



The lighting refurbishment of places of worship: The case study of the Church of “Santa Maria di Piedigrotta”

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Abstract

Christian church buildings constitute most of the architectural heritage in Italy. In this paper, the case study of the exterior lighting renewal of the Church of “Santa Maria di Piedigrotta”, located in Napoli, is discussed. The lighting project was carried out with the goal of emphasizing the original hierarchies of the building details, that can often be difficult to understand with the current lighting system. The study started with the analysis of the architectural features of the façades and belfry as well as the existing lighting system. In order to allow for the comparison and optimization of the various lighting design solutions, a virtual model of the church was realized in the simulation software DIALuxEvo. In the most suitable concept, both diffused and accent lighting were integrated, allowing for a correct perception of the whole of the façades of Church, thus highlighting its most valuable elements. The results obtained have responded positively to the enhancement and conservation of the historical-artistic works, while also resulting in energy saving. Moreover, the Standards of Law restrictions on “light pollution towards the sky” for historical and monumental buildings have been respected.

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Keywords

Lighting Design, DIALux EVO, Led, Visual Comfort, Historical Buildings, Christian Italian churches;

1. Introduction

The illumination of places of worship is an example of interesting but also demanding planning. Illuminating a Church with an historical-artistic value implies, among the various aspects, the integration of two fundamental elements represented by the i) enhancement of the historical-artistic elements and the ii) improvement of the use of the building. The use of artificial light allows to recreate the suggestion of forgotten places. The illuminated façades define the nocturnal environment that surrounds man: they provide orientation, transmit moods and emotions as well as capture interest. However, it is preferable to avoid “isolating” the element by connecting it to other elements and creating a wider lighting scenery; thus, the subject is not extracted from its context. Modern lighting solutions for the buildings façades with historical-artistic interest must contain an added value, so as to make it more beautiful and more visible. With the use of artificial light, the Church has to be a functional place, while also respecting, emphasizing and enhancing the symbolism of the elements that compose it. In order to have a good visual impact, it is necessary to use the light with extreme precision, illuminating the chosen subjects, while avoiding as much as possible that the flux is dispersed in other directions (Thorn Lighting, 2014). Another problem relates to light pollution in the field of external lighting. The dispersion of the direct or reflected light upwards by the external lighting systems constitutes a relevant

aspect of the problem of light pollution (L.R. n. 12, 2002). To solve this problem an adequate direction of the luminaires was chosen.

In this paper, the Church of “Santa Maria di Piedigrotta” and the connected belfry were used as a case study to develop an adequate external lighting system capable of guaranteeing the correct lighting of all the elements of the façade, an adequate fruition of the building, energy saving targets as well as the local Standards restrictions on “light pollution towards the sky”.

2. Case Study

In order to design a lighting system of the Church façades and belfry that is able to highlight its most valuable parts, the lighting projects of three Renaissance churches façades were studied. The study showed a general use of accent lighting for the façade details and a lack of background light for the perception of the façades as a whole.

The Church of “Vilminore di Scalve” façade (Figure 1) is only illuminated at the top parts due to the use of accent lights, while the lower part of the façade is not: the effect obtained is of an almost floating Church. For the Church of “San Bernardino”, the lighting is used to illuminate only the jutting elements of the façade, while the other parts in the background are left in the shade (Storaro, 2015). Only the three false rose windows and all the vertical forms of the façade are highlighted, leaving the horizontal forms in dim light. This lighting design allows to highlight only the twenty-four columns and the nine squares that compose the façade (Figure 2). This type of lighting avoids a floating effect of the church. In the third case study (Bertolaja & Bonomo, 2010), there are both accent lighting and background lighting. Regarding the Basilica of “Nostra Signora di Bonaria”, the jutting elements are highlighted, thanks to the use of a skilful play of light and shadow. The contrast between the jutting elements and the background architecture allows to perceive all the elements of the façade (Figure 3).



