

Energy analysis of lighting in high-impact buildings with transparent envelopes

Análisis energético de iluminación en edificaciones de alto impacto con envolventes transparentes

GARCÍA-SERVÍN, Marco Antonio†, HERNÁNDEZ-LÓPEZ, María Isabel, DEMESA-LÓPEZ, Francisco Noé and SERRANO-ARELLANO, Juan*

División de Estudios de Posgrado e Investigación, Tecnológico Nacional de México / IT de Pachuca. Carretera México-Pachuca Km. 87.5, Colonia Venta Prieta, Pachuca de Soto, Hgo. C.P. 42080. México.

ID 1st Author: Marco Antonio, García-Servín / CVU CONAHCYT ID: 825446

ID 1st Co-author: María Isabel, Hernández-López / CVU CONACYT-ID: 789620

ID 2nd Co-author: Francisco Noé, Demesa-López, / ORC ID: 0000-0001-7197-6017

ID 3rd Co-author: Juan, Serrano-Arellano / Researcher ID Thomson: F-1060-2013

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Abstract

This article exposes the process of energy analysis through the lighting study in an office space in a building with transparent envelopes. With this analysis it will be possible to determine the optimal lighting and therefore the reduction of energy consumption. With the analysis of the results, a lighting design was proposed with improvements to the luminaires. The results show a more efficient way to take advantage of the natural resources of the envelope. For the new proposal, aspects in the design of the building were considered, as well as the standards NOM-025-STPS-2008 and NOM-025-STPS-1994, which establish the minimum lighting levels that must affect a health center. job. And the energy consumption of the building to be considered sustainable.

Resumen

Este artículo expone el proceso del análisis energético a través del estudio de iluminación en un espacio para oficinas en un edificio con envolventes transparentes. Con este análisis se podrá determinar la óptima iluminación y por ende la reducción del consumo energético. Con el análisis de los resultados se propuso un diseño de iluminación con mejoramientos de las luminarias. Los resultados muestran una manera más eficiente para aprovechar los recursos naturales de la envolvente. Para la nueva propuesta se tomaron en cuenta aspectos en el diseño del edificio, Así como las normas NOM-025-STPS-2008 y NOM-025-STPS- 1994, las cuales establecen los niveles mínimos de iluminación que deben incidir en un centro de trabajo. Y los consumos de energía del edificio para considerarse sustentable.

Lighting, Comfort, Workplace

Iluminación, confort, centro de trabajo

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* Correspondence of the Author (E-mail: juan.sa@pachuca.tecnm.mx)

† Researcher contributing as first author.

Introduction

One of the places where people spend the most time in their lives is the workplace, which is why it is a place that must have the ergonomic conditions for their work activity to be carried out efficiently, it must be safe and comfortable. In order to develop effectively, light and vision need to complement each other, as it is considered that 50% of the sensory information received by man is visual, i.e. its primary origin is light, which is why it is a fundamental part of the ergonomic conditioning of the work area. [1].

In this article, an analysis was made of the lighting conditions in the Torres de Plata work centre, located in Camino Real de La Plata, Zona Plateada, Pachuca de Soto, Hgo. in order to make a lighting proposal for the building according to the requirements of the workplace and the tasks to be carried out.

Theoretical Framework

The atmosphere of a workplace is very important, since having a range of colours influences the mood of the people, so a correct lighting has a direct influence on the actions, improves the capabilities when performing tasks enhancing activities and skills achieving greater productivity, It also helps to prevent health problems, and also the type of lighting in places makes customers pay more attention to what they are interested in, which is why lighting can create an atmosphere that favours the image of the place.

Concepts

Workplace: All places such as buildings, premises, facilities and areas where production, marketing, transport, storage or service activities are carried out, or where people are subject to an employment relationship. [2]

Work area: is the place in the workplace where a worker normally carries out his or her activities.

Ergonomic analysis and characteristics of a functional lighting system

Correct lighting is that which allows shapes, colours and moving objects to be distinguished, allowing reliefs to be appreciated easily and without fatigue, i.e. to have permanent visual comfort. Therefore, the ergonomic analysis of the lighting of a work area must consider the conditions of the observer determined by his visual capacity (visual acuity, sensitivity to contrast, speed of perception), conditions of the environment (dimensions, colours, shape, function and texture), conditions of the task (dimensions of the objects to be observed or manipulated, contrast, difficulty of the task (duration, speed of response, etc.) and conditions of the structure of the place (position of the light points, light distribution, typology and design of the light points, natural light-artificial light ratio). [3, 4]

Conditions for visual comfort

An important factor is that workplaces must have natural or artificial lighting, even if there is enough natural light, sometimes it does not guarantee correct lighting, because it varies depending on the weather, the structure of the place, the location of the work area, so to ensure visual comfort, the level of lighting, glare and the balance of luminance must be taken into account. [5]

Lighting levels for visual tasks and work areas

The optimum lighting level for an activity or task corresponds to that which results in the highest performance with minimum fatigue.

