

# Impact of movable external shading system on daylight availability of office building in hot and dry climate of India.



# Shading Devices–Mapping over past.



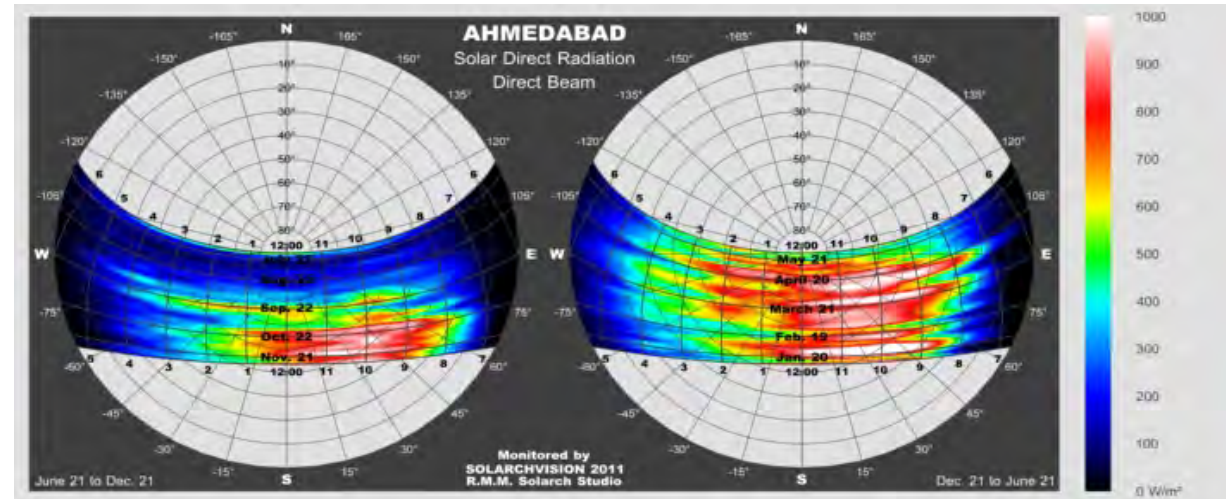
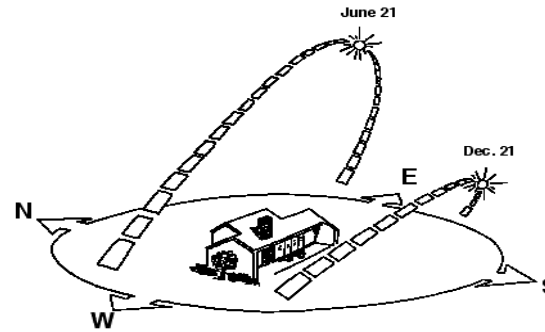
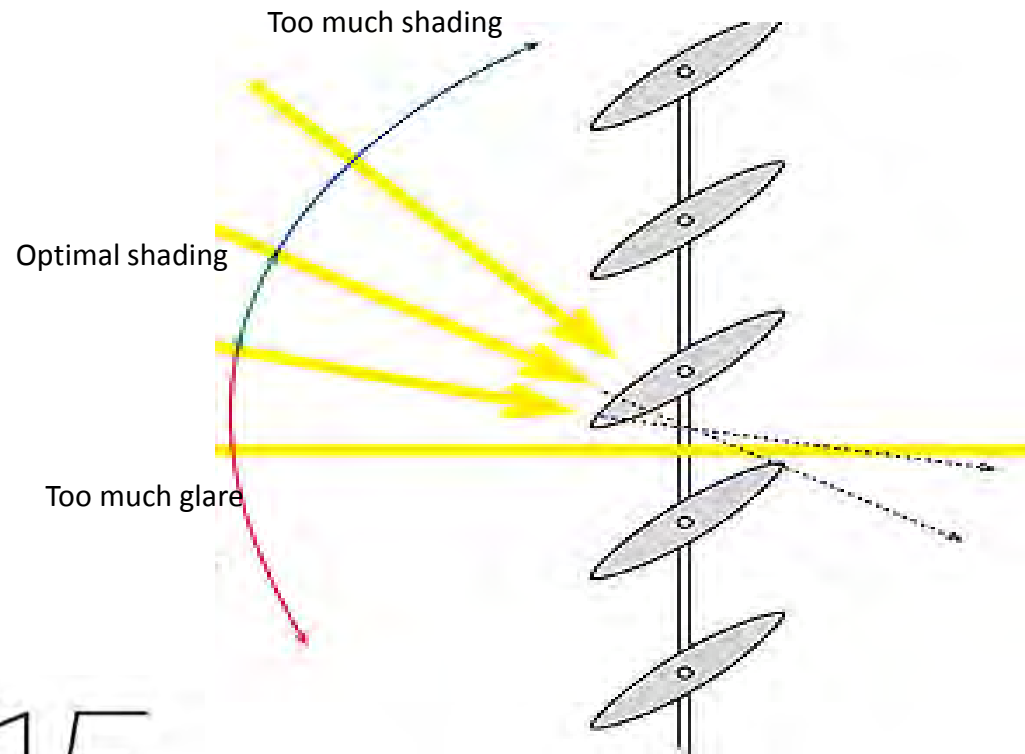
# Architectural response to shading devices.