Figure 1. Church “Vilminore di Scalve”



Figure 2. Church “San Bernardino”



Figure 3. Basilica of “Nostra Signora di Bonaria”

3. The Church of “Santa Maria di Piedigrotta”

The study then focused on the case study of the Church of “Santa Maria di Piedigrotta” in Naples.

According to (Croce & Ceci, 1896), this Church is dedicated to the Nativity of Maria and was erected in 1353 on the site of a previous Church that was dedicated to the Annunciation to the Virgin Maria, that was built in the fifth century in the place where a wooden image of the Virgin had been venerated.

The Church of “Santa Maria di Piedigrotta” is now surrounded by three important buildings: the Mergellina subway station on the left, the "Palazzo d'Arata" on the right, the "Palazzo de Fazio" in front of it. In the 1853, the King Ferdinand II of Borbone entrusted the design of the new façade to Enrico Alvino He created a façade, adorned with stuccos, mixing Renaissance and Gothic lines; the result was a very complex façade from an architectural point of view. The Church front is marked by six fluted columns with composite capitals as well as a walnut portal with wooden images of the four evangelists and apostles Pietro and Paolo (Figure 4). The façade ends with a triangular tympanum in bas-relief above an arched window. These two elements are separated by a space where the engraving “DEIPARAE VIRGINI NASCENTI SACRUM” is shown. On the two sides of the arched window, there are two angels in bas-relief framed by a triangular space (Figure 5).

The study started with a survey on the existing lighting system of the Piedigrotta Square that is mainly associated with the Napoli Mergellina Subway Station and the Church itself. Figure 6 shows the position of the existing Church lighting system that is based on six floodlights (Figure 7) with sources characterized with an unsuited colour temperature light emission. As a result, there are a general lack of shades, that does not allow for a correct perception of all the façade elements. The Church and the belfry appear to be flattened and insufficiently illuminated. On the other hand, the square opposite the Church is lit by two double-arm street lamps (Figure 8) and four luminaires (Figure 9). However, they are not enough for a correct illumination of the area.

All the luminaires are characterized by different correlated colour temperature values.



Figure 4. Church of “Santa Maria di Piedigrotta”



Figure 5. Church of "Santa Maria di Piedigrotta"



Figure 6. 17th November 2017 Photo, at 16:03



Figure 7. Six floodlights



Figure 8. Two luminaires



Figure 9. Four luminaires

Figures 10, 11 and 12 compare the Church of “Santa Maria di Piedigrotta” and the Mergellina Subway Station, highlighting how the Church appears darker than the Mergellina Subway Station; the analysis of the urban surrounding state-of-the-art revealed that only the lighting design of Mergellina Subway Station could influence the lighting design of the Church.

The Mergellina Subway Station, located on the north-west side of the square, is mainly illuminated on the upper part. The floodlights installed on the platform roof illuminate the façade evenly and do not highlight the architectural details; only the clock and the two figures that crown it are highlighted by spotlights (Figure 11).



Figure 10. 17th November 2017 Photo, at 16:31



Figure 11. 17th November 2017 Photo, at 16:14



Figure 12. 17th November 2017 Photo, at 17:28

4. Creation of the virtual model and definition of the materials

In order to allow for the comparison and optimization of the various design solutions, a virtual model of the Church façades, the belfry as well as the opposite area was realized in the simulation software DIALuxEvo (Figs 13, 14, 15); the use of this software allowed for a thorough geometric modelling of both Church and the square opposite.

In the first step, a church survey was carried out with the aim of characterizing the church façades, the belfry as well as the opposite area, from the geometrical and visual points of view; the photometrical characterization of the external surfaces was performed by using a spectrophotometer Konica Minolta CM-2600d. The experimental reflection coefficient values are listed in Table 1. Then, the virtual model of the Church, the belfry and the opposite areas was realized in the simulation software; the virtual model allowed for a comparison between the various design concepts.

