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Lighting of Ski Slopes

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Abstract

The beauty of the nature and the dynamics of the movements make the skiing one of the most popular and attractive sports in a lot of countries. The daylight skiing is the most often practice but not only. The night time practicing has its own beauty and is also attractive. For this purpose is needed appropriate artificial lighting. In some cases and for big international events it is obligatory. The visual tasks, the curved slope fields, the not smooth calculating surfaces, the snow reflection characteristics, the speed of the movement and recognition make this field of lighting design quite interesting and challenging as the sport itself.

In the present paper it is proposed a practical solution for artificial lighting of a skiing slope, completed with 3D modelling of the track surface with its reflecting characteristics and fulfilling the standard requirements for artificial lighting of that kind of sport practicing.

Index Terms: Sports lighting, ski slopes, 3D modeling of surfaces

1 Introduction

The European standard dealing with sports lighting is EN 12193:2009 “Light and lighting - Sports lighting”. There is a new edition of the standard from 2019, but the previous one is still working. The standard requirements for ski slopes are shown in Table 1 [1].

The ski slopes reference area in which are applied the main lighting requirements has no standard sizes due to the differences of the ground surfaces. All illuminance levels for the ski slopes should be calculated (measured) on the slope surfaces. For alpine and freestyle skiing there are no specific requirements for the distances between the grid lines in length. For ski jumps there are some specific requirements for the grid points distances – 2m or less for the run down and 5m or less for the landing area. Moreover there is a requirement for the retardation area in ski jumps, in which the illuminance levels should have at least 30% the landing area but there are no preferable values for the uniformity. The ski jumps illuminance also should have equal levels at the point of take off and the landing.

Outdoor					Reference area		Number of grid points	
					Length	Width	Length	Width
					m	m	m	m
Skiing	Alpine/freestyle				-	-	11	5
	Jumps		Run down		-	-	5	1
			Landing		-	-	11	5
Class	Illuminance Alpine/freestyle		Illuminance Jump run down		Illuminance Jump landing		GR	R_a
	$\overline{E}_m$, lx	$E_{min}/\overline{E}_m$	$\overline{E}_m$, lx	$E_{min}/\overline{E}_m$	$\overline{E}_m$, lx	$E_{min}/\overline{E}_m$		
I	100	0.5	150	0.5	300	0.7	50	20
II	30	0.3	50	0.3	200	0.6	50	20
III	20	0.2	20	0.3	200	0.6	55	-

Table 1. Requirements for ski slopes [1]

E_m is the average illuminance value in lx, E_{min}/E_m is the uniformity of the illuminated surface, GR is the glare rating [1, 2] and R_a is the general color rendering index.

Illumination criteria are defined from the performers' skills and the number of the spectators. The highest class is for top level competitions and trainings with international/national participation and importance and big spectator capacity. The second class includes mid level competitions/trainings (regional or local) and smaller spectator capacity. The third class is generally for trainings, sports education, recreational activities and small competitions without or not many spectators.

In artificial lighting for winter sports special attention should be paid of the surface characteristics because of the reflection when bright lighting sources are applied. This may lead to unacceptable GR. Other key factors for the lighting solutions are uniformity, color rendering and avoidance of stroboscopic effect. All mentioned above could be realized by choosing a proper optics of the luminaires and geometry of the lighting system.

The most often used lighting sources in the sports lighting are luminaires with metal halide lamps and LEDs, fig. 1

Fig.1 Types luminaires used for lighting of ski slopes: a) with metal-halide lamps; b) with LEDs without or with secondary optics, white and RGB [3,4,5,6,7]

The possibilities of LED luminaires for color changing give opportunities for very attractive lighting designs and magical experience. An example for this is the project in the Swedish Ski Resort Åre, fig. 2 [8].

Fig.2 The magical lighting project in the Swedish Ski Resort Åre based on folklore tales of land-forming giants, performed with 240 colour-changing LED luminaires with different optical systems [8]

