

Measurements and analysis of Day Lighting Condition of Schools in Iran.



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Abstract

The drive towards making a sustainable and low-energy building places an increasing emphasis on detailed performance evaluation at the early stage of design phase. Day lighting is one of the important environmental factors that affect the health, emotions and academic performance of the students as well as the energy consumption of the school buildings. It is obvious these days that one must consider both the quantity and quality of the day lighting system of the building. The aim of this research is to develop design methodologies to improve the lighting environment of the school buildings in Iran. In this paper a survey of observation, geometric assessment of devices and the results of measurements of daylight levels of classrooms that were selected with coordination of “Tehran school Organization of renovation and development” are mentioned. Most classrooms in Tehran are either facing north or south. The selected samples include 2 classrooms, one of them with north-faced window plane in the ground level and the second classroom has south-faced window plane in the first level. Also, the monitored results of models were analyzed results of, under the intermediate sky. The points for horizontal illumination measurements in the classroom have been chosen in 12 different locations of working plane (The working plane is on the desks ,70 cm above the floor).The illumination was measured in this experiment by using light meter in selected classrooms. In addition, some simulations were carried out in the selected samples by the means of simulation software “ECOTECH v 5.6”. Finally, the problems were determined and comparison of both results was discussed.

Keywords: Daylight/ classroom / measurement / Analysis/ Iran.

1. Introduction

Previous research on the use of daylight and sunlight in classrooms has shown that these Parameters are closely related to issues like human performance and energy consumption of buildings. (Heschong L., 1999) Although previous researches had focused on the quantity of day lighting in educational spaces, recent works prove that quality of lighting is at least as

important as quantity (Antoniou K. et al., 2005). School designers must consider human characteristics and stimulate higher performance by managing natural day lighting accurately. Establishing day lighting objectives will improve classroom conditions and can help improve student's learning in the classrooms. Classrooms are the places where students would spend most of their time. Therefore the design of the school should improve learning by providing better lighting, air quality as well as create saving in reduced energy consumption (Abdullah Al-Moraines et al.). For this reason, the present work examines the impact of different forms of classrooms on the daylight distribution and illuminance ratios. Main purpose of schools is the promotion of learning and educational level of students. For doing this, they have to create a suitable and attractive environment for students, especially in case of lighting. There are two reasons for requiring natural light: 1) Contact with outside through windows, 2) Nature of such light and its change during a day which cannot be found in artificial light.

2. Data and Material

The research frame is shown as following;

- ✚ Surveys of the lighting environment of Iranian schools, through measuring Daylight Condition such as illuminance values in selected classrooms.
- ✚ Finding problems and analyzing the lighting environments in the Iranian schools of today.
- ✚ Finding and developing a proper simulation programs that can work as a design tool and can support the design of lighting environment of the Iranian schools.

The methodology of current the general day lighting Iranian classrooms and also due to the day lighting classrooms using physical illuminance was measured in this experiment by using these two Instruments: light meter and color analyzer (Fig.1).



project is aimed at assessing performance of existing evaluates the illuminances strategy in the prototype models experiment. The

Fig 1: Left image is Light meter, Right image is color analyzer

The measurements were recorded on 11 January, 2009 at three different time of a day. (9.45 AM, 12.45 Noon and 16.45 PM). The measurements were carried out under intermediate sky (half-way between sunny and overcast state) (Marsh A. 2000). In regard that the curtains were open and electric lights were off.

3. Research Methodology

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The study area of this research includes the schools of Tehran City located in the center of the Tehran province. These schools were selected with the coordination of the organization of development “The Tehran schools renovation and classrooms in north or south side in the wing.”