Different lighting scenarios were created and compared from the architectural and energy points of view for the purpose of identifying the optimal luminaires configuration, the source types and their correct position.

Table 1. External church surface materials.

Materials	Stone Portal	Wood Portal	White Plaster	Gray Plaster	Marble columns
Reflection coefficients	37.64%	16.19%	62.21%	14.58%	42.37%



Figure 13. Church virtual model



Figure 14. Church virtual model

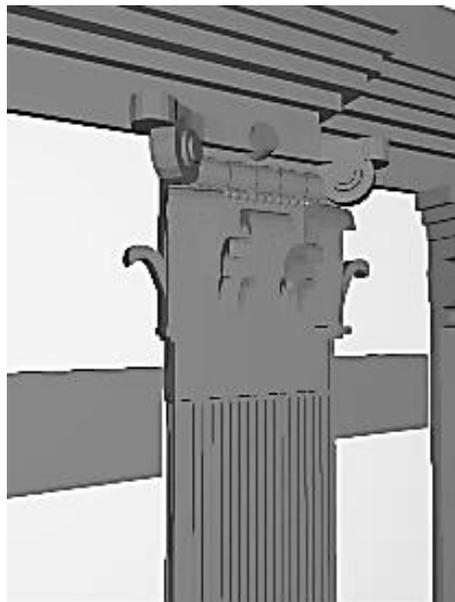


Figure 15. Church virtual model – Capital Detail

5. Lighting Design

The best lighting design concept, from an aesthetic, energetic and light pollution point of view, is the one that provides for the integration of accent light and background light; this implies that all the luminaires are based on LED light technology and have a correlated colour temperature of 3000K.

Spotlights were provided to highlight specific elements; in particular, they were considered facing upwards to create an outline effect; this kind of luminaires were used to illuminate grey geometries and the internal profile of the windows and the tympanum.

Floodlights were placed on the floor, to guarantee a uniform lighting of the surfaces behind the columns as well as to avoid the floating effect of both the Church and the belfry; these systems were also considered to illuminate the white geometries of the upper part of the Church façade.

Linear luminaires were inserted to attenuate the shadow created by the jutting elements; moreover, for the main façade, two linear luminaires were considered vertically, to create a horizontal luminous flux to illuminate two angels in bas-relief framed by a triangular space. In addition, linear luminaires were also considered to illuminate the inscription "DEIPARAE VIRGINI NASCENTI SACRUM", under the tympanum.

The lighting system of the façades was designed with the dual aim of emphasising the architectural details, while allowing for a correct perception of the whole main and Nord façades. However, the main objective of the lighting design for the belfry was to accentuate its slenderness, in harmony with the façades of the Church (Figures 16, 17). Moreover, the terrace with the adjoining dome and the garden near and in front of the Church were also considered; eight floodlights, with asymmetric direct light optic, were provided to light the garden and the opposite area (Figure 18). All the luminaires are shown in Figure 19.

