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A computational method to optimize energy savings of tension structures set in road tunnels

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Abstract. After the successful introduction of transparent tension structures in the portal of road tunnels as an effective measure for energy savings, optimization of such savings has been sought. A computational method based on graphical design capable to simulate the optical properties of the sun, any transparent tension structure and any road tunnel whatever its orientation, has been developed and presented in this paper. A comparison with measurements in a real tension structure placed in the entrance portal of one real tunnel is performed and discussed.

Keywords

Energy Saving, Solar Radiation, Graphical Design, Electrical Lighting, Road Safety.

1. Introduction

Road tunnel lighting is one of the most complex problems when dealing with electrical lighting [1, 2]. Furthermore, in addition to the difficulty of implementing accurate solutions to ensure the correct visibility inside road tunnels (which is a really hard task due to the high variability between the visual systems of drivers), we find that the energetic requirements of tunnel lighting are extremely high because it is necessary that the driver visual system does not suffer any important change in levels of illuminance when going into these structures.

In previous works [3, 4], we demonstrated that implementation of transparent tension structures in the portal of road tunnels could be a very effective an easy measure to use the sunlight during daytime, which is the most critical period of the day when dealing with tunnel lighting. Nevertheless, the advances above were carried out with very simple tension structures because the target was to prove whether they were reliable and profitable.

Furthermore, any test to prove the effectiveness of these structures or look for optimal ones, should be carried out in real tunnels, which, besides the risks for safety, required huge investments in money, human efforts and legal bureaucracy.

Hence, the search of an effective tool to optimize the structures and energy savings in each different condition without going to tests in real tunnels became the main objective of this line of research. One tool that can determine which tension structure is better for each tunnel, will allow us to set such structures in every tunnel with the most optimal compromise