry, warm and humid, composite, temperate and cold.

Chennai is categorized as Warm and Humid climate.

Generally, Climate is defined as ‘Region with certain conditions of temperature, dryness, wind, light, etc’.

Temperature of the air is measured in Celsius(°C). It is also called as dry bulb temperature.

Table 1: Temperature

Daily mean temperature	24 hours reading (per day)	Average from 24 hours
Mean monthly temperature	30 days (average of a month) reading	Average of a month /30
Monthly mean maximum temperature	Each days maximum temperature	Average of each days maximum temperature /30
Monthly mean minimum temperature	Each days minimum temperature	Average of each days minimum temperature /30

Relative humidity is the amount of water in the air compared to the amount of water that the air could possibly hold.

Humidity Ratio (HR or AH): How much water present in one gm of air (gm of water/gm of dry air).

Relative Humidity (RH): Amount of air in the form of percentage (related with temperature).

Saturation line - (100 % humidity).

Dew point - It is the temperature of saturated air.

Specific volume - It is the volume per gram of dry air m³/g.

Wind is the movement of air due to a difference in atmospheric pressure, caused by differential heating of land and water mass on the earth's surface by solar radiation and rotation of earth. Measured in m/s or km/hr.

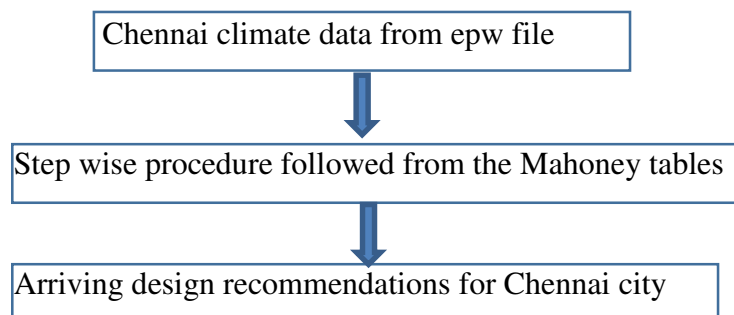
Precipitation is a collective term used for rain, snow, dew etc. It is expressed in mm/day. Mean rainfall in mm/month.

Solar radiation is the radiant energy received from the sun. It is the intensity of sunrays falling per unit time per unit area and is usually expressed in Watts per square metre (W/m²). The radiation incident on a surface varies from moment to moment depending on its geographic location.

METHODOLOGY

This paper aims to comprehend the design guidelines in the design stage from the recommendations of Mahoney table.

The climate data for the study is carried out with epw (Energy Plus weather format) file. EPW File is available for free in online from ISHRAE (The Indian Society of Heating, Refrigerating and Air Conditioning Engineers)



CLIMATE DATA

Table 2: Climatic Data for Chennai

Year and month	Chennai				
	Max. Mean temp.	Min. Mean temp.	Humidity in %		Rainfall in mm
			Monthly mean max.a. m	Monthly mean min.p.m	
January	29	19.5	93	55	35.3
February	31	21	93	46	13
March	33	23.5	94	62	14.5
April	34	26	87	55	15.9
May	36.5	27	85	50	42.4
June	36	26.5	80	48	53.9
July	34	26.5	78	57	99.6
August	33.5	25.5	82	53	129.9
September	33.5	25	88	53	123.5
October	33.5	24	96	65	284.6
November	31.5	22.5	96	72	353.0
December	28.5	21	92	60	146.3

PROCEDURE FOR DESIGN RECOMMENDATIONS FROM THE MAHONEY TABLES

Table 3: Location

Location	Chennai
Longitude	80.18°E
Latitude	13.00°N
Altitude	16m

Table 4: Air temperature: °C

	J	F	M	A	M	J	J	A	S	O	N	D		High	AMT
Monthly mean max	29	31	33	34	36.5	36	34	33.5	33.5	33.5	31.5	28.5		36.5	28
Monthly mean min	19.5	21	23.5	26	27	26.5	26.5	25.5	25	24	22.5	21		19.5	17
Monthly mean range	9.5	10	9.5	8	9.5	9.5	7.5	8	8.5	9.5	9	7.5		Low	AMR

Table 5: Relative humidity: %

	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max. a.m	93	93	94	87	85	80	78	82	88	96	96	92
Monthly mean min. p.m	55	46	62	55	50	48	57	53	53	65	72	60
Average	74	69.5	78	71	67.5	64	67.5	67.5	70.5	80.5	84	76
Humidity group	4	3	4	4	3	3	3	3	4	4	4	4

Table 6: Reference Table (Humidity group)

Humidity group	1	If average RH: below 30 %
	2	30-50 %
	3	50-70%
	4	Above 70 %

Table 7: Rainfall data

Rainfall,mm	35.3	13	14.5	15.9	42.4	53.9	99.6	130	124	285	353	146	1312
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Table 8: Reference Table (Comfort limits in term of temperature and the humidity group)

