Experiences using EN 17037 in evaluation of daylighting of dwellings in Slovakia

J Curpek\(^1\) and J Hraska\(^1\)

\(^1\)Slovak University of Technology, Faculty of Civil Engineering, Bratislava, Slovakia
jakub.curpek@stuba.sk

Abstract. The daylighting of indoor spaces depends particularly on the urban and architectural parameters of the building environment. The new standard EN 17037, Daylight in Buildings, has brought several changes and uncertainties in design process of daylighting for buildings. The submitted paper is focused on analysis of the philosophy of the new standard criteria in relation to the daylighting of dwellings along with the criteria that have been used in Central European countries for decades. EN 17037 does not distinguish between differences in the functional use of indoor spaces in terms of daylight provision. The new European standard requires at the half of subjectively determined reference plane to achieve the same value of illumination for half of daylight hours per year for any occupied room. The EN standard does not sufficiently respect the specifics of daylighting of dwellings.

1. Introduction
EN 17037 [1] is the first European standard that deals exclusively with requirements and criteria of daylight provision, assessment for view out, exposure to sunlight and protection from glare in buildings. This standard replaced analogous standards that had been used in many European countries for many decades and introduced standardization in EU countries that have not had this kind of standard yet. In this paper, we will try to list several positive and negative aspects of this standard in relation to daylighting of living rooms of apartment houses with a specific focus on current Slovak (but not exclusively Slovak) practice. Standard requirements, criteria, relevant calculation methods and methods of their verification by measurement are analysed detailly in this paper in the historical context and in relation to the principles of standards STN 73 0580-2 [2] and EN 17037.

2. Historical background and contexts of STN 73 0580-2 and EN 17037
Marcus Vitruvius Pollio [3] noticed that enough daylight provision in the interior of the building is felt in those places where part of the sky can be seen. This knowledge became the basis for designing the size of windows and the type of their filling, especially in locations with a predominant cloudy sky. In the first half of the 20th century, architects usually designed the size of rooms and windows and their shapes so that even in conditions of external shading, part of the sky was visible, usually from the level of a table half the depth of the room. Such a procedure suited the way of work and thinking of architects at that time. After World War II, the Daylight Factor (DF) method began to be used in many countries to assess the daylight of buildings, which was a continuation of the above window design practice, but also considered light interreflection and therefore internal and external surfaces reflectance had to be used in calculations. Decrees, codes, directives, standards and design tools were created on this basis, that in many European countries have guaranteed a certain level of daylight, depending on the type and utilization of the interior space. Empirical socio-cultural and indirectly climatic specifications were
applied in them, although DF is based on a standard overcast sky. Indirectly, climatic aspects were considered by the required DF values and the places in the interior where they were required to be met. Advances in computer aided design and the development of sophisticated simulations have led to the creation of climate-based daylight simulations at the turn of the millennium. Gradually, several metrics were created to evaluate the data generated by simulation software, of which Spatial Daylight Autonomy was adopted as an alternative method in EN 17037.

2.1. Principles of designing daylighting of residential buildings according to former European state standards illustrated on the Slovakian standard

In several European countries, daylighting design standards of residential buildings were inspired by the German standard DIN 5034 [4], which was largely influenced by scientific work [5]. The philosophy of the approach to daylight design was based on the premise that daylight is a fundamentally important for human health and wellbeing and is not fully replaceable by artificial light. Direct and diffuse daylight should determine the approach to the architectural and urban design of the building environment. The standard criteria for daylighting were not based on visual tasks, but on the satisfaction of occupants of the indoor environment with its daylighting during the overcast sky. If an average DF of at least 0.90% is reached at 2 points 0.85 m above the floor, users do not need to switch on artificial lighting. In Slovakia, state authorities have established this criterion as generally required and controlled in all living rooms of newly designed, renovated and modernized flats. The DF method allows designers to quickly design the size, shape, position and filling of windows with respect to the floor plan layout, the depth of living rooms and the extent of their exterior shading. In Central Europe, cloudy days predominate during the year, in Slovakia the incidence of year-round clouds is about 60%. For this reason, the principles of standardizing the daylighting of residential buildings were considered meaningful. Glare problem and other influence factors (colour of surfaces, blinds, curtain, furniture, etc.) in residential buildings depend on specific users, they are solvable by them and therefore daylighting was assessed only in empty rooms under conditions of low availability of exterior diffused daylight.