3.1 The Case Study “Khalatbari” High School of Art”

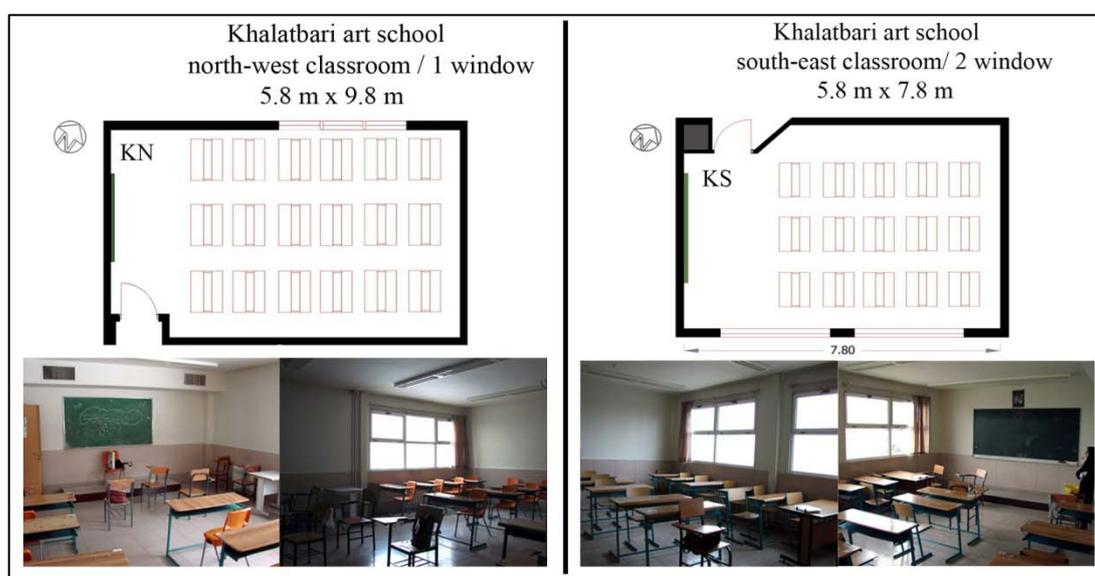


Fig 2: Satellite image showing location of Case study in Tehran.

Source: Google Earthpro4.

3.2. Objective Observations of the Classrooms

In order to differ the two types of classrooms, we use “KN” For north-faced window plane in the ground level and ”KS” for south-faced window plane in the first level. (Fig.3).

Fig 3: The selected classrooms.

Fig 4: the outside of the classrooms. **Fig 5:** The existing curtains.

The overall picture was disappointing because there wasn't any shading element used outside of the classrooms (i.e.in a country with so many hours of sunshine) (Fig.4), and shading should have been seriously taken into consideration. Actually, the curtains were the only shading

classrooms (Fig.5)

The location of Horizontal measurements has been different

working plane plane is 0.70 floor on the points inside placed on the

on grid of the about 2 meters by2 meters (fig.6).

devices in the under study.

the points of illuminance in the classroom chosen to be in 12 locations of (i.e. The working mm above the desks) .These the classroom were intersection points

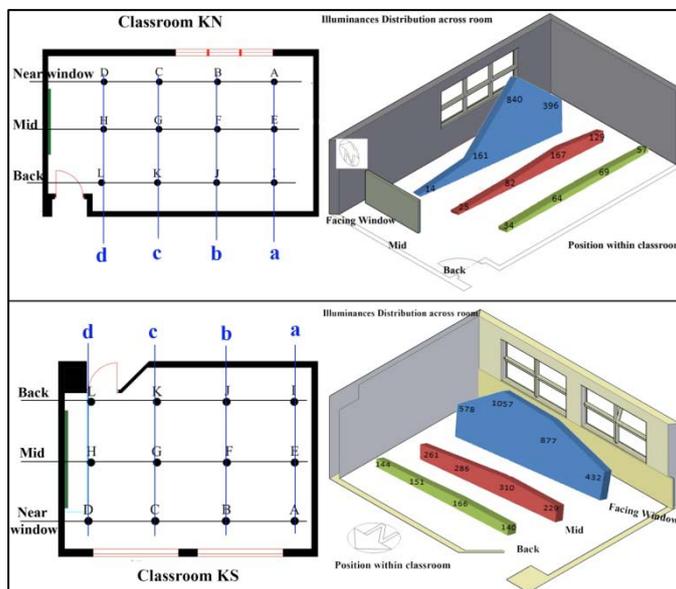
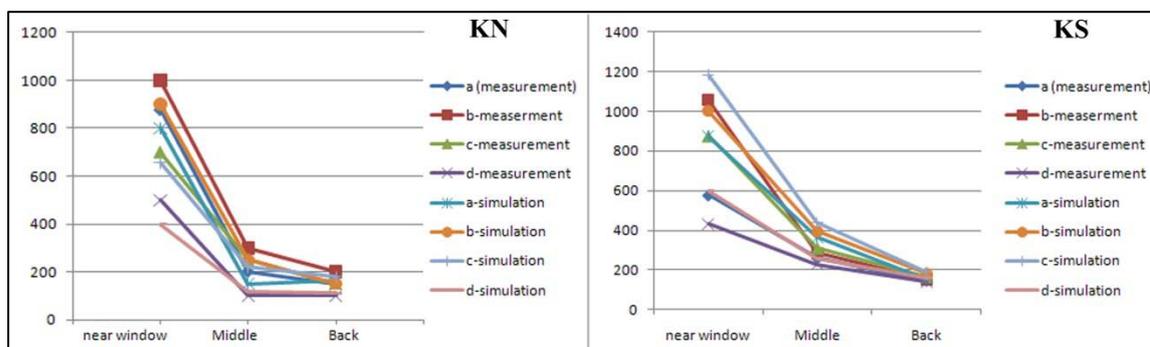