According to NOM-025-STPS-2008 [3], the minimum lighting levels that should affect the work plane, for each type of visual task or work area, are those set out in Table 1.

Visual Workplace Task	Working Area	Minimum Illumination Levels (lux)
Outdoors: distinguishing traffic area, walking, surveillance, vehicle movements.	General exteriors: courtyards and car parks.	20
Indoors: distinguishing the traffic area, walking, surveillance, vehicle movement.	General interiors: low movement warehouses, corridors, stairways, covered parking lots, subway mine workings, emergency lighting.	50
Indoors.	Circulation areas and corridors; waiting rooms; rest rooms; storage rooms; platforms; boiler rooms; boiler rooms; storage rooms; storage rooms; platforms; boiler rooms; boiler rooms; boiler rooms storage rooms; platforms; boiler rooms; storage rooms; boiler rooms.	100
Simple visual requirement: visual inspection, parts counting, bench and machine work.	Personnel services: heavy-duty storage, reception and dispatch, guard booths, rooms, etc. of compressors and piling.	200
Moderate detail distinction: simple assembly, medium bench and machine work, simple inspection, packaging and clerical work.	Workshops: packaging and assembly areas, classrooms and offices.	300
Clear distinction of details: delicate machining and finishing, moderately difficult inspection assembly, data capture and processing, handling of instruments and laboratory equipment.	Precision workshops: computer rooms, drawing areas, laboratories, etc.	500
Fine detail distinction: precision machining, assembly and inspection of delicate work, handling of precision instruments and equipment, handling of small parts.	High-precision painting and surface finishing shops and quality control laboratories.	750

High accuracy in detail distinction: assembly, processing and inspection of small and complex parts, finishing with fine polishings.	Process: assembly and inspection of complex parts and fine polished finishes.	1000
Alto grado de especialización en la distinción de detalles.	High accuracy process. Execution of visual tasks: - low contrast and very small size for prolonged periods of time; - accurate and very prolonged, and - very special tasks of extremely low contrast and small size.	2000

Table 1 Lighting Levels
Source: NOM-025-STPS-2008

Methodology

We started with the site reconnaissance, functional program, survey and architectural plans, materials and construction system, virtual model and the lighting study of a Work Center of the Torres de Plata building, located in Camino Real de La Plata, Zona Plateada, Pachuca de Soto, Hgo,

It was necessary to contemplate the location of the place to trace a faster route of arrival to the place of study, as shown in Figure 1 the location of the Torres de Plata building.



Figure 1 Location of the Torres de Plata Work Center, Pachuca, Hgo.
Source: Google Maps.

The building contains at sight: reception, office floors, meeting room, bathrooms, corridors, subway parking, as well as the construction materials, colors, and the building envelope. Figure 2 shows the main façade of the Torres de Plata Work Center, Pachuca, Hgo. It can be seen that more than 70% of the building envelope is transparent.



Figure 2 Silver Towers, Pachuca, Hgo. Source: Own elaboration

As can be seen, the building has large windows that provide natural light. However, the analysis will be made of space 7, first floor of the building.

AutoCAD Drawings

Once the information on the Torres de Plata building was available, we began to transfer the data of the first floor to the AutoCAD 2019 program (a program for the design of 2D plans, using lines, points and particular characteristics such as hatch, blocks in general and dimensions), to generate the architectural plan to identify the study area (work office) in the plan, analyze it and propose the lighting guided by the Mexican standard NOM-025-STPS-1994. Figure 3 shows the architectural plan of the first floor and Figure 4 shows the work office in the current context of the Torres de Plata building.

