COMPARING VISUAL COMFORT IN DAYLIGHT PATTERN BETWEEN AN OLD AND A MODERN OFFICE BUILDING

Study – The Kolkata Municipal Corporation & The Technopolis Building, Kolkata.

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Abstract –

Office spaces are integral part of modern development and the amount of daylight having an access holds key for efficient functioning of the office spaces. This paper makes a curious attempt with the study of an old office building which is functional for more than 140 years, the Kolkata Municipal Corporation building and comparing with a modern office building - the Technopolis, functional since 2006, of the same scale and typology in Kolkata. The comparison in this paper are based on the amount and pattern of daylight reaching the work plane in the four cardinal directions in both the buildings in the daylight zones and thereby comparing the daylight factor and see how close they are to the prescribed standards of an office work plane benchmark and visual comfort conditions. Based on the findings, the paper will also conclude about the optimum balance in related aspects that needs to be incorporated for efficient functioning of future office buildings.

Key Words – Daylight, Old & Modern Office Buildings, Visual Comfort.

Introduction – The energy crisis, the growing understanding of our limited resources and some major technological failures surely requires a fresh look at our culture of modern buildings. There are many reasons for the renewed interest in day lighting - the high cost of fossil fuels and the realization that sources of electricity have a finite life, being quoted as most cogent; but perhaps even more important are the less tangible aspects of day lighting, i.e, the aspect which relate more to the quality of daily life that an office space needs to be equipped with.

The effective external light reaching the internal building spaces due to the placement of windows and openings is considered, analysed and the daylight factor is normally calculated. But the first and most obvious thing to understand is that daylight is variable: it varies with the season of the year, the time of day, and the weather; for this reason the means of calculation are based on relative rather than absolute values, and this is usually defined in terms of the relationship between the light available outside and that available at different positions inside, a proportion of which is termed as the daylight factor.

Methodology - For both the buildings in this study, old and new, office spaces were identified having vertical external walls on four different directions. The daylight zones were marked in the rooms and simple calculation methods are adopted to work out the percentage of daylight areas in the rooms adjacent to the windows. Then the light levels were measured both by on field physical survey by a standard

The KMC Building.

The TechnopolisBuilding.

luxmeter and software simulation. The graphs generated by simulation are then compared with the actual on field readings. The Daylight factor is simultaneously calculated and compared for all rooms in the respective directions. The 'average' daylight factor generated by both the methodologies adopted is then compared for both the buildings. This is done for the very reason that the software projects the illumination levels in all ideal conditions whereas the physical survey portrays the actual on field situation.

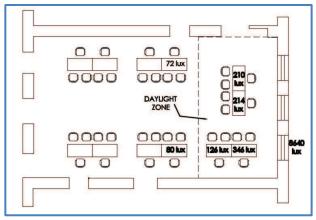
A few common factors for all the readings in KMC and Technopolis were -

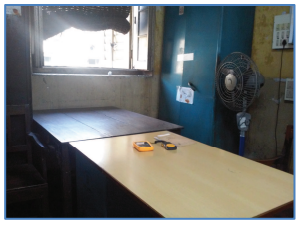
- Sill level of windows - 0.8m - 0.9m (KMC) & 0.35m & 0.6m (Technopolis).
- Lintel level of windows – 2.4m - 2.5m (KMC) & 2.4m & 3.5m (Technopolis).
- Sky conditions – Clear.
- External Illumination readings: at Sill level and at shaded plane.
- Internal readings: at 0.75m work stations.
- All illumination measurements in lux.
- Instrument Used for field readings – Luxmeter, HP make.
- Software used for simulation – DIALux.

Study: The KMC Building -

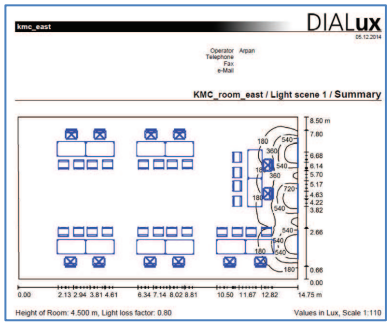
Case I: External wall on East –

- Office – Assessment Department
- Date – 02.12.2014
- Time – 3.35pm IST
- Size of Room – 14.75m x 8.5m
- Size of Windows – 1.5m x 1.5m
- Daylight Zone – 4.8m x 8.5m
- Percentage of Daylight area – 32.54%





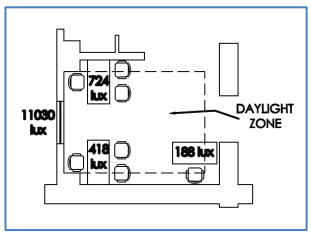
Day light: on field reading and projection through simulation, East Exposure -



Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	346	212	126	228	8640	**2.63**	**3.39**
In software simulation	540	360	180	360		**4.16**	