Fig 6: The comparison of illuminance values of the measurement points in classroom “KN” and” KS”. (Output from Microsoft Excel)

Results of measurements:

- For both of the classrooms, daylight illuminances diminish rapidly with increasing distance from windows.
- The average illuminance in the south orientated classroom (KS) was higher than the



illuminance in the north orientated classroom (KN) where the illuminance in north orientated classrooms were higher.

- For both of the classrooms, seating position near window was considered moderately comfortable for visual performance and was close to the local standard lighting requirement.
- In north orientated classroom, the blackboard area, had the worst daylight condition. The average illumination on the board was 50 Lux which was much lower than the acceptable illuminance that is 100 Lux, (i.e. UDI 'fell-short')¹⁷. it was physically dark and has the least comfortable visual field.
- In south orientated classroom, The blackboard area, had comfortable visual field, the average value was 615 lux, the illuminance is more than 500 lux and less than 2,500 lux, (i.e. UDI autonomous)¹⁷.

3.3 Calibration model in the simulation program (Ecotect v5.6)

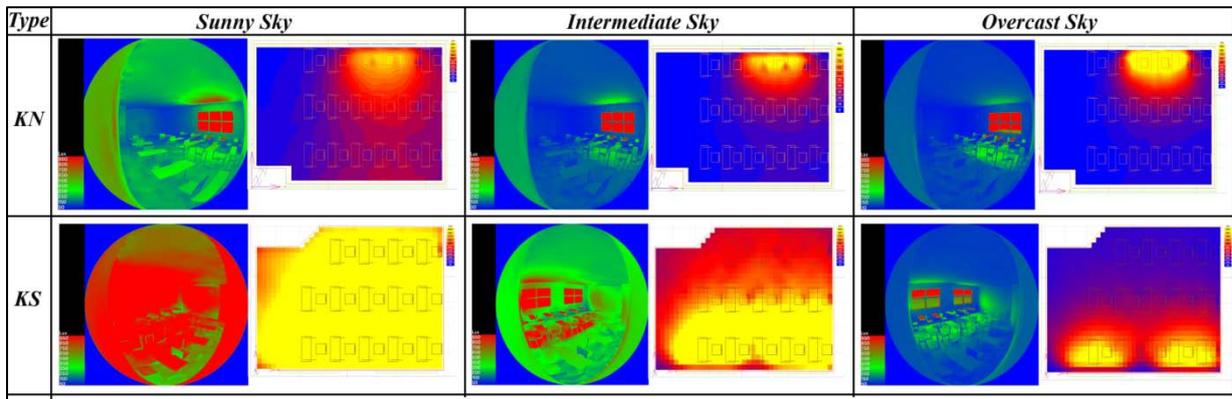
To investigate the status of existing day lighting in selected classes (photometry), we need to simulate class space in the same day and at the same sampled hour. To have more accurate and actual results, it is required to enter accurate materials and colors of walls, ceiling, floor, simulations were carried out in the selected samples by the means of simulation software “ECOTECT v 5.6”. This program is an acceptable interface to make the geometry. Since color recognition and its reflection value cannot be measured by eyes, color analyzer is used to measure the rate of colors (Fig.1). After inputting R.G.B values, in the simulation program Then We calibrated models and compared illuminate values in measurement points which have been measured by photometer. (fig.7)

Fig 7: Illustrates the comparison of illuminances between measurement and simulations in classroom “KN” and “KS”. (Output from Microsoft Excel program)

Results was indicated the verification of the adequacy of simulation program. (fig.7)

Results and Analysis of Simulation;

The models with existing materials were reproduced in the “Ecotect” program to calculate.