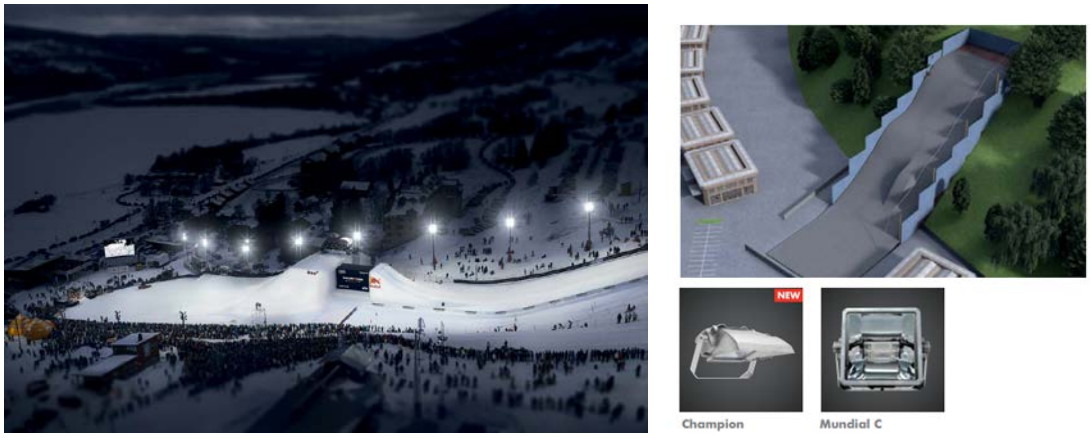

Fig.3 The Störtloppet ski slope is Sweden (Ski Resort Åre) with a vertical drop of 841 metres.The lighting system for illumination 1,308 feet with a vertical drop of 416 meters is realized with 350 Mundial HQI-TS 2000W floodlights illuminate and produces light level of 1000 lx [4].

For the highest classes of ski slopes and meeting television broadcast requirements the luminaires with metal halide lamps are still the preferred lighting solution, fig. 3 [4].

2 Landscape Contours, Tracking and Modeling of Existing Ski Slopes

The needed equipment is a device with GPS maps database. We have to choose the mountain area, starting and end point of the slope. The needed information and a record of the data for the landscape contour, altitude and length could be performed with View Ranger application. The next step is implementing the recorded data in the Sketchup software. The generated model of the chosen existing ski slope for our project is represented on fig. 4. The slope is with length 350 m and width 50 m.

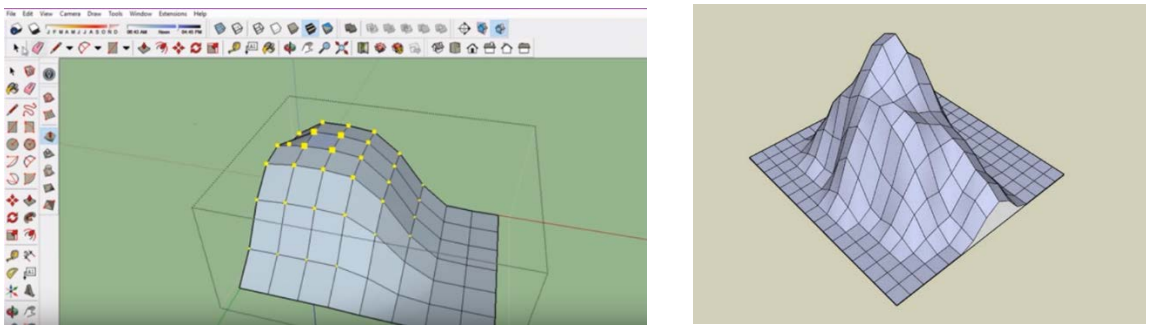

Fig.4 3D modelling of the chosen ski slope based on GPS tracking

After generating in Sketchup the 3D model is inserted in the lighting design program Dialux EVO. An illustration of the created model after adding additional surfaces with real reflection charachteristics is shown on fig. 5.

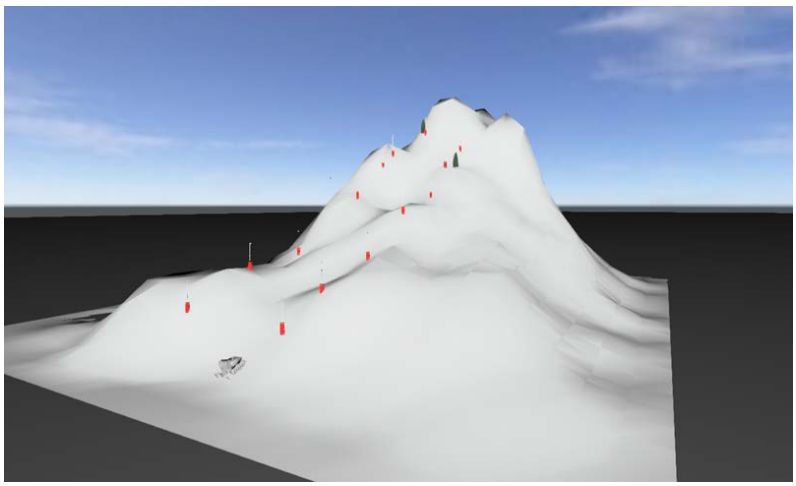

Fig.5 3D model in in the lighting design program Dialux EVO with real added real reflection characteristics of the calculation surfaces.