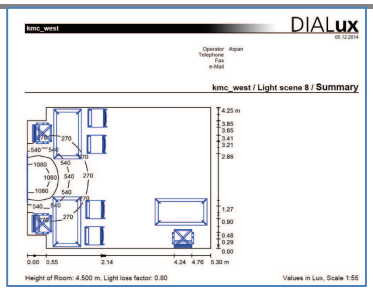
Case II: External wall on West -

- Office – Collection Section
- Date – 02.12.2014
- Time – 2.40pm IST
- Size – 5.3m x 4.25m
- Size of Windows – 1.45m x 1.5m
- Daylight Zone – 4.8m x 3.45m



- Percentage of Daylight area – 73.51%

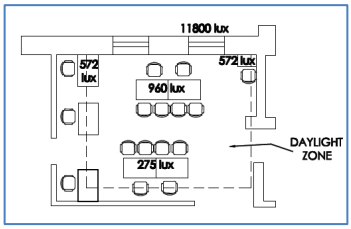
Day light: on field reading and projection through simulation, West Exposure -



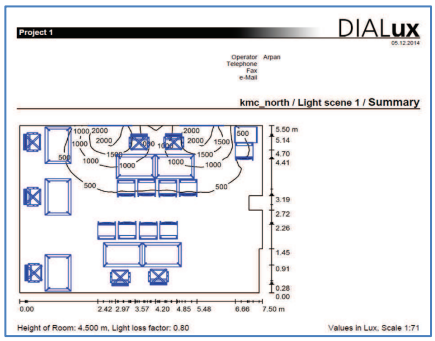
Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	724	418	188	443	11030	**4.01**	**4.86**
In software simulation	1080	540	270	630		**5.71**	

Case III: External wall on North -

- Office – Govt. Audit Department
- Date – 02.12.2014
- Time – 2.10pm IST
- Size – 7.5m x 5.5m
- Size of Windows – 1.5m x 1.65m
- Daylight Zone – 6.18m x 5.0m
- Percentage of Daylight area – 74.9%



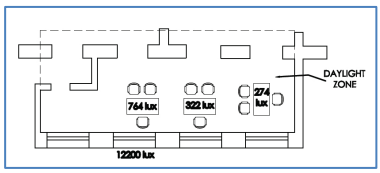
Day light: on field reading and projection through simulation, North Exposure -



Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	960	572	275	602	11800	**5.10**	**6.78**
In software simulation	1500	1000	500	1000		**8.47**	

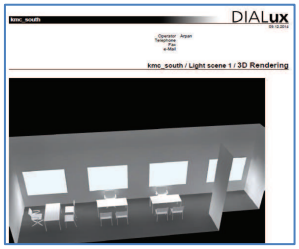
Case IV: External wall on South -

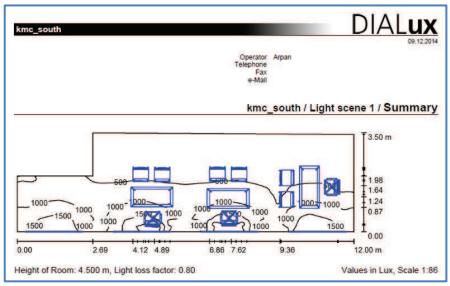
- Office – Office of Ward Officers
- Date – 02.12.2014
- Time – 1.45pm IST
- Sky Conditions – Clear
- Size – 12m x 3.5m
- Size of Windows – 2.0m x 1.6m
- Daylight Zone – 12m x 4.8m



- Percentage of Daylight Area – 100%

Day light: on field reading and projection through simulation, South Exposure -



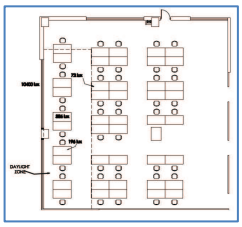


Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	764	322	274	453	12200	**3.71**	**5.26**
In software simulation	1000	1000	500	833		**6.82**	

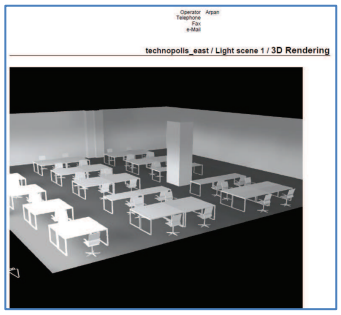
Study: The Technopolis -

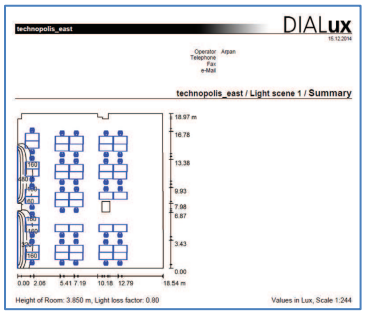
Case I: External wall on East -

- Office – Cognizant Technology Solutions
- Date – 15.12.2014
- Time – 11.45 am IST
- Size of Room – 18.440m x 18.975m
- Size of Windows – 6.9m x 2.05m
- Daylight Zone – 4.8m x 16.025m
- Percentage of Daylight area – 21.98%