These simulations predict the illuminance values (i.e. Illuminances values in this simulation program shows the amount of light Falling on each surface) (Marsh A. 2000) over the measurement grid for 11 JAN at 9:45 under intermediate sky condition.

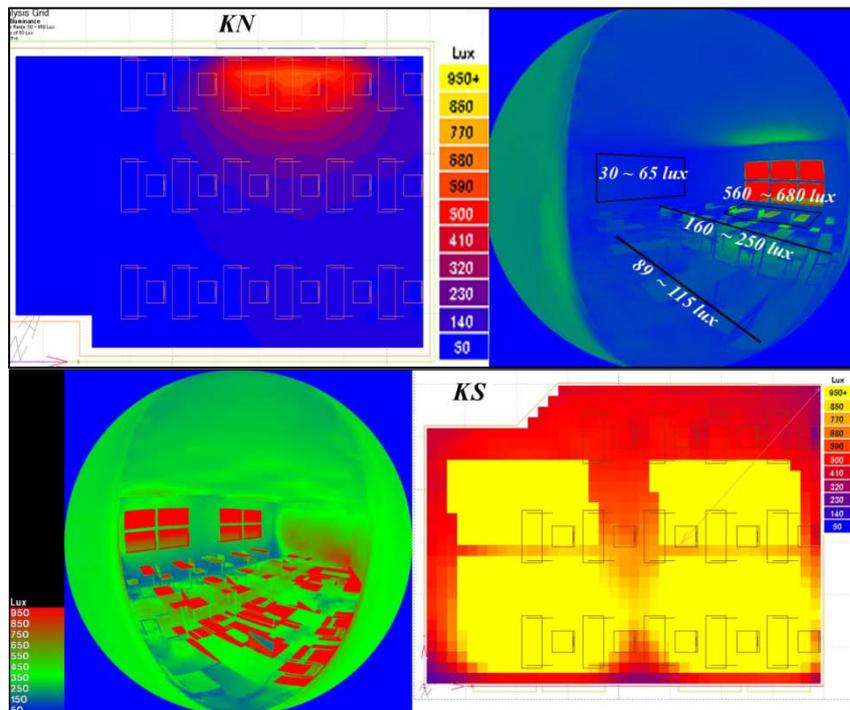


Fig 8:
color
image to
classroom
KN &
KS”.

The
here is to
the

False
rendering
study
“KN &
KS”
intention
compare

evaluative potential of the three different sky conditions assessment. Thus; the results for on

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11 JAN at time 12:45 noon. (Fig.9)

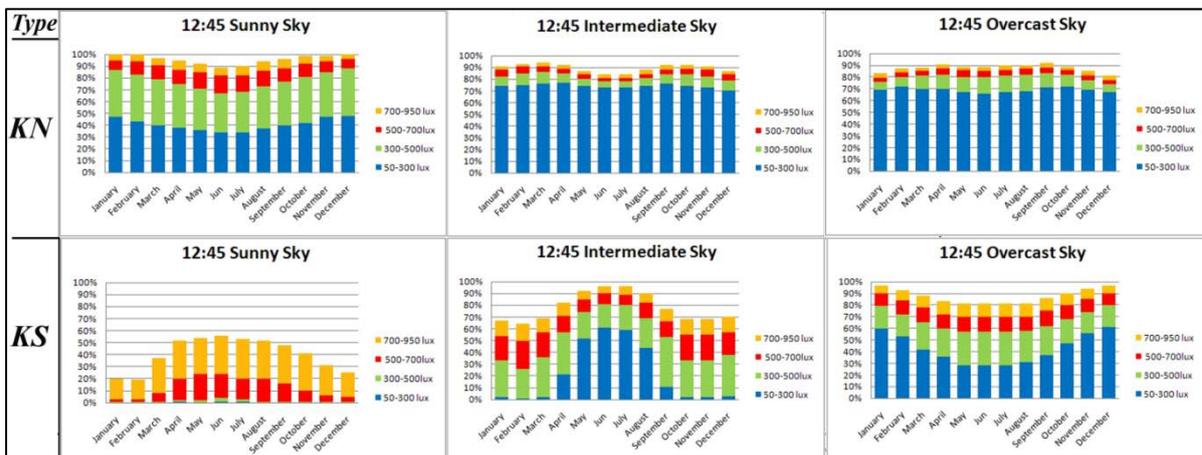
Fig 9: False-colored surface plots that show the illuminance values across the grid for classroom "KN" and "KS". (Output from Ecotect v5.6 program)

Fig 10: Comparison of illuminance values (lux) for 12 months of a year.