		AMT over 20 °C		AMT 15-20 °C		AMT below 15 °C	
Comfort limits		Day	Night	Day	Night	Day	Night
Humidity groups	1	26-34	17-25	23-32	14-23	21-30	12-21
	2	25-31	17-24	22-30	14-22	20-27	12-20
	3	23-29	17-23	21-28	14-21	19-26	12-19
	4	22-27	17-21	20-25	14-20	18-24	12-18

Table 9: Nature of thermal stress

	J	F	M	A	M	J	J	A	S	O	N	D		
Monthly mean max	29	31	33	34	36.5	36	34	33.5	33.5	33.5	31.5	28.5	28	AMT
Day comfort: upper	27	29	27	27	27	29	31	29	27	27	27	27		
lower	22	23	22	22	23	25	23	22	22	22	22	22		
Monthly mean min	19.5	21	23.5	26	27	26.5	26.5	25.5	25	24	22.5	21		
Night comfort:upper	21	23	21	21	21	23	24	23	21	21	21	21		
lower	17	17	17	17	17	17	17	17	17	17	17	17		
Thermal stress: day	H	H	H	H	H	H	H	H	H	H	H	H		
night	O	O	H	H	H	H	H	H	H	H	H	O		

H (hot) -if mean is above limit

O (comfort) –if mean is within limit

C (cold) –if mean is below the limit

Table 10: Indicators (six ‘indicators’ (three humid indicator H 1, 2, 3 and three ‘arid indicators’ A 1, 2, 3)

	J	F	M	A	M	J	J	A	S	O	N	D		
Humid:H1	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	10	Totals
H2													0	
H3										✓	✓		2	
Arid: A1													0	
A2													0	
A3													0	

Table 11: Reference Table (Indicators)

Applicable when:	Indicator	Thermal stress		Rainfall	Humidity Group	Monthly mean range
		Day	Night			
Air movement essential	H1	H			4	
		H			2,3	Less than 10
Air movement desirable	H2	O			4	
Rain protection necessary	H3			Over 200mm		
Thermal capacity necessary	A1				1,2,3	More than 10
Out-door sleeping desirable	A2		H		1,2	
		H	O		1,2	More than 10
Protection from cold	A3	C				

RECOMMENDED SPECIFICATIONS

Indicator Totals from Table10								
H1	H2	H3	A1	A2	A3			
10	0	2	0	0	0			
Layout								
			0-10			✓	1	Orientation north and south (long axis east-west)
			11,12		5-12			
					0-4		2	Compact courtyard planning
Spacing								
11,12							3	Open spacing for breeze penetration
2-10						✓	4	As 3, but protection form hot and cold wind
0,1							5	Compact lay-out of estates
Air movement								
3-12						✓	6	Rooms single banked, permanent provision for air movement
1,12			0-5					
			6-12				7	Double banked rooms, temporary provision for air movement
0	2-12							
	0,1						8	No air movement requirement
Openings								
			0,1		0	✓	9	Large openings, 40-80%
			11,12		0,1		10	Very small openings, 10-20%
Any other conditions							11	Medium openings, 20-40%
Walls								
			0-2			✓	12	Light walls, short time-lag
			3-12				13	Heavy external and internal walls
Roofs								
			0-5			✓	14	Light, insulated roofs
			6-12				15	Heavy roofs, over 8 h time-lag
Out-door sleeping								
				2-12			16	Space for out-door sleeping required
Rain protection								
		3-12					17	Protection from heavy rain necessary

LIST OF DETAILED RECOMMENDATIONS

Indicator Totals from Table 2							
H1	H2	H3	A1	A2	A3		
10	0	2	0	0	0		
Size of opening							
			0-1		0	✓	1
					1-12		2
			2-5				
			6-10				3
			11-12		0-3		4
					4-12		5
Position of Openings							
3-12						✓	6
1-2			0-5				
			6-12				7
0	2-12						
Protection of Openings							
					0-2	✓	8
		2-12				✓	9
Walls and Floors							
			0-2			✓	10
			3-12				11
Roofs							
10-12			0-2			✓	12
			3-12				13
0-9			0-5				
			6-12				14
External features							
				1-12			15
		1-12				✓	16

Table 12: Design recommendations for Chennai

S. No	Design parameters	Design recommendations from Mahoney tables
1	Layout	Orientation north and south (long axis east-west)
2	Spacing	Open spaces for breeze penetration, but protection from hot and cold winds
3	Air movement	Rooms single banked with permanent provision for air movement
4	Openings	Large openings, 40% - 80%
5	Position of openings	In windward side at body height
6	Walls	Light walls, short time -lag
7	Roofs	Light, insulated roofs
8	External features	Adequate rainwater drainage

CONCLUSIONS

Based on the above calculations and ultimately as highlighted in Table 12 it is recommended to adopt these design guidelines specifically for Chennai city. Chennai which is classified under warm and humid climate has to adhere to those strategies as Mahoney Table is considered as a traditional tool for creating climatic building design. These initial recommendations help the designer to design the environment in such a way by enjoying natural gifts for all the living systems. The advantages of these sustainable tools bring the energy efficient building design with building components and building materials playing an important role in providing thermal comfort to the users.

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