A NEW BACKFILL MATERIAL WITH AN EXTREMELY HIGH THERMAL CONDUCTIVITY

Heinrich **BRAKELMANN** , Jörg **STAMMEN** University Duisburg-Essen, Duisburg (Germany),
heinrich.brakelmann@uni-due.de , joerg.stammen@uni-due.de
Jörg **DIETRICH**, HeidelbergCement Baustoffe für Geotechnik, Ennigerloh (Germany),
joerg.dietrich@heidelbergcement.com
Raymund **BÖING**, HeidelbergCement AG, Entwicklung und Anwendung, Leimen (Germany)
raymund.boeing@heidelberger-beton.de
Hans-Peter **MAY,** nkt cables, Cologne (Germany), hans-peter.may@nktcables.com

ABSTRACT

In this report new materials with extremely high thermal conductivities are described. It will enable new designs for power cable trenches as well as the elimination of thermal bottle necks. For cable trenches, a new highly heat conductive cement offers thermal conductivities in a range of 3.0…6.0 W/(K m). For the backfill of cable/tube-systems the material, a newly developed cable cement provides values of 2.5…2.8 W/(K m). Information is given with respect to physical properties and handling of these materials. Possible consequences for the design of underground cable connections are shown.

KEYWORDS

Power cables; backfill materials; high thermal conductivity, Powercrete, CableCem

INTRODUCTION

The backfill material of cable trenches plays an important role with respect to the ampacity of a cable system. Some examples of such materials are summarized in fig. 1. Due to the diffusion of water-vapour and the decrease of the capillary suction tension, normal soils as well as backfill sands tend to dry-out partially when critical temperatures are exceeded. When drying-out such materials show a strong decrease of their thermal conductivity (e.g. [1, 2]). This is shown in fig. 1 for sandy soils (here the light-coloured blocks describe the moist material, whereas the darker blocks are representing low moisture contents). Standard values for the thermal conductivity are given in [3] with 1.0 W/(K m) for the moist regions as well as 0.4 W/(K m) for the dried-out regions in the cable trench resulting in a two-layer-model.

To enable higher current ratings of power cables by avoiding a partial drying-out of the cable trench, thermally stabilizing materials such as weak concretes or selected mixtures of sand and gravel are used [4 to 7]. The thermal conductivities of these materials keep values of approximately 0.8 to 1.2 W/(K m) even in the dry state, comp. fig. 1. An interesting material for the logistics of trenching is the so-called liquid soil. However, the thermal stress of this material must be limited to low temperatures, otherwise liquid soil tends to drying-out with unfavourable thermal conductivities, too [8].

In [9, 10] new materials have been introduced with extremely high thermal conductivities, thus facilitating new designs for power cable trenches as well as the elimination of thermal bottle necks. For cable trenches, the new highly heat conductive cement offers thermal conductivities in a range of 3.0…6.0 W/(K m), comp. fig.1. For the backfill of cable/tube-systems a newly developed cable cement provides values of 2.5…2.8 W/(K m). In the following,

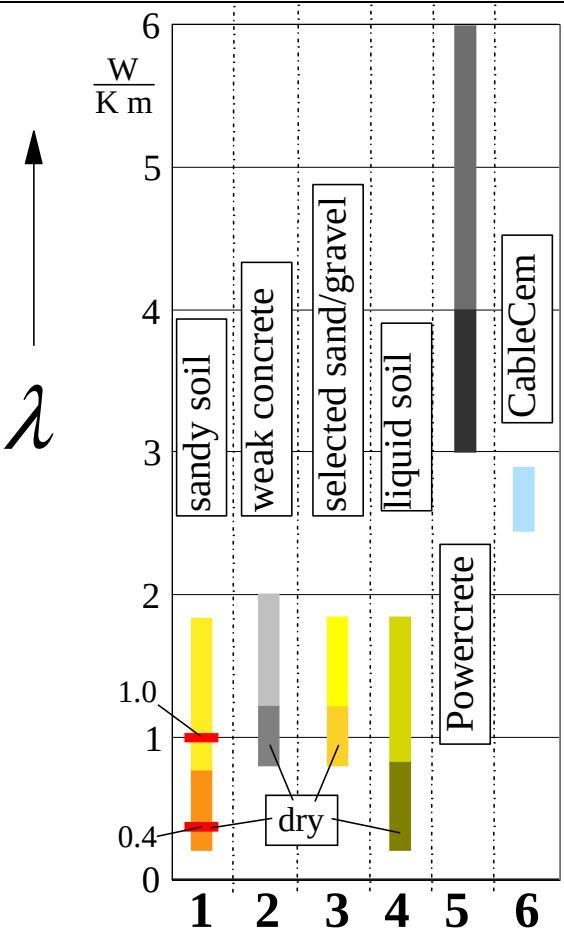

Fig. 1: Thermal conductivities of different materials; the darker blocks present low moisture contents
1 sandy soil [1, 2] 2 weak concrete [4…7]
3 selected sand/gravel [7] 4 liquid soil [8]
5 the new highly heat conductive cement 6 a newly developed cable cement (in closed systems) [10] red: standard values IEC/VDE [3]

information is given with respect to physical properties and handling of these materials as well as to possible consequences for the layout of underground cable connections.

A NEW HIGHLY HEAT-CONDUCTIVE CONCRETE

This new highly heat conductive cement is a patented concrete used as a backfill material for cable trenches. Technical properties of the material as strength categories, consistency categories or another maximum particle size are