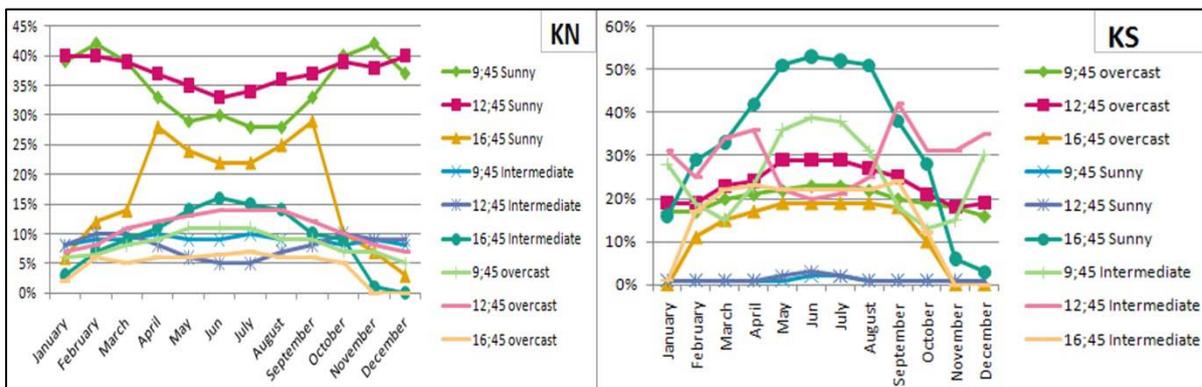
The illuminance on work surface would be compared with the (CIBSE)⁴ Lighting Guide, International Energy Agency (IEA)¹³, (JIS) handbook¹⁴, and (ISIRI)¹² The national lighting committee of standard and industrial organization of Iran. The value of illumination for classroom is 300~500 lux. So the percentage of the total classes' area that have standard optical is shown in Fig.11.

Fig 11: The percent of area had illumination amount of 300 to 500 lux, in sunny, intermediate and overcast sky at AM, Noon and PM.

The results of Fig 10~11:



- In The classroom area of KN type, 10 percent of area had illumination amount of 300 to 500 lux (i.e. standard range limits in the classroom), 70 percent of area had lighting shortage (darkness) and 4 percent of the area had more than 500 lux.
- At 9:45 AM, The classroom area that had average illumination amount (between 300~500 lux) was 9%, 4% had more than 500 lux and 76% had less than 300 lux.
- At 12:45, the classroom area that had average illumination amount (between 300~500



lux) was 8%, 4% had more than 500 lux and 74% had less than 300 lux.

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- At 16:45, the classroom area that had average illumination amount (between 300~500 lux) was 8%, 3% had more than 500 lux and 54% had less than 300 lux.
- In The classroom area of KS type, 24 percent of area had illumination amount of 300 to 500 lux (i.e. standard range limits in the classroom), 31 percent of area had lighting shortage (darkness) and 13 percent of the area had more than 500 lux.
- At 9:45 AM, The classroom area that had average illumination amount (between 300~500 lux) was 25%, 18% had more than 500 lux and 3% had less than 300 lux.
- At 12:45, the classroom area that had average illumination amount (between 300~500 lux) was 29%, 14% had more than 500 lux and 22% had less than 300 lux.
- At 16:45, the classroom area that had average illumination amount (between 300~500 lux) was 16%, 5% had more than 500 lux and 66% had less than 300 lux.

5. Conclusions

The natural day lighting that entered the north faced classrooms were very low so in order to have a proper natural day lighting, the window design factors like shape , location and window plane must be taken into account very seriously.

The natural day lighting of the south faced classrooms are far better than the north faced classrooms but one must acknowledge that the sun glare near the south faced windows is the main problem. It is quite necessary to design more than one window for each classroom in order to have balanced lighting in all areas of classroom. In order to control the entering of direct sunlight and glare, it is necessary to use some shading elements for south faced windows. In conclusion , despite the fact that Tehran sky is clear most of the time and has high amount of illumination if the design is incompetent then the possibility of using the natural day lighting is decreased and the need to use more artificial lighting is undeniable. The Classroom lighting design considering the optimum usage of natural day lighting is based entirely on good understanding of characteristics of natural day lighting.

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