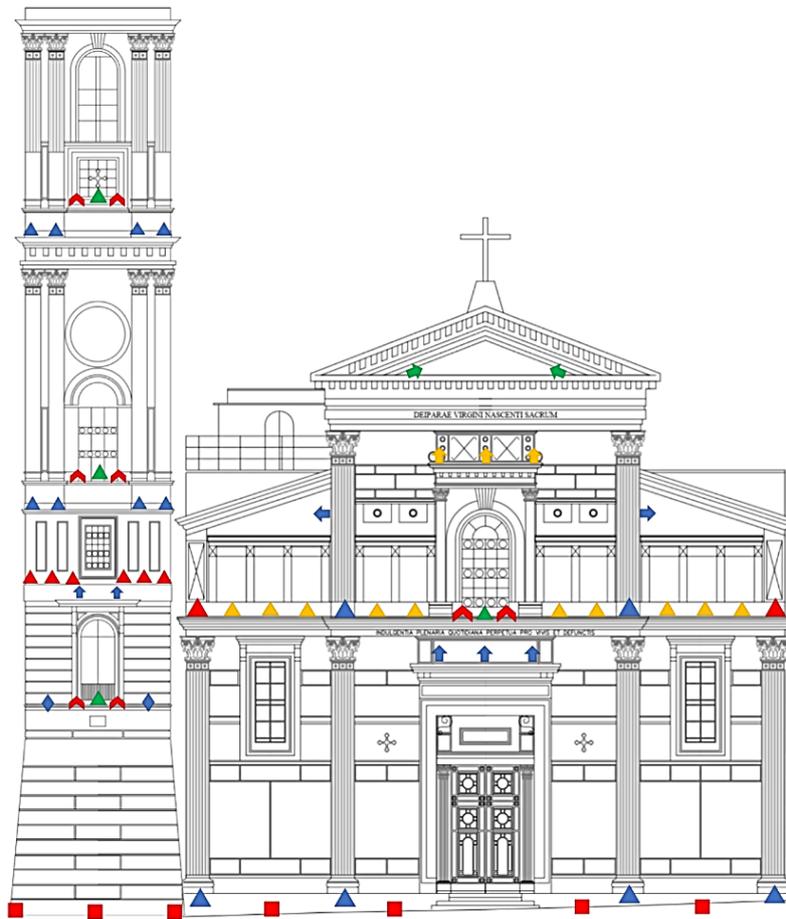


Figure 16. The position of the Luminaires on the main façade and belfry

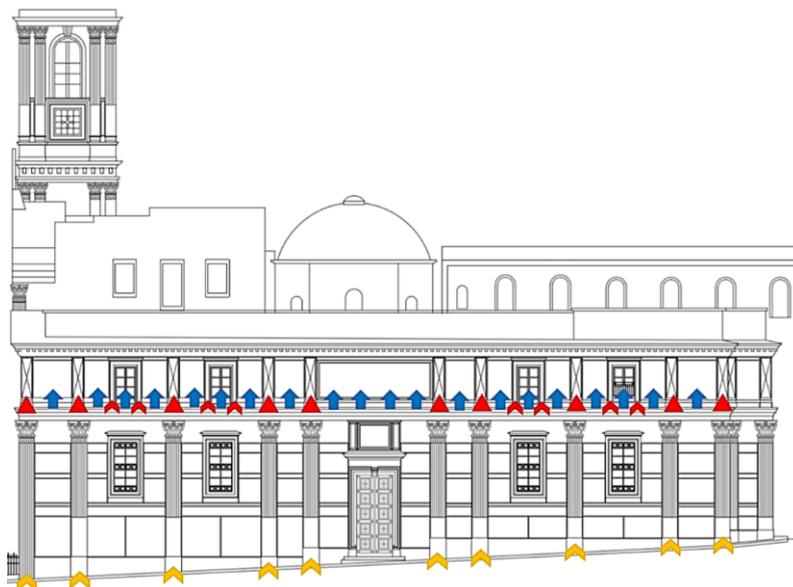


Figure 17. The position of the Luminaires on the Nord façade

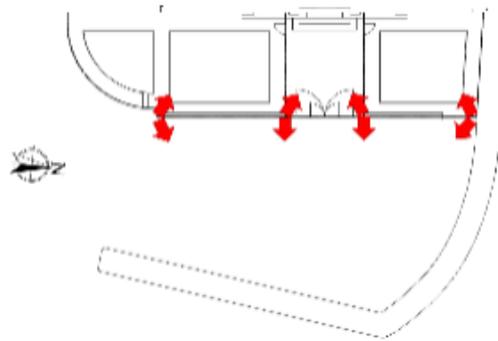


Figure 18. Garden and opposite area of the Church – position of the Luminaires

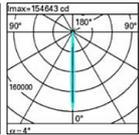
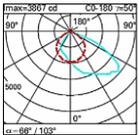
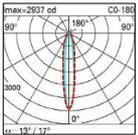
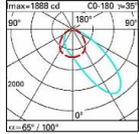
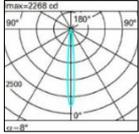
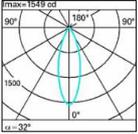
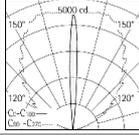
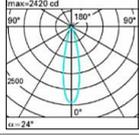
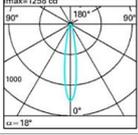
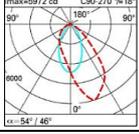
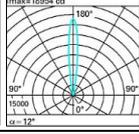
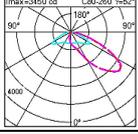
Photos and Photometric curves		
 <p>Proiettore Platea Pro (cod. P791) – iGuzzini</p> 	 <p>Lingotto (cod. 7017) – iGuzzini</p> 	 <p>Linealuce mini (cod. BH19) – iGuzzini</p> 
 <p>Lingotto (cod. TXE0) – iGuzzini</p> 	 <p>Proiettore iPro (cod. BJ91) – iGuzzini</p> 	 <p>Linealuce mini (cod. BM80) – iGuzzini</p> 
 <p>Focalflood (App. per facciate) - ERCO</p> 	 <p>Palco InOut (cod. Q692) – iGuzzini</p> 	 <p>Proiettore iPro (cod. BJ95) – iGuzzini</p> 
 <p>Proiettore Platea Pro (cod. P827) – iGuzzini</p> 	 <p>Proiettore Light Up Earth (cod. E170) – iGuzzini</p> 	 <p>U.F.O. - Sistema da palo (cod. BL16) – iGuzzini</p> 

Figure 19. Technical data of the Luminaires

6. Results

Using the calculation software DIALux, the illuminated three-dimensional model of the Church and the surrounding environment were realized, and a photorealistic effect was obtained, as shown in Figures 20-21-22.

Figure 20 shows an overall view with the aim of illustrating the final lighting design concept; the lighting of the elements from the bottom upwards contribute to the outlining effect of the Church, with an overall view being guaranteed. As shown in Figure 21, the two spotlights on the tympanum frame highlight the geometric profile of the element; moreover, the