THERMAL ANALYSIS OF POWER CABLES IN UNVENTIALTED TUNNEL SYSTEMS USING FEM SOFTWARE

Shruthi **GANESAN** , Mohamad **GHAFFARIAN NIASAR;** Technical University of Delft, (The Netherlands), s.ganesan-4@student.tudelft.nl, m.ghaffarianniasar@tudelft.nl,

Jordi **TRISAN**, Prysmian Group, (Spain), jordi.trisan@prysmiangroup.com

Jos **VAN ROSSUM**, Prysmian Group, (Delft, The Netherlands), jos.vanrossum@prysmiangroup.com

George **ANDERS,** Lodz University of Technology, (Poland), george.anders@p.lodz.pl

☒ **Young Researcher**

ABSTRACT

The IEC 60287-2-3 standard provides the current calculation standard for cables in ventilated tunnels.

For unventilated tunnel systems, there is no longitudinal air flow. Most of the heat generated is through radiation from the cable to the tunnel wall.

The IEC TC 20 WG19 aimed at proving support for developing a methodology for unventilated tunnel systems and modelling the total heat transfer from the cables to the tunnel.

The present paper focuses on performing thermal analysis of power cables in unventilated tunnel systems using Finite Element Method. The results were compared with the proposed analytical formulae present in [1].

INTRODUCTION

Tunnels are used to host cable systems to transport them over large distances or in places where there are space constraints.

The present paper focused on accounting for the radiative heat transfer from the cable surface to the tunnel wall and bringing about a detailed methodology for understanding the thermal analysis of different cable systems inside unventilated tunnels.

First a radiative model for a single cable inside a tunnel is built on FEM software and the results of the simulation involving the radiative heat flux and thermal resistance between cable surface and tunnel wall (T_{st}) is verified analytically for the values of T_{st} according to IEC 60287-2-3.

Next, the influence of tunnel wall's temperature heterogeneity is studied for different tunnel dimensions.

Furthermore, cables with different designs and configurations are modelled to support the calculations and theory present in IEC 60287-2-3 and 2011 Jicable paper "Current ratings of cables present in deep or ventilated tunnels".

Finally, the scope of work is extended to understand the thermal behavior of the system when different groups of cables are present inside the tunnel.

RADIATIVE MODEL OF A SINGLE CABLE INSIDE A TUNNEL

For understanding the radiative heat exchange between a single cable and a tunnel, the first set of theory includes linking the heat loss of the cable with the thermal resistance and temperature rise of the tunnel above ambient temperature. [1]

Next, since there is no air flow inside the tunnel, majority of the heat transfer happens through radiation from the cable surface to the tunnel wall, therefore, the thermal resistance is represented as T_{st} which is the radiative heat transfer between the cable surface and tunnel inner wall.

$$W_t = T_{st} \cdot (\theta_s - \theta_t) \quad [1]$$

Here, W_t is the heat loss of the cable, θ_s is the cable surface temperature and θ_t is the inner tunnel wall surface temperature.

Based on this, a single cable inside a tunnel was modelled on FEM software using surface to surface radiation physics. The model below represents a simple 2D figure of a single cable of 75 mm diameter inside a tunnel wall diameter of 1,5 m and a wall thickness of 15 cm. The cable and the tunnel wall were set as opaque bodies and the air inside the tunnel was set as a transparent body.

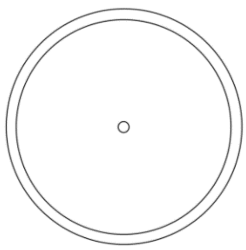

Fig.1 Cable inside a tunnel