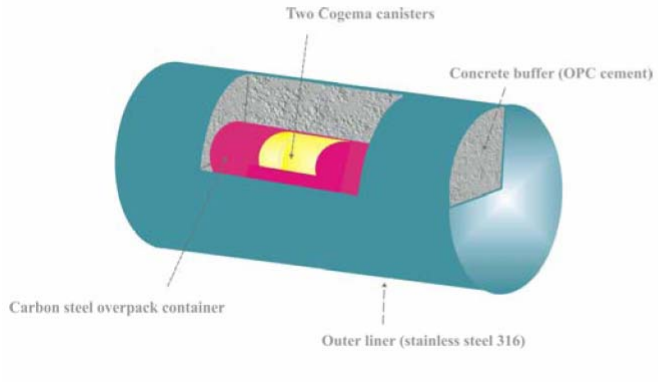
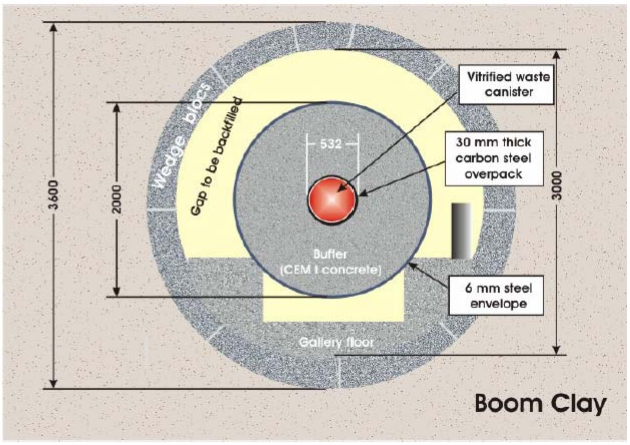
THE ESDRED PROJECT: ENGINEERING STUDIES AND DEMONSTRATION OF REPOSITORY DESIGNS

Background

The construction, operation and closure of a deep geological repository for spent fuel and long-lived radioactive waste in clay involves specific technologies. The demonstration of these techniques at an industrial scale is being carried out in the frame of a technological integrated project within the 6th Framework Programme of EURATOM. The Belgian design for high level waste disposal is based on the so-called Supercontainer concept. Within this concept, the waste is encased in a carbon steel overpack, which is consequently fitted into a 70 cm thick concrete shell, in its turn enveloped by a stainless steel liner. A Supercontainer measures about 2 m in diameter. In the design of the repository, the Supercontainers will be emplaced, one after the other, in disposal galleries. The space between the Supercontainers and the gallery lining needs to be filled up with a solid material. The most essential function of this component, referred to as backfill, is to prevent a collapse of the gallery. A secondary function is to limit the presence of free oxygen, to limit corrosion. In the ESDRED project EIG EURIDICE, together with SCK•CEN and ONDRAF/NIRAS, investigates technologies to apply the backfill.





Objectives

After testing two techniques to apply the backfill in 2007 at limited scale (unite with granular material and grouting with backfill mortar), grouting was selected as the preferred technique. This technique then should be tested at full-scale (30 m long mock-up). First, a full-scale structure needs to built, including an extensive instrumentation programme. In addition, the logistical needs to ensure a continuous backfill operation have to be worked out. The objective is to have the almost 100 m³ backfilled in 4 hours.

Principal results

The large-scale test stand consists of a 30 m-long concrete tube, simulating an underground disposal gallery (see figure, left). The cross-section is at real scale. This tube is assembled from concrete segments with a steel liner at the inside. These liners are welded together, creating a continuous, hermetically sealed tube. The supercontainers are replaced by a steel tube placed inside the tube, and which rests on the gallery floor (see figure, right: installation of this tube). An electrical heater is placed inside this tube to simulate the heat dissipation of the supercontainer; the remaining volume is filled with sand to obtain a thermal mass comparable to that of a supercontainer.

Different sections are instrumented with temperature and level sensors to monitor the grouting process (i.e. filling without leaving gaps) and the temperature evolution (combination of heat dissipated by the supercontainer and the curing grout). Other sensors include strain gauges (to monitor long term shrinkage), Time Domain Reflectometers (to monitor the water evolution during curing and at longer term), and thermal conductivity sensors (to obtain the in situ value of the grout thermal conductivity). (Figure, right) shows a detail of the instrumentation, with a TDR sensor, vibrating wire strain gauge and several thermocouples.

The grouting of the test stand requires an on site grout preparation and pumping facility, allowing a complete filling in 4 hours. The grout preparation consists of several concrete mixers working in parallel, delivering their output to the pumping machine. Several injection tubes are installed inside the tube; in principal, only one tube (bottom tube) has to be used, the other ones have been provided so that the grouting can continue should the bottom tube cause problems.

Future work

2008 will see the completion of a full scale mock-up test, with the actual demonstration of the grouting, followed by an extensive investigation of the results (on-line measurements and analysis of samples).

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Main reference

1. www.esdred.info
2. Van Humbeeck H., Bastiaens W., De Bock C., 2007. "Demonstrating the construction and backfilling feasibility of the Supercontainer concept for HLW". Proceedings not yet published. REPOSAFE Conference, Braunschweig, Germany.