JOURNAL OF ARCHITCTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 6 Issue 2, 2016

DAY LIGHTING ANALYSIS IN VERNACULAR HOUSES OF RURAL KARNATAKA, INDIA

Shaila Bantanur, Sanketh P Bharathish

Srinivas School of Architecture, Karnataka, India

ABSTRACT

Day lighting is an important passive strategy for indoor architecture which helps in reducing the consumption of electrical energy or reliability on artificial lighting, thus enhancing the psychologically and physiologically effects on the health and wellbeing of building occupants. The paper analyses the day lighting in typical rural houses more specifically, three vernacular residential dwellings in Mala village situated in Karkala District, Karnataka, India. The survey includes enlisting or recording building materials used in construction, dimensioning individual rooms, doors and window openings and total number of lighting fixtures used in each room. Ratio of window to floor area (AW/AR) is calculated in each room of the dwellings. Monitoring the daylight and further, illuminance at various levels is measured with the help of Lux meter . Three houses are further simulated using ECOTECT2011- software. The ratios of areas of window to floor of each room in all the houses are less than 10% resulting into poor illuminance. The quality of the light inside the kitchen was still poor. Adopting few strategies like making wall surfaces more reflective and few modifications in the grill patterns will help to increase the indoor illumination.

Keywords: Day lighting analysis, Ecotect, Floor to Window Ratio, Vernacular housing, Sustainability

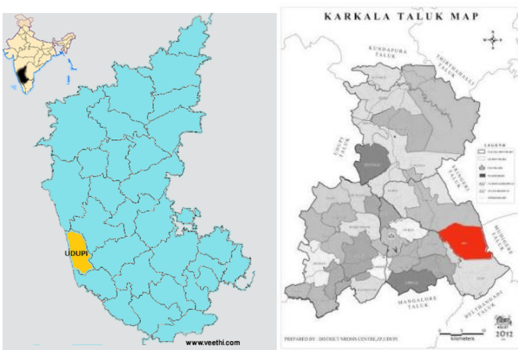
INTRODUCTION

India's large population lives in its villages. Villages are known for their local/regional rich tradition and culture, which are also reflected in their rural settlement patterns. Understanding the traditional architecture with respect to climate responsive built-environment, construction techniques, air movement, humidity, thermal comforts and day lighting provides vital lessons for prevailing architectural practice in the region. Vernacular houses were analysed in many ways to identify performance of traditional houses constructed to withstand extreme weather conditions. The materials used for the construction also help to improve the energy performances of the dwellings/buildings, (Zhai and Previtali 2010). Vernacular housing designs were analyzed on the aspects of building physics and identified that under extreme climatic conditions the measures may not be sufficient (Nguyen et al. 2011)Climate responsive strategies of Iranian houses were analyzed application of the building elements and solutions to bring daylight into different parts of traditional courtyard houses concluded that adopting these strategies will even enhance the quality of modern houses as well (Nabavi, Ahmad, and Goh 2013). Vernacular houses strongly reflect the culture and traditions of the local region and responds to the local climate (Dili, Naseer, and Varghese 2010,Majid, Shuichi, and Takagi 2012, Jayasudha et al. 2014, Bodach, Lang, and Hamhaber 2014),(Shanthi Priya et al. 2012). Furthermore, few suggested modifications to the existing houses can achieve better performances (Xuan 2013). Few researchers analysed that vernacular dwelling follow all the principles of bio climatic strategies (Bodach, Lang, and Hamhaber 2014), (Shanthi Priya et al. 2012). Energy performance of historic rural houses were analysed in three countries namely Estonia, Finland and Sweden. The study explored the potentials of improving the building service or infrastructural systems (Alev et al. 2014). Similar study was also being conducted by using Ecotect Software v.5.2 and potential improvements were proposed (Michael and Malaktou.2015). Solar passive techniques in vernacular houses (n=150) of north east part of India has been studied including temperature, humidity, illumination level and building design parameters. The study provided range of comfort temperature for different seasons. The study also identifies low performance during winters (Singh et al. 2010).

A study conducted in Suggenahalli village of India to understand the thermal comfort in naturally ventilated vernacular dwellings using Fanger's predicted mean vote (PMV) and Humphrey's adaptive thermal comfort and proposes aggregated PMV model (Shastry, Mani, and Tenorio 2016).The study majorly highlights that vernacular housing is climate responsive and strongly reflects the social and cultural identity of community and place. Study focusing on daylight highlights, optimization methods of day lighting using lighting simulations (Haqparast and Maleki 2014). The present study thus, analyses the day lighting with respect to floor to window ratio, luminance level within the rooms and finally simulating with the Ecotect-2011 software.

