# Study of thermal backfill materials for directly buried HV cables

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## ABSTRACT

*A study of six different backfill materials was performed by Laborelec in collaboration with Elia, in laboratory and on site. After a pre-selection three materials were retained for further testing (including one of the qualified backfill materials to allow control sample during the tests).*

*The most important soil parameter in the heat transfer around the cable is the thermal resistivity in dry conditions; this is influenced by the soil's porosity, density, saturation degree and grain size distribution. During field research the in situ characteristics of the backfill material were tested and these results were used for additional laboratory testing.*

## KEYWORDS

Power cables, backfill materials, thermal resistivity

## INTRODUCTION

The increase of energy consumption and the pressure on permits (for overhead lines) in Belgium, as elsewhere in Europe, drive the Belgian TSO Elia to invest more in the development of its underground cable network. The common practice of cable installation in the Belgian HV network is directly burying in trenches (figure 1). The maximal ampacity of the cable strongly depends on the surrounding soil capacity to evacuate the heat generated by the cable (25-50W/m). To evacuate this heat Elia places a backfill material around the cables. This backfill material is a granular soil that meets defined thermal characteristics assuring a low thermal resistivity in dry state, which should also ensure safe cable installation.

For the ampacity calculations Elia considers that the soil around the cable is completely dried-out on the 50°C isotherm, therefore the backfill material will be selected based on its thermal resistivity in dry state. The thermal resistivity on site has to be smaller than 100 K*cm/W. In order assure this limit, it will be considered in laboratory the selection criterion of the thermal resistivity in dry state of 90 K*cm/W.

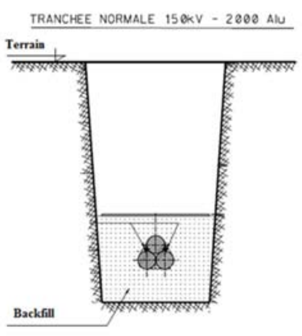


Figure 1: standard cable trench 150kV

## WHY USE A BACKFILL

Elia uses a backfill to ensure a good evacuation of the heat from the cable because operating conditions can create a dry out of the soil around the cable, which can create hotspots. These will create accelerated ageing of the cable insulation which can lead to hot spot related failures.

The dependence between ampacity and the dry thermal resistivity of the backfill is shown in figure 2, the thermal resistivity of the backfill and the consequent maximal ampicity in these situation is shown. Here you can clearly see the importance of the use of a backfill material with a low dry thermal resistivity on the ampacity.

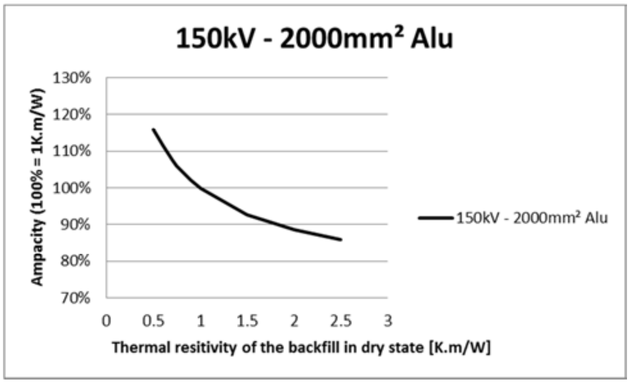


Figure 2: relation between dry thermal resistivity of backfill and ampacity of the cable

If the cable is placed in a natural soil, we always take the 2.5°K.m/W as dry thermal resistivity, so you can see that we lose 14% of transport capacity of the HV link. So to use the cable efficiently we use a thermal backfill to ensure good heat evacuation and a safe cable installation.

## CHARACTERISATION OF GRANULAR BACKFILL MATERIAL

In this context, Elia and Laborelec analysed six granular backfill from thermal heat evacuation point of view in laboratory and in the field. The granular backfill is a soil different from the soil of origin placed around the HV cable thanks to its good thermal properties. The heat transfer could be evaluated by the thermal resistivity of the material. The thermal resistivity is depending on several parameter.

The most important parameters in the heat transfer in soil around a cable are:

- the grain size distribution is necessary for a good heat transfer in order to avoid air inside the soil. Therefore the volume occupied by the soil must be filled as much as possible with solid (Figure3).