- Jali
- Jarokha
- Overhangs
- Sun cutters
- External shading



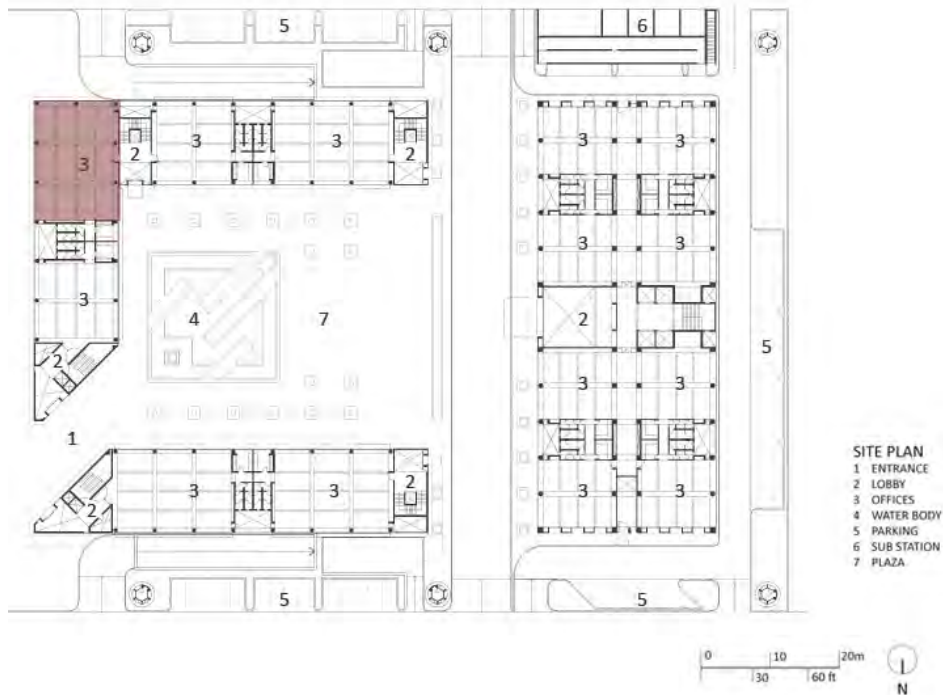
# Solar geometry and science of shading.



The balance between daylight and radiation



## Site and the study:



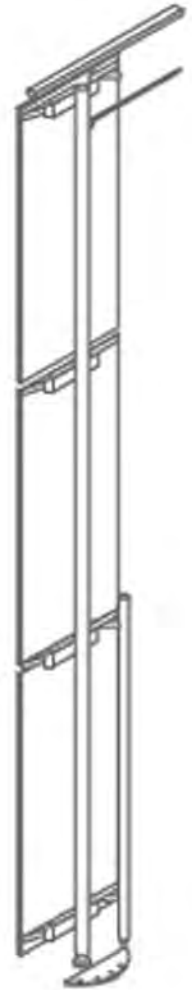
- The field study took place in a office building with movable shading devices in hot and dry climate of Ahmedabad, India.
- The main building comprises of 4 separate blocks around a central courtyard. The study took place in a vacant office measuring 20x12 meters, openings in three directions except north.



## The Device.

**The VRLS** – The Vertical Rigid Louver System consists of panels fixed to aluminium pipes. The pipes in turn are fixed at the top and bottom to the building ledges. The louver panels are joined to the structure from the inside only.

