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Methodology for clamping load measurement of locking systems based on white light digitalization

Carlos Javierre [a], Isabel Clavería [a,*], Jorge Santolaria [b], Daniel Elduque [a]

[a] Mechanical Department, University of Zaragoza EINA, Maria de Luna 3, 50018 Zaragoza, Spain
[b] Department of Design and Manufacturing Engineering, University of Zaragoza EINA, Maria de Luna 3, 50018 Zaragoza, Spain

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ABSTRACT

This paper presents a new methodology to measure clamping force of locking clips of a weatherproof luminary from the previous determination of its stiffness and the elongation they suffer under assembly conditions. Application of the methodology includes determination of the clip stiffness both experimentally and by FEM analysis, and measurement of the elongation by structured white light digitalization techniques.

Elongation values measured by white light are similar to those analyzed by conventional methods. The relationship between clips elongation and load applied is linear, so stiffness can be deduced from the slope of the curve. Results show that functionality of the clips can be achieved with different values of stiffness. There is not any direct relationship between clip stiffness and load performed by them because of the influence of initial length on the final load performed. Therefore, manufacturing tolerances must be taken into account to assure the proper performance of the clips.

1. Introduction

When developing mechanical components, it is essential to know working conditions under which it is going to be subjected along its working life to be able to make the proper calculations from this information in order to determinate its technical viability.

Leak-free or weatherproof luminaries are lighting systems used all around the world for both industrial and domestic purposes [1–2]. Weatherproof luminaries have an outer cover to protect the electrical and lighting devices from impacts and from physical and chemical agents that are present in the environments where luminaries are allocated, see Fig. 1. In many cases the kind of lighting is fluorescent, although nowadays LED technology-based lighting is increasingly used [3].

According to Fig. 2, main components of a weatherproof luminary are the outer cover formed by two elements: a transparent or translucent diffuser (1) and an opaque housing (2); the sealing performance is achieved thanks to locking clips (3); a flexible gasket (5), and the lighting system (4), usually assembled on a metallic tray.

For tensile joints, the theoretical sealing performance is guaranteed by the compression of the elements that form the joint generated by the initial clamping force [4]. For a luminary, the initial clamping force is achieved by the locking clips, which compress a polyurethane (PU) gasket located between the housing geometry and the diffuser rib as seen on Fig. 3. An optimum sealing performance depends on the proper contact between the diffuser and the gasket propitiated by a proper design of it [5], and the compressive clamping force applied.

By means of the locking clip, the gasket remains compressed, assuring a sealing performance. The only element

* Corresponding author. Tel.: +34 649116405; fax: +34 976761861.
E-mail addresses: carlos.javierre@unizar.es (C. Javierre), Isabel.claveria@unizar.es (I. Clavería), jsmazo@unizar.es (J. Santolaria), danielduque88@gmail.com (D. Elduque).

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Fig. 1. Sample cases of weatherproof luminaries.

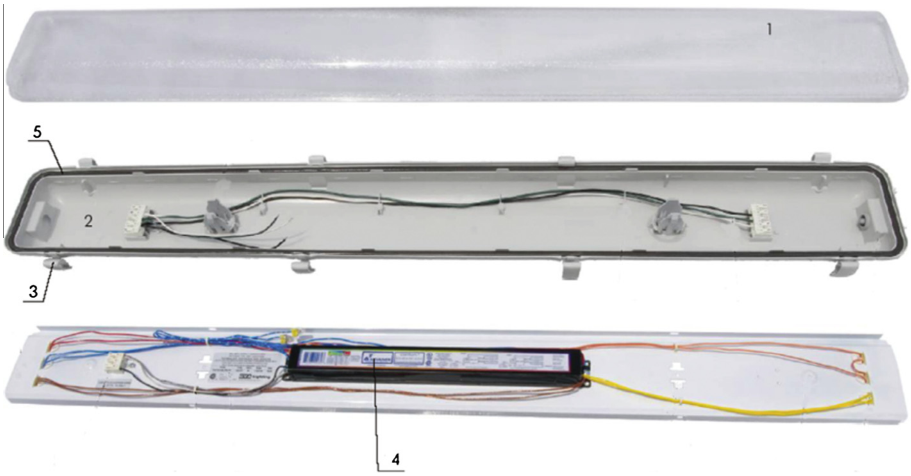

Fig. 2. Elements of a weatherproof luminary.

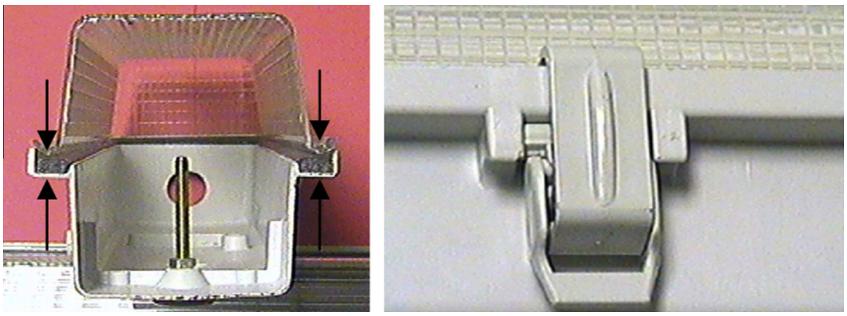

Fig. 3. Sectional view of the elements intervening on the sealing (left) and locking clips performing the clamping force (right).

that prevents environmental agents from entering into the luminary is the gasket. The sealing is kept if the compression of the gasket is guaranteed by the clamping force exerted by the clips [6]. The level of gasket compression depends on both the stiffness of the elements involved in the joint (clips and cover), and the initial clamping force as described on [7].

Fig. 4 describes the stiffness distribution between the elements involved in the joint and its influence on the stretching of the clip and compression of the diffuser-gasket subassembly. Tan β stands for stiffness of the clip, and tan α stands for stiffness of the cover-gasket sub-assembly. Point A stands for an assembled position of the clips performing an enough clamping force Fi to keep the gasket compressed. δ_C is elongation length of the clip due to assembly situation A and δ_D is compression length of the gasket due to clamping force on situation A.

The locking clip is very important for the proper functionality of the tensile joint of the luminary and its design is a critical point for the development of these components [8]. The design process includes determination of the load that must apply the locking clip, and the suitable design of housing, diffuser, gasket and clip to achieve desired load. A clamping force lower than a proper one does not guarantee