LIGHTING FEATURES IN INDIAN-STYLE TRADITIONAL ARCHITECTURE

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ABSTRACT: Due to the effect of impinging solar radiation, high thermal loads can be predicted in buildings in many climates of South-East Asia. The logical need to protect and ventilate the façades has been known for centuries. Features such as the jalis or lattice work combined with deep overhangs and elements conceived to reflect excessive sunlight such as water tanks or ritual ponds have adorned Indian-style palaces and temples since ancient times. Those features have subsequently inspired modern architects like Le Corbusier, Antonin Raymond, Benjamin Polk and Geoffrey Bawa to cite just a few. Climatic control elements were well suited to the craftsmanship of traditional architecture but their use as industrial products that could be prefabricated is more controversial. Not only has the climate changed since the origin of Indian-style architecture, but also the use of glazing has increased in an alarming way and thus the need to protect the façades is now even more demanding. If this is not properly done the performance of air-conditioning systems would be compromised and the lifespan of the windows would result severely affected. Nonetheless, depending on the type and reflective nature of the shading system selected, undesirable effects for ventilation, comfort and especially for day-lighting tend to occur in the space that, paradoxically, we are trying to protect. In this paper, within the context of Indian civilization we will present the simulation of the radiative field generated by different types of solar protection and reflective surfaces, especially ponds and systems of louvres or brise-soleil. In the process we intend to extrapolate the procedures for ancient fabrics to some modern counterparts found in internationally acclaimed buildings and to obtain useful design insights for future projects.

Keywords: solar protection, daylighting simulation, tropical architecture

1. INTRODUCTION

The problem of dealing with excessive solar radiation in architecture is certainly not a new one. Likewise, we have to recognize that this question was not related to the buildings of temperate climates but rather to the requirements of hot and humid tropical climates. Though scarcely known to the Europeans such climates constitute one of the distinctive features of vast areas in Asia, considered by many the cradle of civilization, due in great part to its unique art and architecture.

In the ancient monuments of South-East Asia, India, China and Japan, elements such as canopies, awnings, jalousies and ponds to reflect the light were so much in use that they reached the status of religious symbols.

These creations were always connected to at least two of the most subtle and powerful events that occur in the natural world: wind and light.

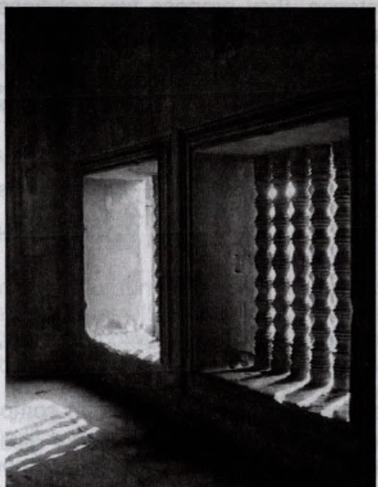

Figure 1: Stone balusters at a window bay in the temple of Angkor Wat, Siem Reap (Cambodia)

Craftsmen of all epochs had striven to ensure that the design solutions implemented conveyed the light and wind as far as the materials and technology allowed, without rejecting or impeding the beneficial effects of nature.

Figure 2: An exquisite jalis at Lal Qila (Red Fort) New Delhi (India). Notice also how if necessary, water can be conducted under the screen to further enhance evaporation.

Contemporary architects recalled some of those buildings as a sound basis for their forthcoming works, but their visionary approach was often confined to design gestures or elaborate idioms of reduced efficacy. Because of the former, some of the solutions proudly displayed during the modern period were doomed by time and dwellers and subsequently abandoned.

From a scientific point of view we are now in the position to offer some powerful, simple tools that may help to bridge the gap between the design expectations and the real performance. The tools are based on the form factor theory for the radiative field, first presented by Yamauchi and Moon.

For instance, they propose two solutions for the complex expressions of F_{12} (the form factor between two surfaces 1 and 2), whether parallel or perpendicular sharing a common edge, based on the knowledge of a certain function .

$$\phi_0(\mu)=\frac{1}{2}(\mu-\frac{1}{2}\tan\mu\ln\sin\mu+\frac{1}{2}\cot g\mu\ln\cos\mu) \quad (1)$$

And thus,

$$F_{12}=\frac{2*b}{\pi}\left[a*\phi_0(\alpha)+c*\phi_0(\beta)-(\sqrt{a^2+c^2})*\phi_0(\beta_1)\right] \quad (2)$$

Programming those expressions for computer use, most kinds of reflectors and obstructions like screens and blinds can be simulated taking into account their reflective properties and not only the degree of shade that they may provide.

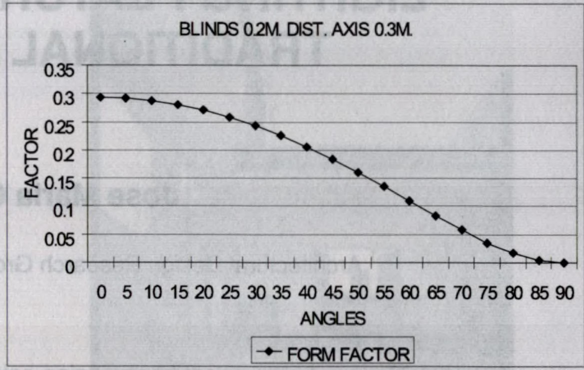

Figure 3. Form factors for different angles of louvres (dimensions 0.20 m. separated 0.30 m. along the vertical axis).

2. ARCHITECTURAL EXAMPLES

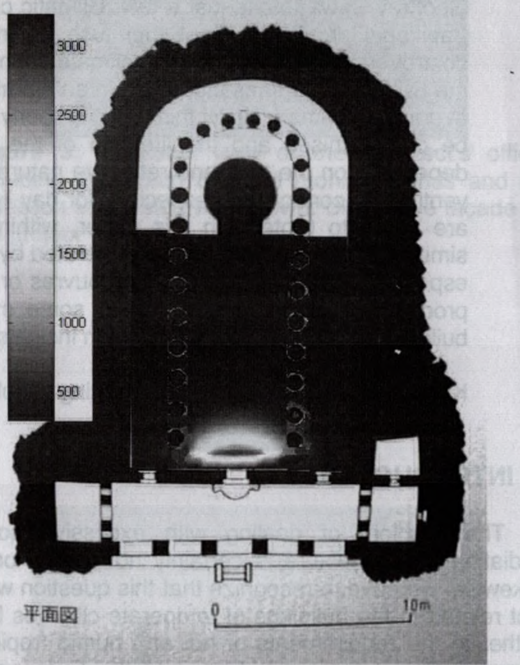

Figure 4: Partial radiation field over the plan of the Chaitya n.26 in Ajanta (India) with illuminance levels (3000-50 lux).

Figure 5. Geoffrey Bawa's Studio in Colombo, with wooden galleries and a reflective pond.