**Structure:** Aluminium, Panel options: Cement bonded fibre boards/jute fibre composite board/high pressure laminated board

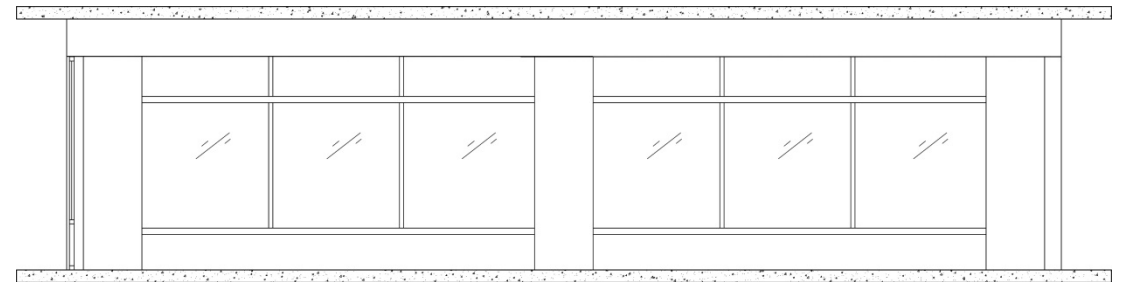
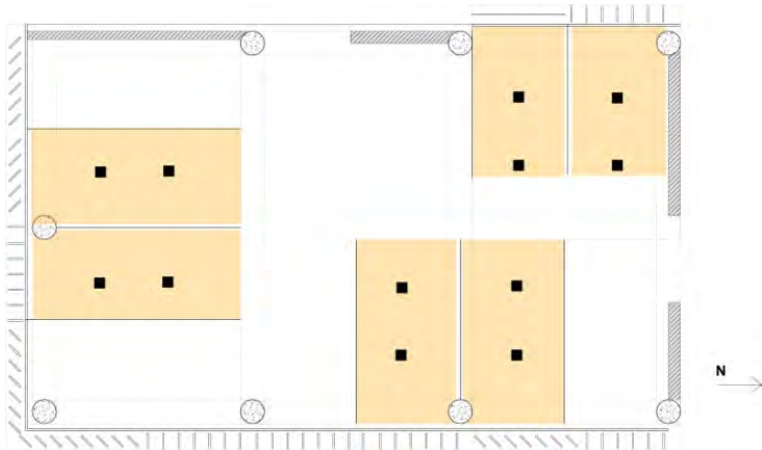


## The strategy:

Lux data was recorded at working desk height of 800millimeter at a distance of 2 and 4 meters inside of the façade.

Surface Temp of :

- Inside and outside of the shading device
- Inside and outside of beam and sill
- Overhang above and below
- Inside and outside of window glass and the edge of the glass
- Inside and outside of the window frame



## The strategy:

### ***Measuring of SHGC (solar heat gain coefficient) through:***

Surface temperatures on both sides of the shading devices., the beam/overhang, the frames of the window.

### ***Measuring the amount of light falling on:***

Lux measurement of the interior work surface at 2 and 4 meter distance from the window.

### ***Study conditions of the movable shading devices at various positions as follows:***

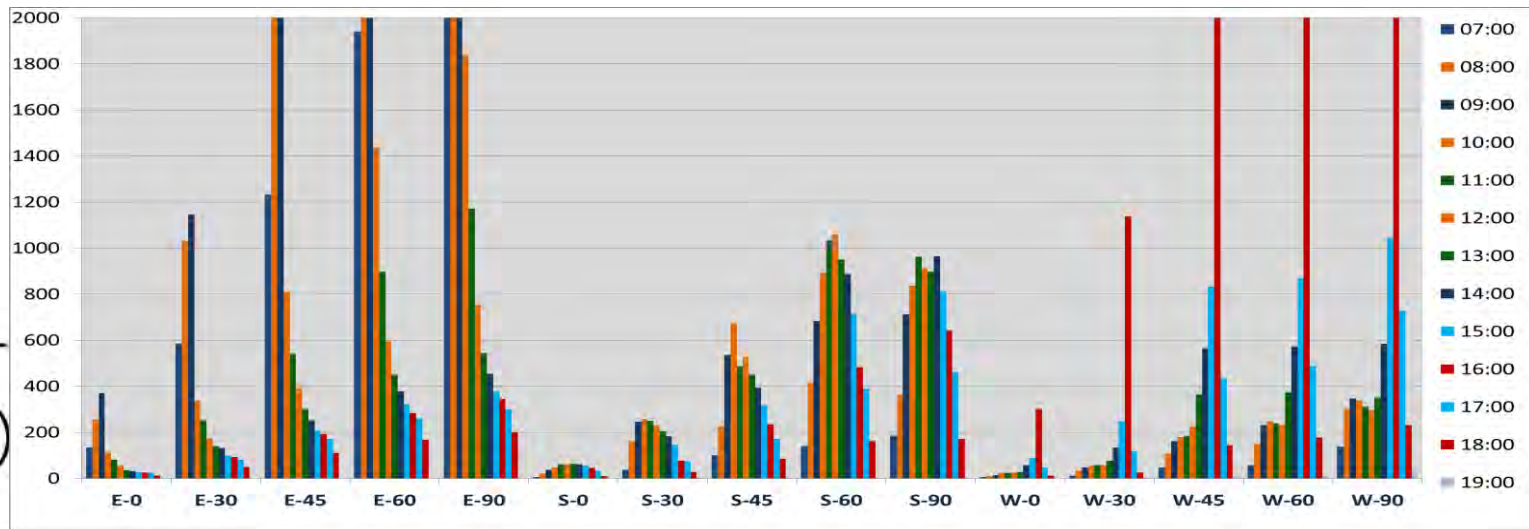
No louvers, Louvers @ 30°, 60°, 90° and completely closed with respect to the building façade.