Day light: on field reading and projection through simulation, East Exposure -

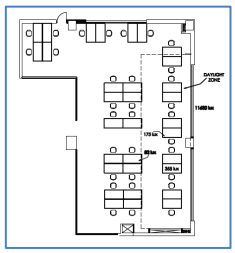


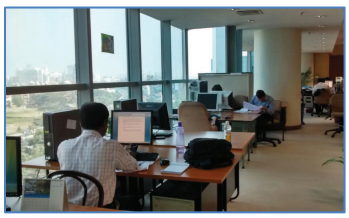


Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	386	196	72	218	10400	**2.09**	**2.58**
In software simulation	480	320	160	320		**3.07**	

Case II: External wall on West -

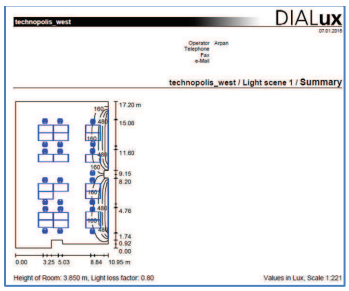
- Office – Cognizant Technology Solutions
- Date – 15.12.2014
- Time – 12.10 pm IST
- Size of Room – 10.950m x 19.675m
- Size of Windows – 6.9m x 2.05m
- Daylight Zone – 4.8m x 16.025m





- Percentage of Daylight area – 35.70%

Day light: on field reading and projection through simulation, West Exposure -

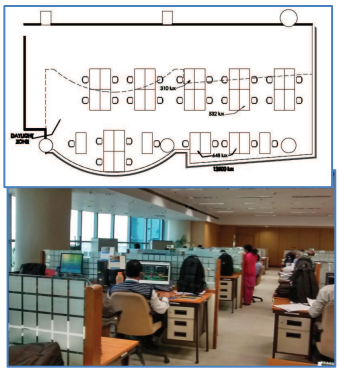


Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	355	175	82	204	11630	**1.75**	**2.25**
In software simulation	480	320	160	320		**2.75**	

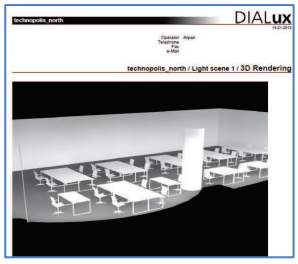
Case – III: External wall on North -

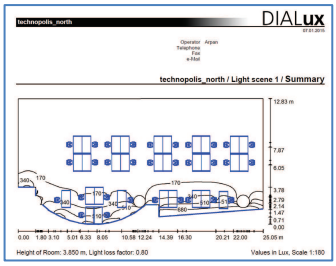
- Office – Cognizant Technology Solutions
- Date – 15.12.2014
- Time – 12.50 pm IST

- Size of Room – 25.050m x 12.850m
- Size of Windows – 23.250m x 2.90m
- Daylight Zone – 23.250m x 7.00m
- Percentage of Daylight area – 50.56%



Day light: on field reading and projection through simulation, North Exposure -

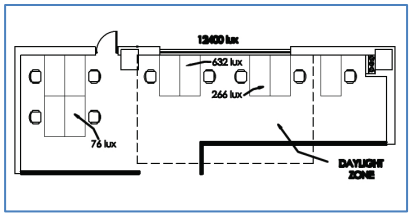


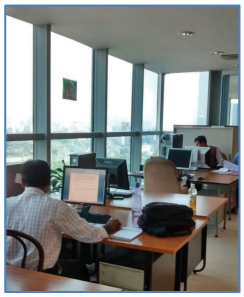


Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	648	532	310	497	12500	**3.97**	**4.10**
In software simulation	680	570	340	530		**4.24**	

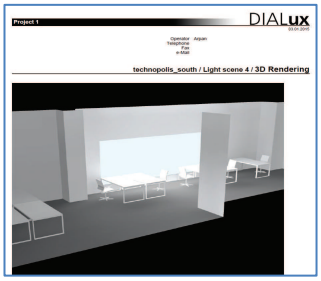
Case – IV: External wall on: South

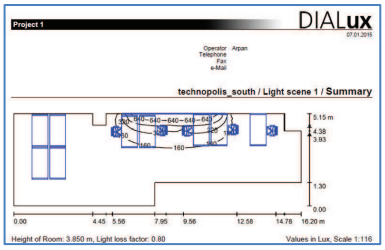
- Office – Cognizant Technology Solutions
- Date – 15.12.2014
- Time – 12.50 pm IST
- Size of Room – 15.95m x 3.85m
- Size of Windows – 6.90m x 2.05m
- Daylight Zone – 7.80m x 4.80m
- Percentage of Daylight area – 60.93%