3 Lighting system geometry and basic principles

3.1.1 Pole positions - basic principles

The lighting poles should be situated with priority to the safety of the participants taking into account the curvature, trees, rocks, cliffs and etc. The height of the poles should be chosen considering the biggest expected snow amount [9].

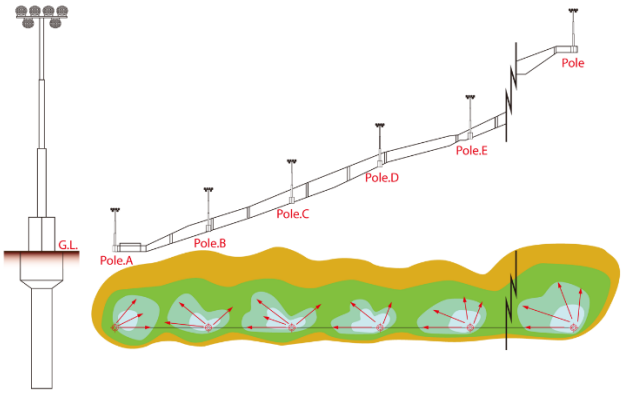

Fig. 6 Lighting pole positions and illuminance of the slope surface [9]

3.1.2 Orientation of the luminaires – basic principles

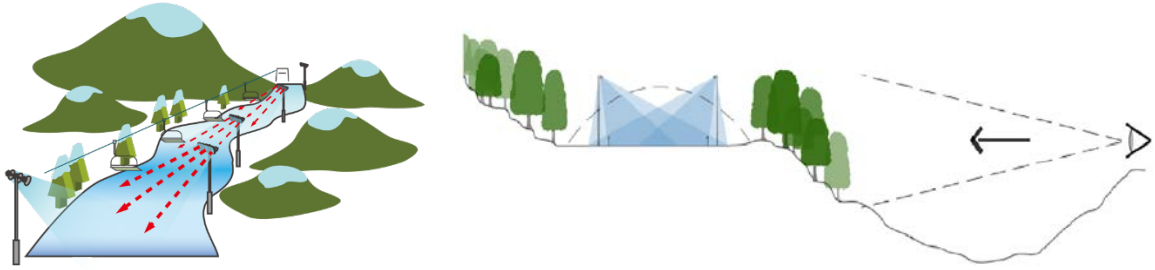

Fig. 7 Orientation of the luminaires aiming less obtrusive light [9,10]

The landscape, its contours and the luminaire orientation could be used for limiting the glare, fig. 7. The athletes' shadows must be avoided. They may disturb the participants and the spectators. As uniform is the slope field as comfortable and safe are the winter sport performers. The proper orientation of the luminaires leads to less lighting design pollution.

3.1.3 Project details

For the represented project are used Siteco LED luminaires Flood light 20 midi LED, 208W, 29599lm, CCT 5000 K and CRI > 80. Their mounting height is 12 m. The pole distance is 30m. The construction and the lighting distribution curve are shown on fig. 8.

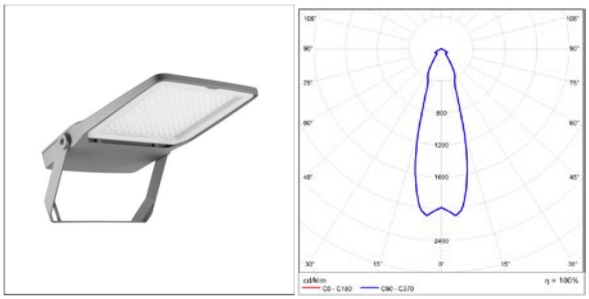

Fig. 8 Design and LDC of the used LED luminaires

The calculation results from the lighting design software are represented on fig. 9