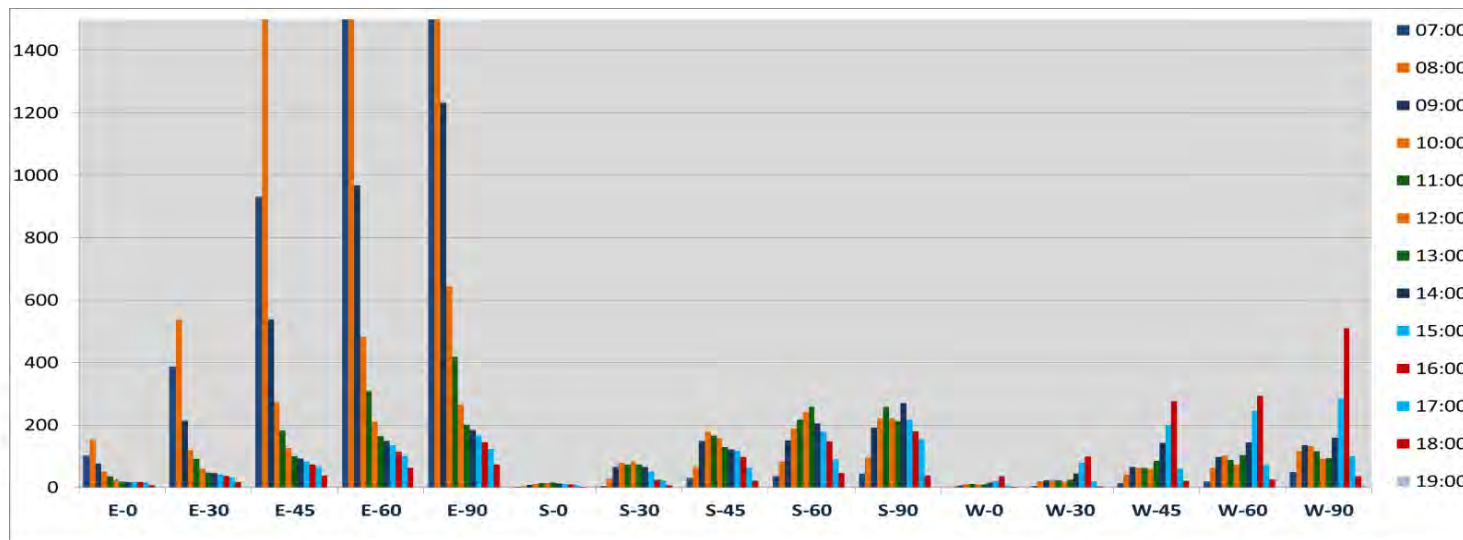
# Lux Readings at 2 meters from the window

	East					South					West				
time	E-0	E-30	E-45	E-60	E-90	S-0	S-30	S-45	S-60	S-90	W-0	W-30	W-45	W-60	W-90
07:00	132	583	1231	1939	2270	5	36	100	139	184	5	11	47	57	136
08:00	256	1032	2708	4475	5370	21	162	226	415	364	10	33	108	150	302
09:00	371	1145	3280	6005	8120	38	247	535	683	713	14	47	162	230	347
10:00	113	337	811	1437	1839	48	257	674	892	837	23	56	180	248	338
11:00	81	252	541	897	1172	61	250	486	1034	962	24	57	185	239	312
12:00	55	173	391	595	753	61	229	528	1058	913	26	57	224	233	295
13:00	35	140	301	450	543	64	205	450	950	898	27	77	365	375	350
14:00	31	132	252	377	454	61	184	393	887	964	57	133	564	572	584
15:00	28	99	209	320	378	55	145	317	715	813	89	248	832	869	1045
16:00	25	92	192	283	344	46	77	234	482	641	301	1138	2470	3389	5520
17:00	23	81	172	259	300	34	75	171	389	461	47	119	433	488	728
18:00	11	50	111	168	198	9	28	85	162	172	12	25	143	178	230
19:00	0	0	0	0	0	0	4	1	2	2	0	4	8	9	31