STUDY AREA

The present study is conducted in the village called Mala in the district of Karkala, Karnataka state, India (Fig.1) .It is situated at the foothills of westernghats. The area of the village is 11617.29acre (as on 2015).Total population as per 2011 census is 5998 with 2920 male and 3078 female. Total number of households in of the village is 1338, 150 households have water supply connections. Village is located at the latitude 13.2374789 longitude 75.1100228. The average annual temperature is 26.8 degree celcius with an average rainfall 4372.7 mm. Water for the domestic purpose is from-underground water resources like hand pumps (37 nos) and wells (12nos) are used. The settlement is scattered and constructed using locally available material by local craftsmen or with local craftsmanship finishes. The houses were provided with the traditionally designed teak wood panel and battens which reflects the use of traditional building material with Laterite stone and mud for walls, teak wood for windows, cement for flooring and sloping roof with Mangalore tiles. Most of the houses observed in the villages are single-storey, load-bearing structures. Typical house includes rooms like verandah, living room, bedroom (varies from one to three in number), kitchen and cattle shed situated outside. Storage spaces were generally provided above kitchen.



Source:mapsofindia.com
Fig.1: Showing the location of the study area

RESEARCH METHODOLOGY

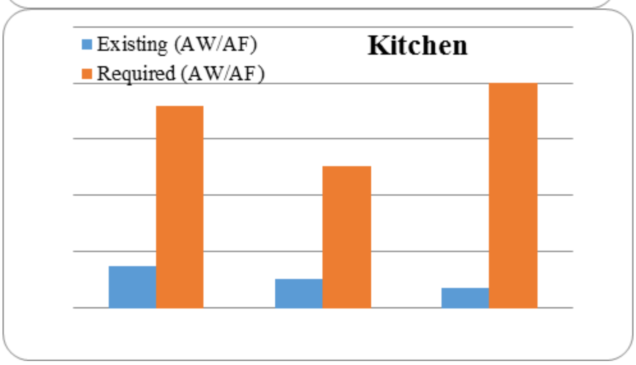
All the three dwellings differ in terms of area and number of rooms, but they follow the similar principals of traditional architecture (fig 2).

The primary survey was conducted in the month of January, 2016. The survey includes listing of building materials used for various parts of the building, measuring the size of individual rooms, measurements of doors and window openings and total number of lighting fixtures used in each room. With the help of the measurements, ratio of window to floor area is calculated for each room of the three dwellings. Monitoring the daylight and its illumination at various levels is measured with the help of Lux meter (LX1102). All the readings of the Lux meter were recorded at the height of 1.0 m from the finished floor level of the respective room. Based on the room sizes, relevant grids were made on the floor and data was collected accordingly. All the artificial lighting fixtures were turned off, while conducting the experiment. Maximum and minimum data for each grid point is measured. Finally, the collected data is simulated using ECOTECT 2011 software. During the simulation the following conditions are pre-considered window cleanliness as -dirty x (.075), sky component as-15000lux, overcast sky condition with the increased accuracy mode. With this input data results were analysed and discussed in detail.

Fig.2: Houses selected for the study of Mala Village, India

DISCUSSIONS

The three houses of Mala village were analysed by taking detailed dimensions of indoor spaces. The ratios of areas of window to floor of each room in all the three houses are calculated and crosschecked with the standards, which suggests that the size of the openings should be 10% of total floor area ((“Model Guidelines for Development & Building Construction Including Safety Provisions for Natural Hazards in Rural Areas”, 2008). The result shows that the windows provided in each room are extremely inadequate as shown in (Fig 3.)The quality of the light inside the kitchen area was very poor. The illumination level using the lux meter was also recorded at certain nodes. It shows that the illumination level in living room ranges from 36-65 lux, in kitchen from 1.1-9.33 lux and in bedroom, it is from 0.36 -37.4 lux. This shows day lighting in kitchen and bedroom is comparatively very less. Biomass was used as cooking fuel due to which most of the walls were covered with the soot resulting into less reflective wall surface. It is also noted that most of the time the windows were shut in fear of wild snakes.



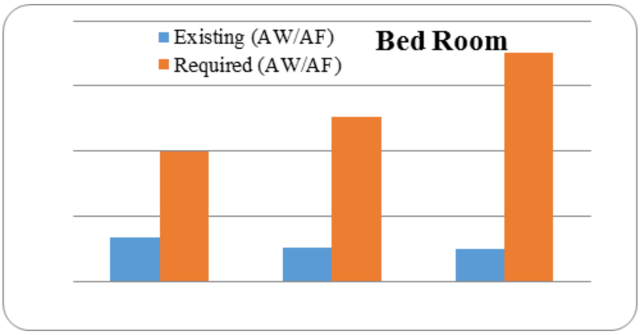


Figure (3): Window to Floor area percentage/ratio in living room, Kitchen and Bed Room

Further, all the indoor spaces were simulated using ECOTECT Analysis 2011 to study overall daylight illumination. The result shows that most of the areas were less illuminated to perform day-to-day activities (Fig.4, 5, 6) which affected the physiological and psychological health of users. This would undoubtedly result in increase in the energy consumption. Adopting few strategies like making wall surfaces more reflective and few modifications in the grill patterns will help to increase the indoor illumination.