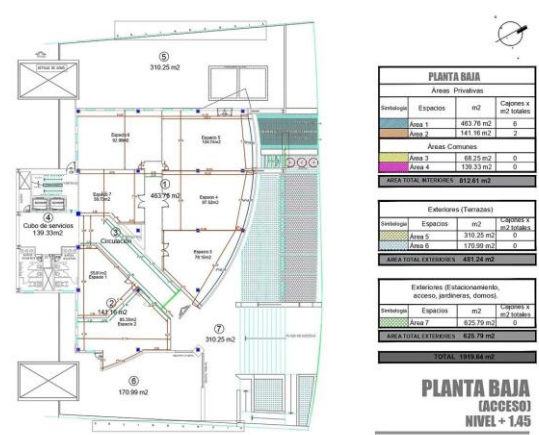


Figure 3 Architectural floor survey Source: General Information Torres de Plata (torresdeplatapachuca.com)

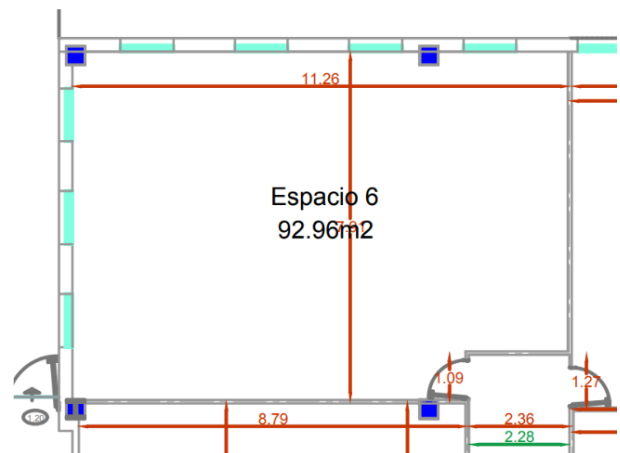


Figure 4 Plan view of the office to be worked on measuring 12 m x 8 m. Source: General information Torres de Plata (torresdeplatapachuca.com)

Architectural modeling

With the architectural plan in AutoCAD 2019 we started with the 3D modeling with ArchiCad 22 (a three-dimensional modeling program that generates volume, perspectives and rendering), designing a proposal for the design of a work office, which brings to solve all the problems of lighting, comfort and safety. [7]. The design is divided in a translucent way for visual improvement, incorporating furniture and decorations for user comfort and above all provide satisfaction when working, as shown in Figure 5 and 6, shows a rendering of the proposed design of the office.

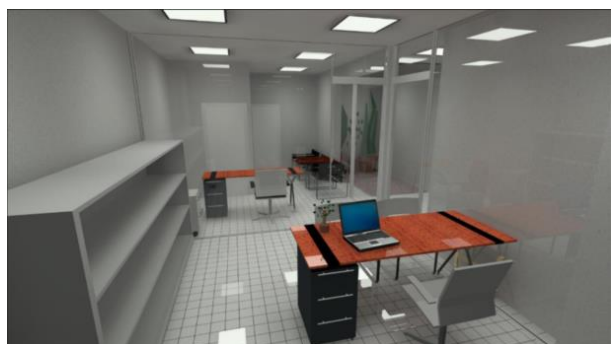


Figure 5 Office design proposal
Source: Own elaboration

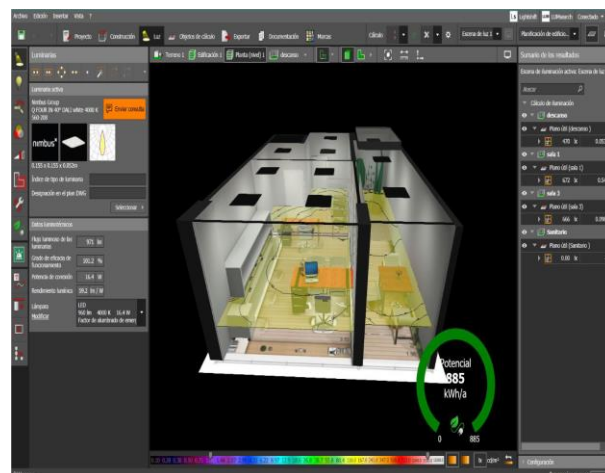


Figure 7 Geometry of the office proposal in the Dialux program for processing
Source: Own elaboration



Figure 6 Plan view of the proposed office design
Source: Own elaboration.

Modeling with the current context in DIALux evo 8.0 software

The modeling and simulation of the lighting of space 6, on the first floor of the Torres de plata building, was carried out with the DIALux evo 8.0 program, which allows us to analyze the artificial lighting aspects such as the luminaires that are installed and the natural ones such as the windows and doors that are on the site, based on its platform.