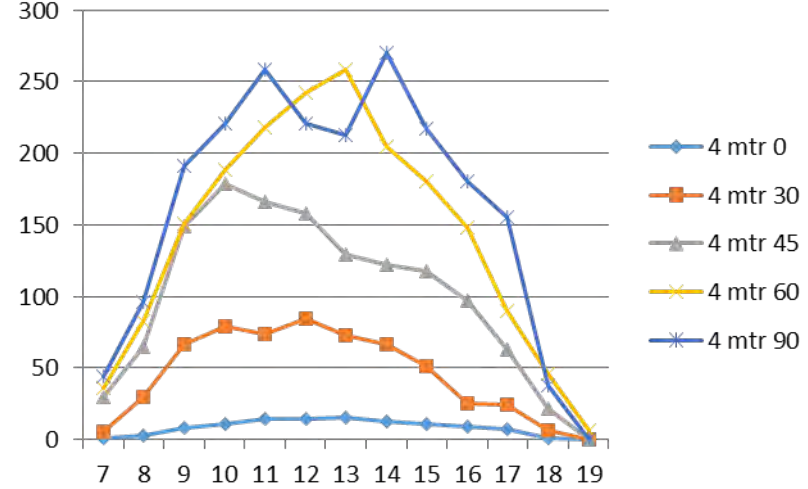
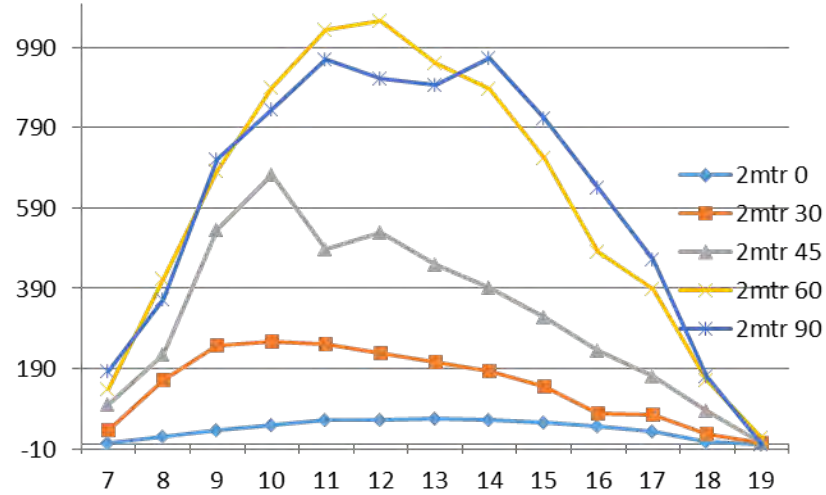