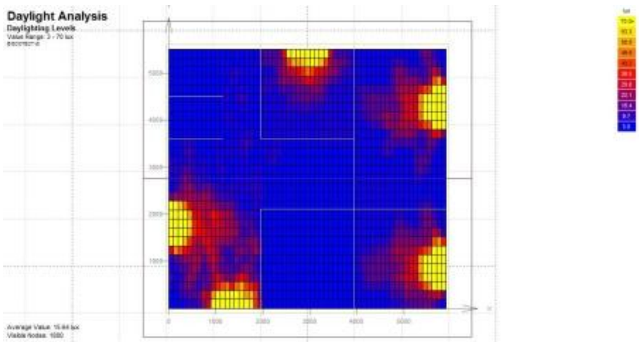


Fig.4: Simulation of House .1 through Ecotect

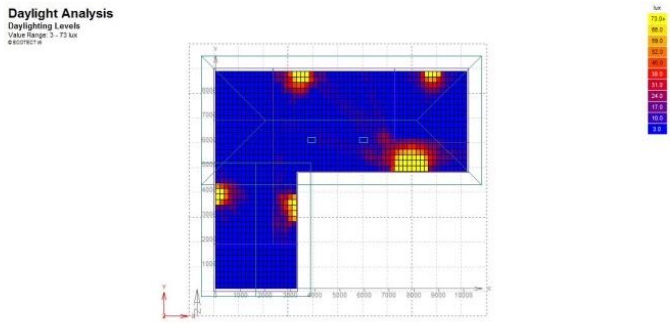


Fig.5: Simulation of House .2 through Ecotect

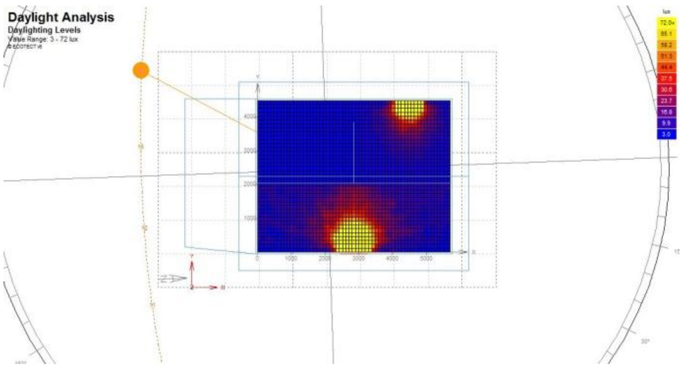


Fig: 6: Simulation of House .3 through Ecotect

CONCLUSIONS

The three rural houses were studied and analysed with respect to day lighting in this paper. Data related to village profile, carpet areas of the houses, opening details and material specifications were collected. Further, day lighting illumination was recorded with the help of the Lux meter at specific points and using the ECOTECT software indoor illumination levels were simulated.

Based on the study, the following conclusions are drawn:

1. Architectural built forms of the vernacular settlements reflected traditional building materials, vernacular construction techniques along with socio- cultural aspects.
2. Size and proportions of the rooms plays an important role. Rooms with greater depth with smaller windows resulted with unequal distribution of the sunlight. Size of the windows provided was very small with respect to room sizes. Ratio of window to floor area is poor.

3. As compared to living room, Illumination levels inside the kitchen and bedroom were more critical.
4. It is observed that less reflective wall finishes and soot deposition on kitchen wall further reduced the reflectivity making the space more dull and dark.
5. Most of the rooms have only one window due to which distribution of daylight throughout the spaces was not uniform. Few modifications in the existing building can improve considerable indoor day lighting.

ACKNOWLEDGEMENT
The authors would like to thank Ar. Premnath, practicing architect from Mumbai, for his financial support.

DECLARATION
An earlier version of this paper was blind reviewed by two referees and presented in the **3rd ICABE** Conference held in Kuala Lumpur, Malaysia, 5-6 October, 2016.

REFERENCES
Alev, Üllar, Lari Eskola, Endrik Arumägi, Juha Jokisalo, Anna Donarelli, Kai Siren, Tor Broström, and Targo Kalamees. 2014. "Renovation Alternatives to Improve Energy Performance of Historic Rural Houses in the Baltic Sea Region." *Energy and Buildings* 77: 58–66. doi:10.1016/j.enbuild.2014.03.049. http://dx.doi.org/10.1016/j.enbuild.2014.03.049.