Table 1. Comparison of some requirements and criteria of Slovak standards for daylighting in dwellings with requirements and criteria of EN 17037

| Parameter / property             | STN 73 0580-2 and directly related generally obligatory regulations | EN 17037                  |
|---------------------------------|---------------------------------------------------------------------|---------------------------|
| Obligation                      | obligatory through regulations, controlled by hygienists            | recommended               |
| Principle of criteria           | empirically based in conditions of overcast sky                     | taken from the criteria of artificial lighting of interior (office) spaces |
| Specification of the interior   | different levels of daylight are required for differently designed interior spaces | uniform requirement for all types of regularly occupied spaces |
| Daylight calculation method     | defined requirements that the used method must meet                 | two different calculation methods are recommended, the results of which differ significantly from each other |
| Suitability for routine building design | acceptable, although there are possibilities to simplify and approximate for architect | in the field of simulation calculations, highly specialized experts are needed, time consuming |
| Verification of daylight calculations by measurement | it may be implemented, although several conditions need to be met | it is perhaps only a very “foggy” and ambiguous way |
| Limiting the transmission of light and light reflection factors from surfaces | the minimum transmission of light through the glazing in regularly occupied spaces is limited by law | recommended in a relatively wide range of selectable values |
| The impact on the surrounding buildings | obligatory daylighting criteria directly limit the density of buildings | no direct specification, indirectly through recommended requirements for view |
| The influence of orientation of lighting openings in the cardinal direction | orientation does not affect the criteria for diffuse daylighting of interior spaces | one of the methods also considers the distribution of brightness in the sky and direct sunlight in daylighting assessment |
| The consideration of internal equipment | without furniture and other internal equipment | furniture can also be considered |
2.2. Principles of EN 17037
DF does not take into account the amount of light that enters to specific interior spaces in a given location during the year and does not allow the assessment of glare. EN 17037 uses two equivalent methods for the assessment of daylighting in buildings, which are principally different. The DF method is retained, but its criteria are related to the median diffuse horizontal illuminance value in the given locality. The second, a new method in the normalization of daylight, makes it possible to calculate “illuminance levels on the reference plane using climatic data for the given site”. For this reason, we can evaluate the daylighting of the same room according to EN 17037 according to one method positively and according to the other negative. The Spatial Daylight Autonomy method was implemented in EN 17037 to evaluate daylighting and was inspired by [6]. Daylighting is assessed in lux values in EN 17037, however, the criterion values of daylighting have been taken from the standards for artificial office lighting. Numerous studies as well as personal experiences have confirmed that daylighting and its perception has several specifics compared to artificial lighting. In the EN standard, daylighting has fallen into partial replacement (an artificial lighting supplement), this supplement covering half of the reference plane and half of the daylight hours. The size of the reference plane is not clearly defined in EN 17037. The requirements for daylighting apply to all spaces that are regularly occupied, the purpose and nature of people's activities in the space are not distinguished. However, the requirements are stepped to a minimum, medium and high in the standard, for living rooms the minimum requirements of the EN standard are in many cases unattainable.

3. Conclusion
The introduction of the same daylight provision for all indoor regularly occupied spaces in EN 17037 causes an increase in the required value of DT by 100% (from 0.90% to 1.80%). At the same time, the EN 17037 criteria reduce the Slovak requirements for daylighting in school facilities, where Slovak standards require a minimum value DF = 1.5% on the entire reference plane reduced to DTM = 0.6%. Only in the case of daylighting of offices, the relative compliance of the requirements of the original Slovak standards with EN 17037 was achieved. The realist will say: achieving a 100% higher DF value in the living room is a problem, because even the original values could often only be achieved with considerable problems. The cynic can say: in Bratislava it is relatively sunny from March to October, at half of the "appropriately" selected reference plane with bright interior surfaces and with a little "creativity" we simulate the required minimum target illuminance levels in EN 17037. It is therefore clear that in Slovakia it will be necessary to evaluate the real benefits of EN 17037 in relation to the design of residential buildings in real urban environments and apply them appropriately in generally obligatory hygiene regulations.

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