# Lux Readings at 4 meters from the window

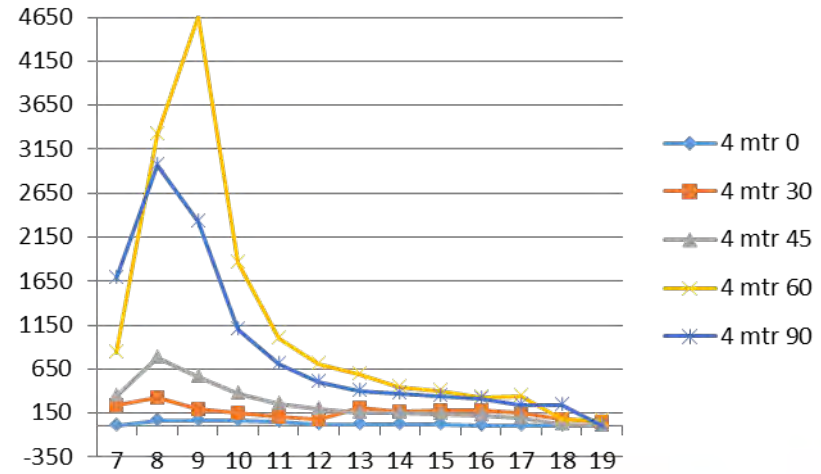
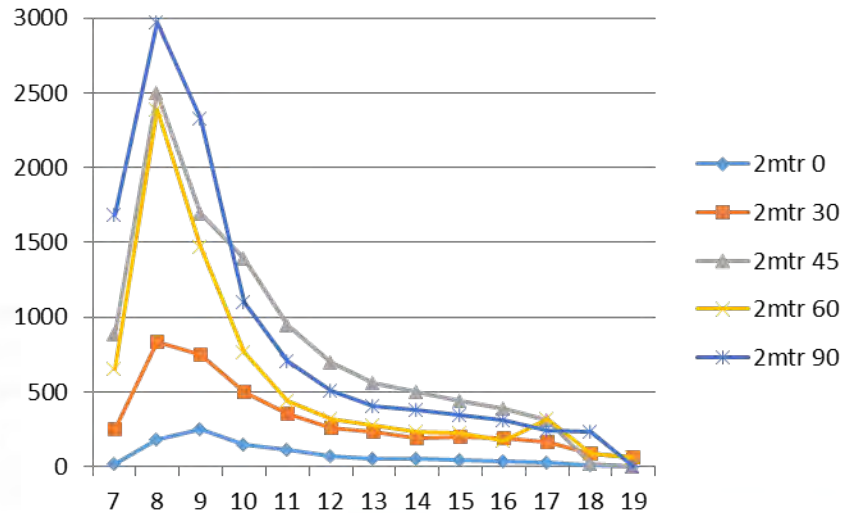
	East					South					West				
time	E-0	E-30	E-45	E-60	E-90	S-0	S-30	S-45	S-60	S-90	W-0	W-30	W-45	W-60	W-90
07:00	101	387	930	1858	1861	1	5	30	36	44	0	4	13	18	48
08:00	154	537	1516	2723	2889	3	30	65	83	96	4	20	42	62	115
09:00	77	214	538	967	1233	8	66	149	151	191	7	23	65	98	136
10:00	50	120	273	483	645	11	79	179	188	221	11	25	63	102	132
11:00	35	91	183	308	419	14	74	166	218	258	11	24	62	88	115
12:00	25	61	126	211	266	14	84	158	242	221	10	19	60	74	91
13:00	19	48	100	164	201	15	73	129	258	213	10	25	86	104	94
14:00	17	46	93	149	184	13	66	122	205	270	15	44	143	145	159
15:00	17	42	83	135	166	11	51	118	180	217	22	80	199	245	285
16:00	17	37	73	114	144	9	25	97	148	180	35	99	277	293	510
17:00	16	32	65	101	124	7	24	63	90	155	6	20	61	72	100
18:00	6	17	39	63	73	1	6	22	46	38	1	4	21	27	36
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6



## Lux level vs Time factors in the SOUTH direction at 2 and 4 meters.



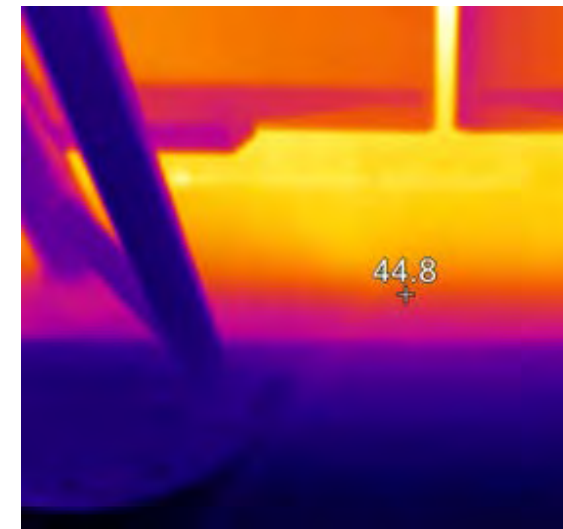
## Lux factors in the EAST direction in respect to time at 2 nd 4 meters.