Having the modeling in archicad 22 was transported to the DIALux program to analyze the current interior context of luminosity of space 6, on the first floor of the Torres de plata building, as shown in figure 7 the interior modeling with the DIALux evo 8.0 program.

Results and lighting proposal

The following are the characteristics of the luminaire to be used for the work center in space 6 of the Torre de Plata, in order to achieve adequate lighting for users so they can perform their daily activities effectively without adversity, also respecting and complying with the Mexican standard NOM-025-STPS-1994. [3]

Luminaria X

Hoja de datos de luminarias

nimbus^x

Q FOUR IN 40° DALI white 4000 K
560-208

Flujo luminoso total	960 lm
Potencia de conexión	16.4 W

Descripción

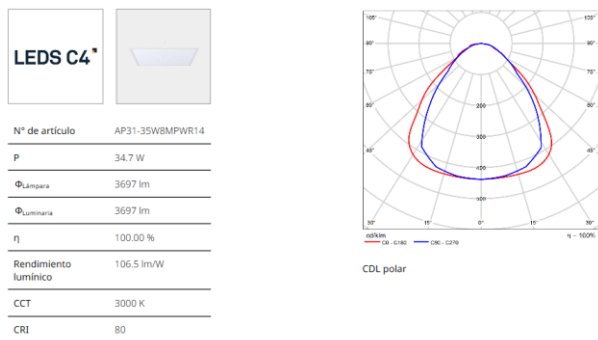
Recessed LED ceiling spot for cavity mounting in a suspended ceiling, 4 integrated Bartenbach lenses for focussing light and reducing glare, narrow beam (beam angle 40° or 80°) for accentuated illumination of surfaces and rooms, the full light performance thus appears on the illuminated area, design formally adapting to the Nimbus families Q ONE, Q FOUR and FRAME, operation by means of an external converter (within the scope of delivery), dimmable via DALI or via trailing/leading edge in combination with a conventional wall dimmer.

Table 2 Characteristics of the proposed lighting for the offices in space 6 of the Silver Tower

Likewise, the proposal of luminaires for the space is made, as shown in Figures 8 and 9, general characteristics of the type of luminaire to be implemented, such as degrees of reflection and energy consumption.

Ficha de producto

LEDS-C4 S.A. - Ecofit Plus 60 x 60 Sensor autonom



Figures 8 General characteristics of the proposed luminaire type

A metal halide lamp was chosen for its aesthetics, energy savings and easy maintenance. Figure 9 shows the luminous intensity that the project will obtain with the proposed luminaires, taking into account the luminous intensity in this type of areas. [7]

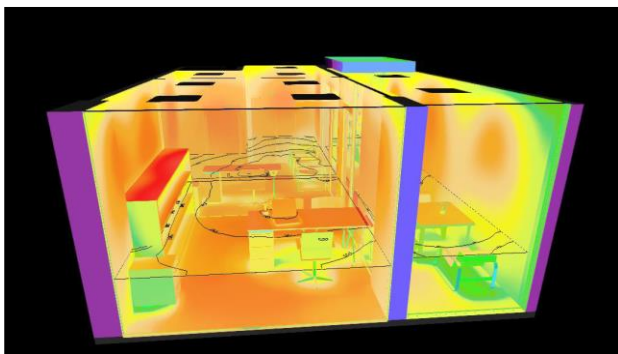


Figure 9 Luminous intensity with the proposed luminaires for space 6 inside the Silver Towers

Source: Own elaboration

It is important to consider the lighting levels in workplaces, because if there is too much natural-artificial light due to inadequate conditions, it can cause glare from natural light entering through windows or lights, causing discomfort that reduces visual perception and causing discomfort, so it is important to eliminate bothersome reflections and maintain a balance by conditioning the places with sufficient natural light and adequate lighting according to the area of the workplace and activities to be carried out.

Conclusions

All workplaces should consider the regulations to establish adequate lighting levels as it helps to prevent occupational hazards in workers. The balance between the structure, environmental conditions: temperature, wall colors and a correct natural and artificial lighting will help people feel in a comfortable environment improving their skills and abilities, increasing productivity.

Therefore, the design must be oriented to safety, for that same reason, it is convenient to consider design elements such as: the orientation of the space to provide natural lighting according to the envelope. This in accordance with the artificial lighting according to the study area, in such a way that they complement each other to obtain the necessary lux at any time. This complies with the regulations. Another important consideration is to change traditional walls for translucent walls, so that with an adequate design it will reduce the energy consumption of the work center. In addition, providing a safe and healthy environment for workers.

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