Almssad, Asaad, and AmjadAlmusaed. 2015. "Environmental Reply to Vernacular Habitat Conformation from a Vast Areas of Scandinavia." Renewable and Sustainable Energy Reviews 48: 825–834. doi:10.1016/j.rser.2015.04.013. http://www.sciencedirect.com/science/article/pii/S13640321 1500283X.

Bodach, Susanne, Werner Lang, and Johannes Hamhaber. 2014. "Climate Responsive Building Design Strategies of Vernacular Architecture in Nepal." *Energy and Buildings* 81:

227–242. doi:10.1016/j.enbuild.2014.06.022. http://dx.doi.org/10.1016/j.enbuild.2014.06.022.

Dili, a. S., M. a. Naseer, and T. Zacharia Varghese. 2010. "Passive Environment Control System of Kerala Vernacular Residential Architecture for a Comfortable Indoor Environment: A Qualitative and Quantitative Analyses." *Energy and Buildings* 42 (6): 917–927. doi:10.1016/j.enbuild.2010.01.002. http://dx.doi.org/10.1016/j.enbuild.2010.01.002.

Haqparast, F, and B Ahmadkhani Maleki. 2014. "Daylighting and Daylight Simulation" (September): 116–120.

Jayasudha, P, M Dhanasekaran, Monsingh D Devadas, and N Ramachandran. 2014. "A Study on Sustainable Design Principles : A Case Study of a Vernacular Dwelling in Thanjavur Region of Tamil Nadu , India" 13 (October): 762–770.

Majid, Noor Hanita Abdul, Hokoi Shuichi, and Nozomi Takagi. 2012. "Vernacular Wisdom: The Basis of Formulating Compatible Living Environment in Oman." *Procedia - Social and Behavioral Sciences* 68: 637–648. doi:10.1016/j.sbspro.2012.12.255. http://www.sciencedirect.com/science/article/pii/S1877042812057382.

Michael, Aimilios, and Eleni Malaktou. "Lighting Performance in Rural Vernacular Architecture in Cyprus : Field Studies and Simulation Analysis ."

"Model Guidelines for Development & Building Construction Including Safety Provisions for Natural Hazards in Rural Areas."UNDP report,2008.

Nabavi, Faezeh, Yahaya Ahmad, and Ai Tee Goh. 2013. "Daylight Design Strategies: A Lesson from Iranian Traditional Houses." Mediterranean Journal of Social Sciences 4 (9): 97–103. doi:10.5901/mjss.2013.v4n9p97. http://www.mcser.org/journal/index.php/mjss/article/view/1050.

Nguyen, Anh Tuan, Quoc Bao Tran, Duc Quang Tran, and Sigrid Reiter. 2011. "An Investigation on Climate Responsive Design Strategies of Vernacular Housing in Vietnam." *Building and Environment* 46 (10): 2088–2106. doi:10.1016/j.buildenv.2011.04.019. http://dx.doi.org/10.1016/j.buildenv.2011.04.019.

Shanthi Priya, R., M. C. Sundarraja, S. Radhakrishnan, and L. Vijayalakshmi. 2012. "Solar Passive Techniques in the Vernacular Buildings of Coastal Regions in Nagapattinam, TamilNadu-India - A Qualitative and Quantitative Analysis." *Energy and Buildings* 49: 50–61. doi:10.1016/j.enbuild.2011.09.033.

Shastry, Vivek, Monto Mani, and Rosangela Tenorio. 2016. "Evaluating Thermal-Comfort and Building Climatic-Response in Warm-Humid Climates for Vernacular Dwellings in Suggenhalli (India)." Architectural Science Review 59 (1): 12. doi:10.1080/00038628.2014.971701. http://dx.doi.org/10.1080/00038628.2014.971701.

Singh, Manoj Kumar, Sadhan Mahapatra, S. K. Atreya, and Baruch Givoni. 2010. "Thermal Monitoring and Indoor Temperature Modeling in Vernacular Buildings of North-East India." Energy and Buildings 42 (10): 1610–1618. doi:10.1016/j.enbuild.2010.04.003. http://dx.doi.org/10.1016/j.enbuild.2010.04.003.

Xuan, Huang. 2013. "Daylighting Analysis of Vernacular Architecture in Guizhou Province , China" (December): 1–8.

Zhai, Z. J, and Jonathan M. Previtali. 2010. “Ancient Vernacular Architecture: Characteristics Categorization and Energy Performance Evaluation.” Energy and Buildings 42 (3): 357–365. doi:10.1016/j.enbuild.2009.10.002