# Surface temperature inside and outside of surfaces in the west direction.

	West Inside Temp.																			
	West Louveres					West beam					West sill					West overhang Above				
	0	30	45	60	90	0	30	45	60	90	0	30	45	60	90	0	30	45	60	90
07:00	29	25.9	25.9	25.8	28.6	31.1	29.8	29.8	29.2	29.7	31	28.3	28.3	27.5	29.7	31.6	27.9	27.9	27.7	29.9
08:00	30.1	26.8	26.8	26.7	30.1	31.2	29.9	29.9	29.4	29.8	31	28.4	28.4	27.8	29.9	31.6	27.9	27.9	27.5	30.1
09:00	31.3	28.4	28.4	28.2	31	31.2	29.9	29.9	29.5	29.9	31	28.6	28.6	28.5	30.5	31.6	28.3	28.3	27.8	30.3
10:00	32.5	29.4	29.4	29.3	32.8	31.2	29.9	29.9	29.6	30	31.3	28.7	28.7	28.8	30.7	31.7	28.5	28.5	28	31.1
11:00	33.8	31.6	31.6	31.4	34.6	31.2	29.9	29.9	29.6	30.2	31.4	29.2	29.2	29.2	31.5	32.1	29.3	29.3	29	31.8
12:00	35.5	33.4	33.4	33	36.3	31.2	29.9	29.9	29.6	30.3	31.6	30.1	30.1	30.2	32.2	32.4	30	30	29.5	32.3
13:00	38	36.1	36.1	35.4	37.4	31.3	29.9	29.9	29.9	30.5	32	30.6	30.6	31.1	32.6	33.5	30.9	30.9	30.4	33.2
14:00	43.4	38.5	38.5	38.9	44	31.3	29.9	29.9	30	30.5	32.9	32.2	32.2	32.7	34.1	33.9	31.8	31.8	31.3	34.6
15:00	47.8	41.6	41.6	39.1	43.4	31.4	30.1	30.1	30.2	30.8	33.7	35.1	35.1	35.4	36.8	36	33.4	33.4	31.8	35.5
16:00	49	45.6	45.6	41.1	43.4	31.4	30.3	30.3	30.3	31.1	35.2	37	37	37.2	39.5	37.5	35.4	35.4	32.2	36.1
17:00	42.9	35.5	35.5	35.5	39.8	31.5	30.2	30.2	30.1	31.3	36	36.7	36.7	38.2	43.3	38.4	35.1	35.1	33	36.8
18:00	35.6	34.1	34.1	34.3	37.6	31.1	30.1	30.1	30	31.2	35.3	35.5	35.5	36.6	41.6	37.6	35.1	35.1	33.1	36.3
19:00	33.9	33.1	33.1	33.2	36.6	31	30.1	30.1	29.9	31.1	34.6	35	35	35.7	39.4	37.4	34.7	34.7	33	36.3

	West Outside Temp.																			
	West Louveres					West beam					West sill					West overhang Below				
	0	30	45	60	90	0	30	45	60	90	0	30	45	60	90	0	30	45	60	90
07:00	28.7	25.7	25.7	25.8	28.8	31.3	28.1	28.1	27.7	29.8	30.9	27.8	27.8	27.4	29.4	31.4	28.3	28.3	27.5	29.7
08:00	30.2	26.9	26.9	27.3	31.1	31.6	28.2	28.2	27.8	30.3	31	27.9	27.9	27.9	30.1	31.3	28.4	28.4	27.8	29.9
09:00	31.5	28.6	28.6	29	32.6	31.6	28.8	28.8	28.2	30.8	31.1	28.3	28.3	28.1	30.7	31.6	28.6	28.6	28.5	30.5
10:00	32.6	29.7	29.7	30.2	33.7	31.9	29.1	29.1	28.8	31.3	31.6	28.7	28.7	28.6	31.3	31.8	28.7	28.7	28.8	30.7
11:00	34.1	32.1	32.1	32.3	36	32.2	29.8	29.8	29.3	31.7	32.2	29.8	29.8	29.6	32.3	32.3	29.2	29.2	29.2	31.5
12:00	35.9	33.7	33.7	33.7	37.1	32.5	30.7	30.7	30.9	32.8	32.7	30.4	30.4	30.4	32.8	32.7	30.1	30.1	30.2	32.2
13:00	38.6	36.5	36.5	36.5	37.8	33.3	31.2	31.2	30	33.8	33.3	32.6	32.6	32	33.9	33.4	30.6	30.6	31.1	32.6
14:00	44.3	39.3	39.3	37.6	42.5	34.2	31.8	31.8	31.6	34.1	35.1	36.6	36.6	36.5	37.4	34.8	32.2	32.2	32.7	34.1
15:00	48.4	41.9	41.9	38.8	42	35.4	32.9	32.9	31.9	34.1	37	39	39	38.3	40.1	36.7	35.1	35.1	35.4	36.8
16:00	50.2	46.2	46.2	41.1	43	36.5	33.7	33.7	32.6	36.2	37.7	40.9	40.9	40	44	37.5	37	37	37.2	39.5
17:00	42.1	35.4	35.4	34.6	39.4	36.6	33.5	33.5	32.3	36.3	37.3	37.5	37.5	38.8	46.1	38.6	36.7	36.7	38.2	43.3
18:00	35.5	33.8	33.8	34.3	37.3	36	33.3	33.3	31.9	35.4	36.1	35.9	35.9	37.1	42.2	36.7	35.5	35.5	36.6	41.6
19:00	33.7	32.8	32.8	33.3	36.5	35.1	33	33	32.5	35.2	35.2	35.7	35.7	35.5	40.7	36.4	35	35	35.7	39.4



