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Expected potential of bound and recycled backfill material in low temperature district heating networks

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Abstract

Special requirements for backfill material for district heating pipes are defined in the relevant standards and codes of practice. Sands shall be used in particular in the pipe zone around the pipe perimeter. Significant costs for adequate bedding material are reported unless sands are available in the local region. Because of this, the economic optimization of utilities has led to construction projects where the trench spoil is reused for the whole trench. Furthermore, the reuse of materials within the construction industry is a key element in achieving sustainable construction, with targets related to sustainability becoming an increasingly important part of tendering. Bound and recycled materials for backfilling are modern options for fulfilling these targets. Decreasing supply temperatures in future networks may mean that static design issues become a background concern. Mechanical soil issues preventing the application of bound and recycled materials will then only play a minor role. This makes new economic and environmental friendly backfilling possible.

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Keywords: backfill; bound aggregates; recycling; district heating

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1. Introduction

1.1. State-of-the-art backfill material in district heating

For the installation of district heating pipelines, a trench needs to be built along the pipe route. The trench spoil should be stored near to the trench for refill; otherwise, the trench spoil shall be disposed of and replaced by a new material. Depending on possible contamination, a risk classification for the trench spoil shall be carried out before disposal. After digging out the trench, an adequate soil bedding of approximately 10 cm thickness for the pipeline is recommended. The pipeline is placed in its position in the trench and the different pipe sections are connected to each other. If necessary, insulation measures must also to be carried out. The trench is then covered with backfill material layer by layer. During the filling of the trench, each layer must be compacted to the required degree. This procedure is illustrated in Fig. 1.

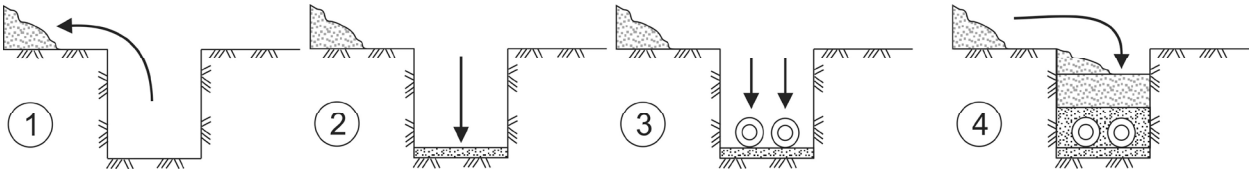

Fig. 1. Installation process for district heating pipes.

Strict requirements for backfill material for district heating pipes are currently defined in the relevant standards and codes of practice. The reason for this is an intense interaction between the pipe and the surrounding bedding material due to thermal expansion during operation. Because of the interaction between the pipes and bedding material, a pipe zone was defined. For Europe, the standard EN 13941 requires a pipe zone of at least 0.1 m around the pipe perimeter with granular backfill material [1]. Sands are allowed, which may contain single grains with a diameter of up to 32 mm. The percentage for fines with a grain diameter less than 0.1 mm may not exceed 15 %. Recycled material is not addressed here, thus not excluded. The German code of practice AGFW FW401 [2] limits the maximum grain size of the bedding material in the pipe zone to 4 mm and requires natural sands. Furthermore, requirements for bedding material for district heating joint testing were defined in a grain size distribution curve according to EN 489 [3]. These testing conditions represent an upper limit regarding the grain coarseness stressing the joints in a worst-case scenario. Developments for the European Standard EN 13941 summarized in prEN 13941:2015 [4] will allow grain size distribution curves within the limits shown in Fig. 1.

The qualities for the backfill material in the pipe zone were chosen to avoid unwanted cohesive interaction between the pipe and bedding material. The geotechnical models that were used for static calculation according to EN 13941 and AGFW FW 401 do not apply for cohesive soils.

Significant costs for the adequate bedding material are reported unless sands are available in the local region. Because of this, the economic optimization of utilities has led to construction projects where the trench spoil is reused for the whole trench. Furthermore, the reuse of materials within the construction industry is a key element in achieving sustainable construction, with targets related to sustainability becoming an increasingly important part of tendering [5]. A collection of bedding material currently used in Germany from [6] is compared with the requirements according to the cited standards in Fig. 2.