three linear systems (equipped with arms) illuminating the underlying inscription, guarantee a clear reading. Figure 22 shows the lighting used for the side angels; the horizontal flux allowed for a light effect that highlights the element. The results show how there is no excessive luminance contrast on the surfaces. The results obtained have responded positively to the enhancement and conservation of a place of historical-artistic interest, while also resulting in energy saving thanks to the use of LED sources and the local Standards restrictions on “light pollution towards the sky” being respected. The results show that, as required by the law for historical and monumental building, the luminous flux towards the sky does not exceed 10% of the total luminous flux of the lighting luminaires.



Figure 20. Lighting Design of Church “Santa Maria di Piedigrotta”



Figure 21. Tympanum and Inscription Detail



Figure 22. Angel Detail

7. Conclusions

In this paper, the Authors describe the concepts and results of lighting design which mainly concern the main façade, the belfry and the Nord façade of the Church of “Santa Maria di Piedigrotta” in Naples. In order to design a lighting system of the Church façades and belfry capable of highlighting its most valuable parts, lighting projects of three Renaissance churches façades were studied and in the second step, a study of the urban surrounding was carried out. A geometric and material characterization of the external part of the Church as well as a virtual model were then realized in order to allow for the comparison and optimization of the various design solutions.

The final lighting solution proposed expresses the synthesis of the aesthetic-scenic, functional, safety, low energy consumption and environmental compatibility requirements, with the aim of respecting the symbolic value and architectural features of the Church: the results obtained have responded positively to the enhancement and conservation of places of historical and artistic interest.

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