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The Design and Model of Daylighting Control System for Sasana Budaya Ganesha Underground Tunnel

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Abstract

Sasana Budaya Ganesha Institut Teknologi Bandung (Saraga ITB) Tunnel is an underground tunnel connecting ITB Campus with the Saraga Sports Center. Despite being an underground tunnel, the original design of Saraga Tunnel was to utilize daylight. It has two skylights and fitted mirrors to distribute daylight across the tunnel. In order to study the potential of the daylighting inside the tunnel, this study developed a simulation model of light distribution inside the tunnel. The model's parameters included the geometry of the tunnel; the photometric properties of inside surfaces, i.e. the reflectance, transparences, and colors; the geometry of skylight, and the resulting illuminance. This result demonstrated the potential use of daylighting control system of Saraga Tunnel.

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1. Introduction

One major challenge with an underground tunnel is to distribute natural light inside its corridor (Hopkirk and Breer, 2000). One of such tunnel is the Sasana Budaya Ganesha (Saraga) Tunnel in the city of Bandung, Indonesia. This tunnel connects the campus of Institut Teknologi Bandung (ITB) with the Sasana Budaya Ganesha Sports Center. The tunnel facilitates 45 m long, 4.5 m height and 9 m width of a walkway underneath the Siliwangi road that separates these locations. Figure 1 shows the appearance of the tunnel's gate at the campus side.

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Fig. 1.The south gate of Saraga tunnel.

For around fifteen years after its opening in 1996, the tunnel was operated only to facilitate pedestrian path between ITB campus with Saraga Convention Center during the graduation days in April, July and October every year. Since 2012, the tunnel opened for pedestrian, mostly students and staffs, during workdays, from 6.00 am to 5.00 pm. As shown in figure 1 and 2, the services such as canteens just next to the tunnel's gates, exhibits of student's posters and tables along the walkway, photocopy service, ATM booth and convenience store; all marked the significant increase of activities inside the tunnels.

Both pedestrians who spend less than 30 minutes inside the tunnel and staffs who operate the services for at least 8 hours during the weekdays inside the tunnel could benefit from proper use of daylight. Studies have shown that proper use of daylight enhances the appearance of the walkway, excite positive moods of staffs and improves the eye adaptation of pedestrians (Edwards and Torcellini, 2002).

Having that concept in mind, the original design of the tunnel incorporated two skylights, A and B, as shown in figure 3. These were equipped with reflectors (mirrors) as shown in figure 4. Unfortunately, due to long non-operational state of the tunnel, some of the reflectors were long gone. Today, artificial lighting supports the activities inside the tunnel throughout the operational hours.

In a spirit to revive daylighting of the Saraga Tunnel, this paper presents daylighting simulation and control strategy inside the tunnel. The simulation parameters are the geometry of the tunnel; the photometric properties of inside surfaces, i.e. the reflectance, transparences, and colors; the geometry of skylights, and illuminance obtained. This study assumes that each skylight has a set of reflectors, and the reflector's angle can be varied to find the maximum daylight penetration in the corridor.

Fig. 2.Services inside the tunnel.(a) exhibition area and study desks;(b) photocopy services;(c) ATM booth; (d) convenience store.