# Temperature distribution in the centre of glass.

Centre of glass inside surface temperature.															
TIME	EAST					West					South				
	0	30	45	60	90	0	30	45	60	90	0	30	45	60	90
07:00	27.38	26.89	27.65	26.92	27.75	27.51	30.07	30.04	28.00	29.38	28.75	29.74	27.14	26.87	28.52
08:00	28.17	30.37	31.23	33.50	33.39	27.97	29.02	31.08	28.64	31.90	31.10	29.89	27.36	27.04	29.69
09:00	30.04	32.74	33.52	38.70	38.62	28.79	31.59	32.51	31.00	33.16	30.27	30.04	28.00	27.90	30.52
10:00	31.61	33.89	34.86	39.77	40.75	30.55	33.86	34.36	33.05	33.76	30.80	30.70	28.87	28.84	31.56
11:00	32.77	34.44	35.50	37.07	37.45	32.02	35.50	35.64	34.62	34.62	31.46	31.46	29.94	29.97	32.38
12:00	33.00	34.02	35.40	36.02	35.96	32.79	36.55	36.88	37.18	35.89	32.07	32.15	30.80	30.87	33.16
13:00	32.64	33.73	35.05	34.18	35.13	33.44	36.23	36.85	37.76	37.76	33.03	33.18	31.94	32.15	33.73
14:00	32.56	34.31	35.48	34.57	35.37	34.26	36.20	36.80	37.48	38.12	36.72	38.25	37.18	37.65	38.45
15:00	32.59	34.62	35.42	34.76	35.26	34.52	36.17	37.02	37.21	38.27	36.15	36.74	35.85	38.45	39.57
16:00	32.51	34.20	35.10	34.36	35.05	34.78	35.21	36.91	35.93	37.90	36.34	36.85	36.96	43.07	46.23
17:00	32.41	34.12	34.68	34.12	34.52	34.41	34.55	36.23	35.29	37.27	36.47	36.80	33.97	34.49	44.97
18:00	32.05	33.57	33.94	33.44	33.81	33.76	34.20	35.72	34.52	36.05	33.73	33.84	32.92	32.82	35.48
19:00	31.48	32.38	32.90	32.15	32.79	33.05	33.21	33.37	33.05	33.78	32.92	32.82	32.07	31.77	34.20
20:00	30.87	31.15	31.43	30.87	31.43	32.30	32.54	32.69	32.20	33.59	32.28	32.12	31.54	31.23	32.98
21:00	30.07	30.37	30.65	30.04	30.72	31.82	32.07	32.90	31.16	32.12	31.66	31.43	30.95	30.67	32.23
22:00	29.62	29.62	30.14	29.39	30.02	31.31	31.51	32.43	30.75	31.87	31.03	30.82	30.60	30.34	31.64
23:00	29.24	29.34	29.64	29.07	29.59	30.75	31.13	32.00	30.29	31.08	30.29	30.09	30.32	30.12	31.26
00:00	28.92	28.94	29.27	28.64	29.32	30.07	30.87	31.56	30.02	30.52	29.79	29.67	30.02	29.79	30.90
01:00	28.57	28.47	28.67	28.20	28.74	29.49	30.60	31.26	30.01	30.37	29.79	29.64	29.69	29.49	30.55
02:00	28.32	28.07	28.10	27.78	28.20	29.32	30.70	30.93	29.97	30.04	29.57	29.41	29.39	29.22	30.37
03:00	28.05	28.05	27.55	27.83	27.55	29.44	30.60	30.87	29.79	29.72	29.44	29.29	28.97	28.92	30.12
04:00	27.70	28.05	27.14	27.85	27.11	29.09	30.42	30.44	29.67	29.41	29.14	28.94	28.79	28.74	29.94
05:00	27.55	28.00	26.84	27.85	26.77	28.47	30.24	30.09	29.24	29.28	28.84	28.67	28.67	28.59	29.82
06:00	27.38	27.97	26.79	27.90	26.70	28.25	29.89	29.72	28.82	28.87	28.59	28.39	28.57	28.49	29.41

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