“The design of a CEDD® connector for evacuation systems in tunnels”

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Designing a connector that enables the application of the CEDD® system, developed by USE System Engineering, in a tunnel evacuation system.

USE System Engineering has developed a technology called CEDD® for the lighting of takeoff, landing and taxiways, where so called nodes can send and receive contactless data and energy. This contactless transfer takes place by means of a clamp that is clamped with a certain force around a special CEDD® cable. CEDD® is a solution for the disadvantages of galvanically connected systems that rust and sparks. In addition, a fast two-way communication is possible. USE is interested in applying CEDD® to other markets and to know whether application of CEDD® in the Tunnel & Infra market is possible. The design of the connector will be used as a basis for further development.

The aim of the assignment was to explore the possibilities for CEDD® in the market Tunnel & Infra and design a line connector (or clamp) that can be used in this specific market. This clamp will be part of a fixture that serves as evacuation guidance.

First, an analysis has been carried out to clarify the stakeholders, environment and techniques already used. This analysis was important because there was no knowledge within USE in the area of the Tunnel & Infra market. The analysis consisted of a literature research, a field study and conversations with stakeholders. By means of the knowledge gathered in the analysis phase, a statement of requirement and design considerations could be drawn up that could then be used in the iteration phase.

Then an iteration was performed by means of a morphological scheme and form studies. The morphological scheme, drawn up on the basis of the design considerations, resulted in the choice of three concepts based on advantages and disadvantages of the options in the diagram. These concepts have been drawn and the working principle of the dampers has been validated by means of a test.

A concept was chosen based on comparison to the statement of requirement and design criteria. A detail drawing has been made of this concept and subsequently converted into a 3D model. This model is modeled based on design guides for plastic and simulated for resistance to impact.

The final product met the requirements of the client except for one requirement, a maximum thickness of 25 mm. This requirement is not met as standard components had to be used. The 25mm requirement can be met when custom parts are used like custom dampers and ferrite cores. The shape can also be changed.

It can be concluded that there are several solutions used in tunnel evacuation systems, but there is no system that will guide victims to the closest emergency exit using light signals. CEDD® enables the combination of an evacuation system and observing, for example air quality, real-time. As 1300 kilometers of tunnel in Europe have to be upgraded to the highest safety standard in the coming years[1], there is a certain demand for smart systems such as CEDD® in the market Tunnel & Infra. The connector that has been developed offers USE the opportunity to enter this market with the CEDD® technology with this evacuation system (figure 1). The product is resistant to the harsh environment and is very easy to understand and install for inexperienced users. This will save time on installation as well as maintenance, which is beneficial for both the customer and USE.

[1] B. Martín, S. Vogler, C. Diers, M. Martens, J. Lacroix, M. Steiner, P. Schmitz, M. Serrano (2005) Recommendations for the enhancement of preventive tunnel safety, retrieved from https://ec.europa.eu/transport/road_safety/topics/infrastructure/tunnels_en

The effectiveness of the designed connector is tested in as much ways as possible. However, it is recommended to test the actual pressure the spring in the cap of the connector provides. In that way it is possible to select a suitable spring, it is possible that a coil spring will be more suitable to this design.

It is also recommended to make a prototype by, for example, using a 3D printer to test if all parts are connected properly. This 3D parts can be used for performing other impact tests to receive better results. At last it is recommended to perform a proper cost estimation.

Figure 1: The final product in context.