

# Cost Effective District Heating & Cooling Networks

## Reuse of Excavated Materials (1999: T3.3)

On grounds of environmentally friendly construction the utilities are trying to use recycled material or industrial leftover instead of raw material as trench backfill. Environmental protection has been proven to not always increase construction costs, but also lower costs in certain cases. Priorities in the case of trench-backfilling are with the use of excavated materials because they are the least-cost alternative available.

Today's standard practice is the use of the before mentioned materials for the pipe and filling layers in the trench in combination with mechanical compaction. In the past serious quality standards were defined for materials and their manual installation to be applied in the pipe layer for reasons of pipe-protection. With the background of the current investigation these requirements may be loosened towards the approval of recycled material which seems to fulfill the demand for pipe protection just like the Swedish recommendation of 0/16 mm grain sizes instead of formerly required 0/4 mm. Further release of those rules seems possible in the future.

A very promising technology is the installation of the backfill material by hydraulic compaction. The material is mixed with water and a binding ingredient to form a fluid which then is poured in the pipe-trench. The fluid encloses the pipe entirely which takes away the need for costly manual compaction. However, the main economic advantage of this method is its reduction of required trench-width by about 30 cm when compared to manually compacted trenches. Thereby, the masses of excavated soil, backfill and reinstalled surface layer are reduced significantly. The application of this technique becomes interesting if the savings exceed the costs of the stabilized mixture. The prices for the mixture will possibly decrease in future due to higher volumes of production and a developed competition between suppliers.

Dependent on recipe, excavated soil may be almost exclusively used as the basis for the mixture (frequently referred to as SSM), if standard soil properties prevail. The casting of the pipes with fluid mixture seems to favor the use of coarse materials. By means of the fluidization coarser grains are encapsulated and their location fixed by fine ones. – The trench may be filled up to the street's level interface, above which the road will be reinstalled in a conventional fashion.

The above method of construction offers potential for further development in case that SSM will be granted the approval as frost-resisting road construction material. The trench could then be filled up to the interface on which the bituminous layer is installed instead of stopping the fluid refill underneath the support layer.

As a consequence, the cut-backs of the bituminous layer could be avoided which normally are required in the area of highly frequented roads to assure the quality of the bituminous joint between existing and restored surface. The construction-time has already been reduced significantly, the so called Single-Day-Construction became possible.

Even the simplest way of hydraulic compaction – the washing-in of backfill with water – has its justification in the construction of buried pipe systems. Soil and backfill need to be permeable to water. Admittedly, the compression is a little lower than with mechanical compaction but it is sufficient for pipe laying underneath paved areas with small loads like sidewalks or bicycle lanes. Also, it may be useful to add a step of final mechanical compaction to a pipe which has been washed-in in the first step.

This report is no construction guideline for the real case. It rather informs about the ongoing efforts aiming to ease the way for the use of

recycled materials for the backfilling of pipe trenches in general. In the meantime, it is meant to catalyze the participation and discussion on the unsolved questions of this technique.

Obviously, it is possible to achieve a decent quality of district heating pipes without utilizing high-quality materials for the bedding resp. the backfilling of the pipe. Moreover, costs may be saved while, at the same time, resources are conserved, transportation and landfill-volumes are reduced and obstructions by construction works are minimized.

These findings yield first suggestions for the reuse of former construction material in district heating pipe installation. More systematic investigations are necessary before further optimization of construction works becomes possible which would bring about even higher cut-backs in costs.

The owner of a pipe system is always aiming at low cost solutions thus installing the most cost-efficient materials as trench backfill. The least-cost alternative that is readily available is the excavated material. If it is not possible to store the overburden next to the trench it has to be removed leaving the backfill options with virgin sands – as commonly used in the past – recycled or landfilled material. The price will be decisive amongst these choices.

In the past, usually natural sands were required for installation in the pipe zone. If this requirement is lifted crushed, thus sharp-edged, material may be used assuming that it is less expensive. In Sweden, crushed material of corresponding fine grading is permitted equivalent to natural material. In other countries, for instance Germany / Austria, natural sands are still required. The results presented in this report do not justify these requirements anymore.

The specifications of the materials used for pipe bedding are primarily governed by pipe-safety concerns. Thereby, it is necessary to distinguish whether the pipe is in the fully restrained zone – remaining fixed in the soil – or in the friction zone thus moving in axial direction. In addition to that, the pipe may shift radially at the tails of the friction zones or close to branches.

Besides the requirements for a long service-lifetime and low costs in the pipeline construction business aspects of environmental protection have become increasingly significant. It is urgently wanted that natural resources within and outside the construction site are conserved as much as possible. In this context fall the demands to restrict the transport of excavated material and backfill to a minimum and to avoid any unnecessary inconvenience for neighbors caused by the construction activities. For use in the construction site the before excavated material should be taken if possible and new material should be avoided for the backfill of the trench wherever possible. Conserving the resources can further be done by using recycled materials, industrial leftover or waste-material.

The calls for cost-efficiency and ecology don't necessarily exclude but may rather complement each other in the case of pipeline construction. The elevated prices for new material and the frequently rising prices for the deposit of overburden both point in the same direction as does the call to protect the environment, i.e. to reuse existing material. Despite the fact that the cost relations and boundary conditions are varying within regions and even more on a national level since the access to resources underlies strong regional differences, the protection-constraints apply in general. Facing these constraints the utilities are trying to use advanced technologies since they are exposed to specifically high attention by the public as compared to private companies.

For the reuse of material for pipeline construction several interesting solutions exist at different places. In this report only construction methods will be described that may be trans-

posed onto other places and their construction sites. The report will cover construction techniques which use mainly recyclable materials or recycled industrial waste.