Day light: on field reading and projection through simulation, South Exposure -





Internal Illumination	at 1.2m	at 2m	at 3.5m	Avg. Int. Illumination	External Illumination	DF (in %)	Average (in %)
In field reading	632	266	76	325	12400	**2.62**	**2.81**
In software simulation	640	320	160	373		**3.0**	

Comparative Observations of the Daylight Factor (DF):
Average of reading and simulation –

Sl. No.	Directions	Avg. DF - KMC	Avg. DF - Technopolis
1.	**East**	**3.39**	**2.58**
2.	**West**	**4.86**	**2.25**
3.	**North**	**6.78**	**4.10**
4.	**South**	**5.26**	**2.81**

Observations –

It is important to note that SP- 41/1987 suggest variability in the lux levels is provided by an overcast sky as per the climate zone. In Kolkata, (Warm and Humid climate) considering the latitude, the altitude, air-quality and the variable nature of daylight, a diffuse sky is considered to produces 9000 lux on average for 85% of the day, or lower for the remaining 15%. Thus, the value of 1% DF shall

be 90 lux, a 2% DF will give a light level of 180 lux, the latter being a figure considered good to provide some sense of the room being day lit, but not sufficient to carry out normal office tasks. Normally a minimum level of 300 lux, i.e, a DF in access of 3% is necessary in a work situation to provide a day lit space for a large part of daylight hours in Kolkata. The DF found in the table is suggestive that the KMC, the old building captures more daylight and ensures better daylight performance when compared to its modern counterpart, the Technopolis. The KMC building projects in access of 3% in all directions whereas the Technopolis achieves that only in the north facade. The percentage of overall window openings in external facades for KMC is 21% whereas of Technopolis is close to 41%. So, it's not the percentage of openings alone that ensures ample daylight. The Technopolis being centrally air conditioned and is also totally dependent on artificial lighting. For example, the northern façade of the Technopolis that faces the main access road is almost fully glazed - 98% with double glass panels. The visible light transmittance (VLT) of the glass is kept as low to 23%.

The software projects daylight situations in ideal conditions. So, the average of both DF was found

to see the approximate DF that the respective rooms were capable to achieve. The lower proportions of DF as found against the on field readings suggest that proper care is not taken to the day light penetration that could have been achieved in ideal conditions. The placement of furniture's and depth of the office space from the windows i.e, the allotment of work stations in the daylight zone holds the key. The day light performance of the KMC can still be enhanced if the following observations are taken care of -

- A large number of windows and openings were found blocked or partially closed by furniture's, stacks and other obstructions - blocking the pure day light. A few windows were found to be partially closed by the users.
- Undesirable arrangement of furniture's in the interiors results in improper sitting arrangements resulting in obstruction to the natural day lighting penetration.
- Unplanned and unorganized addition of work space aided by various forms of partition walls, shelves and racks were a hindrance to daylight.
- Windows were also found being blocked by full height plywood and glass partitions as AC spaces were created making total dependence of those spaces on artificial lights.

Conclusions This paper has tried to illustrate the presence of day lighting in an old functional office building and compared with a modern rated one. The results reveal that it was an age old consideration while planning of a space and placement of windows to capture the available natural light in the interiors and which still holds good. It is not suggested that daylight can in all circumstances replace artificial light entirely during the day as there are some areas in buildings where daylight can never reach and artificial lights will always be required but by careful use of 'daylight linking controls' the use of electrical energy can significantly be reduced. The results are suggestive that they may be emulated under the present context for future building instead of making them centrally air conditioned, fully glazed and low in VLT. There are some countries such as the Netherlands and Germany, where there are regulations determining that in a work situation, the staff must not be located further than six metres from a window.

The energy used by artificial lighting in buildings is a major part of energy use and heat generation in office buildings in the modern day. The heating effect due to daylight is between half to one tenth less than that of typical artificial lighting. So the greater use of daylight can ensure thermal comfort and is a major consideration in the reduction of the use of electrical energy and assist significantly in the battle to solve the energy crisis. The sunlight when it is available has a therapeutic effect and the importance of its access during the day is most noticeable when it is denied. So it's fundamental for designers to address the relevance of energy problems today; but most of all is the less tangible aspects of day lighting, i.e., improving the quality of human life. During daylight hours in a work situation where people are in a fixed position for most of the time, the method to achieve the desired illumination level by the designer is clearly crucial. An office goer spends considerable amount of time in his office space and hence the quality of visual comfort should be of utmost importance in ensuring a pleasant visual environment contributing to a feeling of belongingness of the users to their work space, their well being and enhance work output.

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