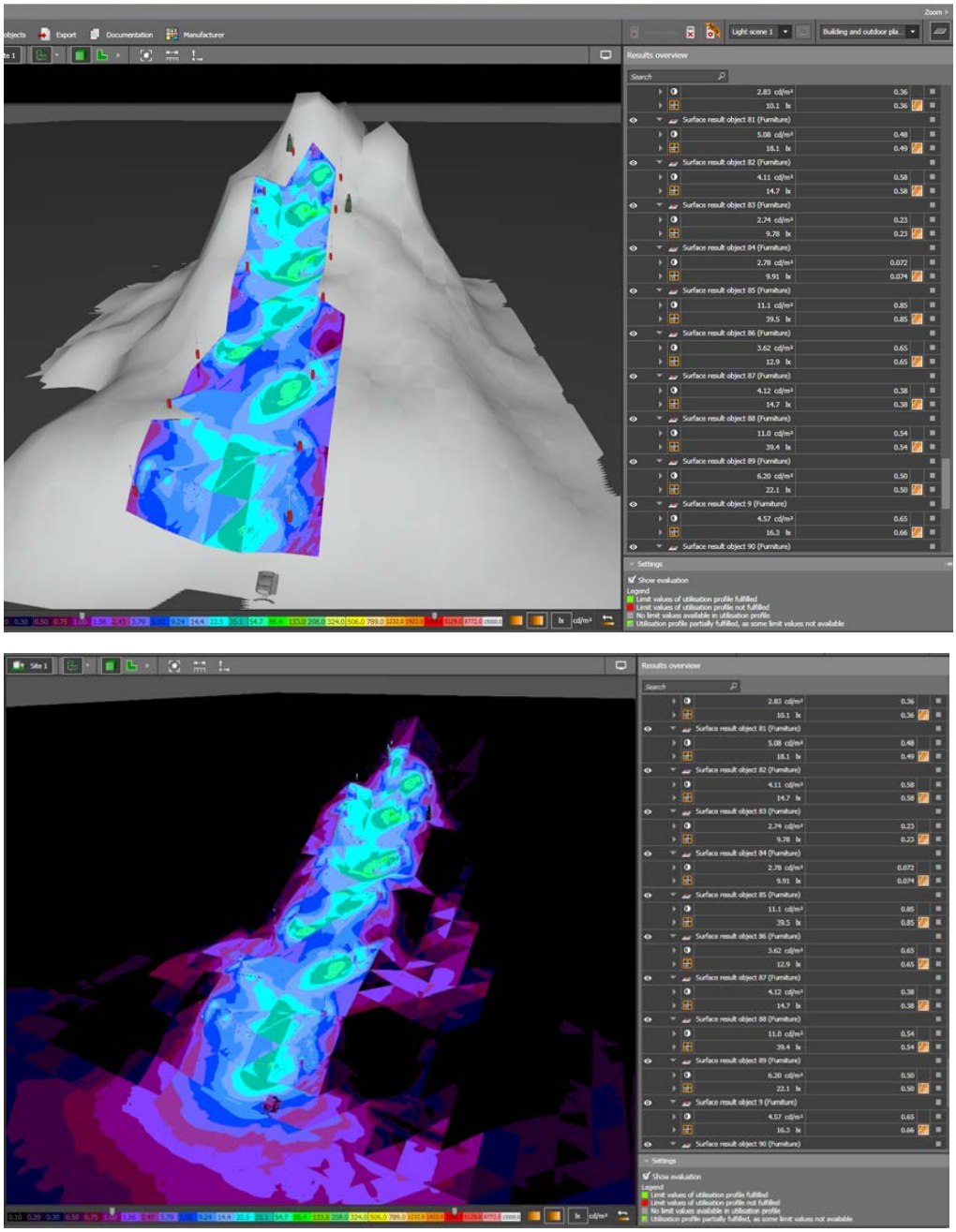

Fig. 9. Calculated values for the illuminance of the different surfaces

The average illuminance for the calculated surfaces is 24 lx, the uniformity is 0.27 and the glare rating is under 50.The results comply with standard requirements for a ski slope of Class III.

4 Conclusions

The realistic modeling of the calculation surfaces is one of the most important goals for every lighting designer. Although it seems complicated the recent technology progress gives a lot of opportunities for generation of 3D models. The realization of good

practices in ski slope lighting should be conformed with the characteristics of the landscape, curvature of the slope, athletes performance and movement direction, safety of the performers and the spectators, avoidance of stray light and light pollution. The possibilities of color changing LED lighting give the designers opportunities to create extraordinary and very attractive scenes even for ski slopes.

5 References

[1] EN 12193:2009, Light and lighting - Sports lighting, 2009.

[2] CIE Publication 112:1994, Glare evaluation system for use within outdoor sports and area lighting, 1994.

[3] http://www.slopelightingsolutions.com.

[4] http://www.thornlighting.com.

[5] https://www.zumtobel.com.

[6] http://winled.com.

[7] http://www.musco.com/project-showcase/moonstone/

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[9] http://sports-lighting.co.kr/ski_lighting_en/?lang=en

[10] https://www.sportengland.org/media/4181/artificial-sports-lighting-design-guide-2012-051112.pdf

[5] CIE Publication 112:1994, Glare evaluation system for use within outdoor sports and area lighting, 1994.