

## Module #4 - Temporary Sealing Technology

### *(Low pH shotcrete for rock support and plug construction technology)*

#### 1.- OVERVIEW

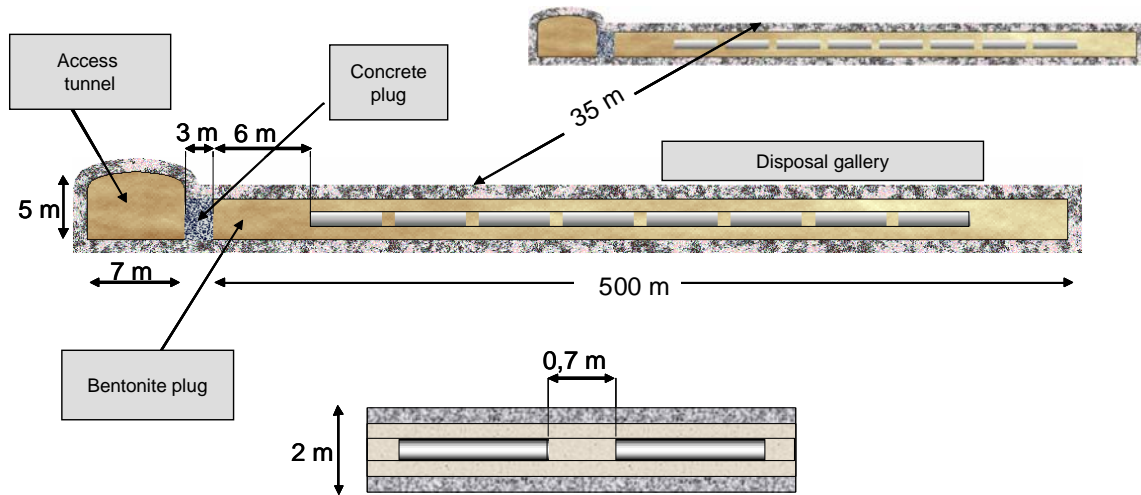
OBJECTIVES	JUSTIFICATION
<ul style="list-style-type: none"> <li>• Development and validation of low-pH cementitious materials for industrial application in repository construction.</li> <li>• Development of low pH shotcreting techniques for construction of repository plugs and rock support</li> <li>• Full scale demonstration of a low pH shotcrete plugs and rock support</li> </ul>	Long term safety (chemical interaction), Cost optimisation, Monitoring

CONCEPTUAL APPROACH
<p>This module addresses the issue of the use of cementitious materials in repositories either for the rock support of the underground works or for the mechanical support of a swelling material seal. Within this Project the concrete used for these two applications must comply with two main requirements:</p> <ul style="list-style-type: none"> <li>• the pH has to be as low as possible (below 11) in order to minimise the plume effect,</li> <li>• the concrete has to be emplaced by shotcreting technique.</li> </ul> <p>Therefore, this module will focus as well on the issue of the compatibility of low pH concrete with available shotcreting techniques:</p> <ul style="list-style-type: none"> <li>• the most appropriate composition of low pH concrete will be elaborated.</li> <li>• the shotcreting technique will be adapted or modified if needed.</li> </ul> <p>In order to demonstrate the applicability of the solutions obtained for both uses the module will follow two parallel lines:</p> <ul style="list-style-type: none"> <li>• for the plug, a first step of demonstration will comprise the construction and test of a short low-pH shotcrete plug to investigate and validate the feasibility of its construction and performance and to improve the plug design calculations. This will be carried out at the Äspö HRL (Sweden). Thereafter, a full scale and fully monitored test of a low-pH shotcrete plug will be carried out at the Grimsel URL (Switzerland) under real conditions, where the plug is loaded with the swelling pressure of a bentonite buffer.</li> <li>• for rock support, shotcrete tests for rock support will be carried out both at the Äspö HRL (Sweden) and at the Hagerbach Test Gallery in Sargans (Switzerland).</li> </ul>

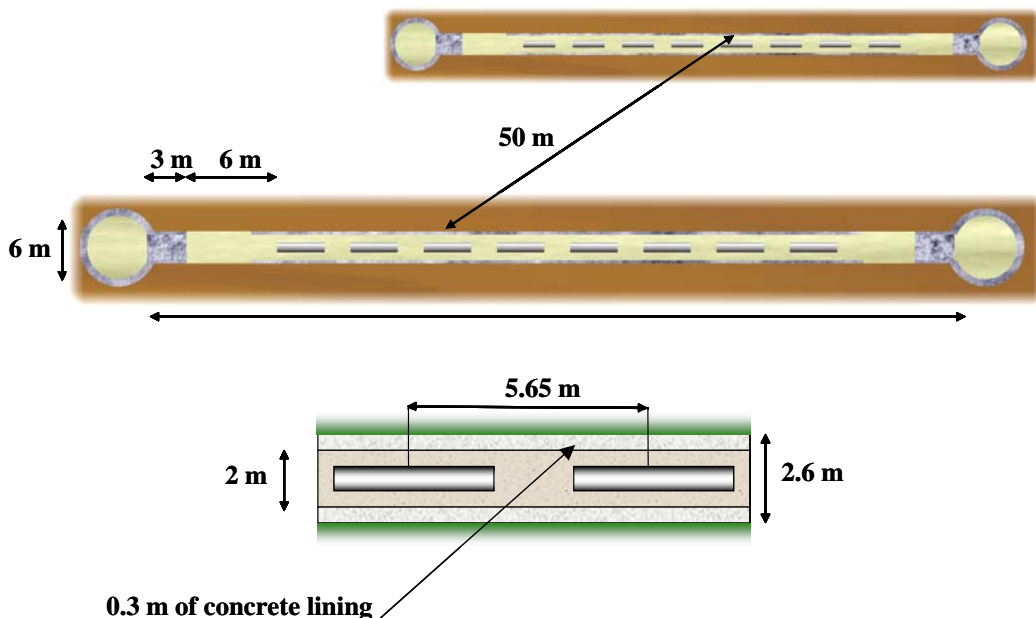
WORK BREAKDOWN STRUCTURE		
WP(date)	DESCRIPTION	BUDGET(k€)
WP1 (2004)	INPUT DATA – FUNCTIONAL REQUIREMENTS	
WP2 (2004-2005)	DESIGN OF LOW-PH CEMENTS	
WP3 (2004-2008)	FULL SCALE DEMONSTRATION: - WP3.1. STUDIES AND LABORATORIES TESTS - WP.3.2. IMPLEMENTATION IN URLS	
WP4 (2007-2008)	EVALUATION AND FINAL REPORT	
<b>TOTAL</b>		<b>1704</b>

## 2.- DESCRIPTION OF TECHNICAL CONCEPTS AND OF DEMONSTRATION OBJECTIVES

In most repository concepts the use of cementitious materials (concrete, grout, etc) is considered for providing structural support for the swelling clay buffer (plug or bulkhead, see sketch #4.1) and rock instabilities (lining, grouting, bolting, see sketch #4.2). It will also be utilised for conventional construction purposes (inverts, pavements, etc). The main concern for their use in radioactive waste repositories comes from the potential chemical interaction with the engineered barrier system (mainly the waste itself and the clay buffer). The reduction of the pH is a long-term safety issue since cement based materials would most likely be used in a repository construction and even might be considered as a potential buffer component. Therefore, the concrete used for these applications must comply with a specific requirement: pH has to be as low as possible in order to minimise the pH plume.



Sketch #4.1 Horizontal disposal galleries for crystalline rock in the Spanish concept



Sketch #4.2 Horizontal disposal galleries for clay rock in the Spanish concept

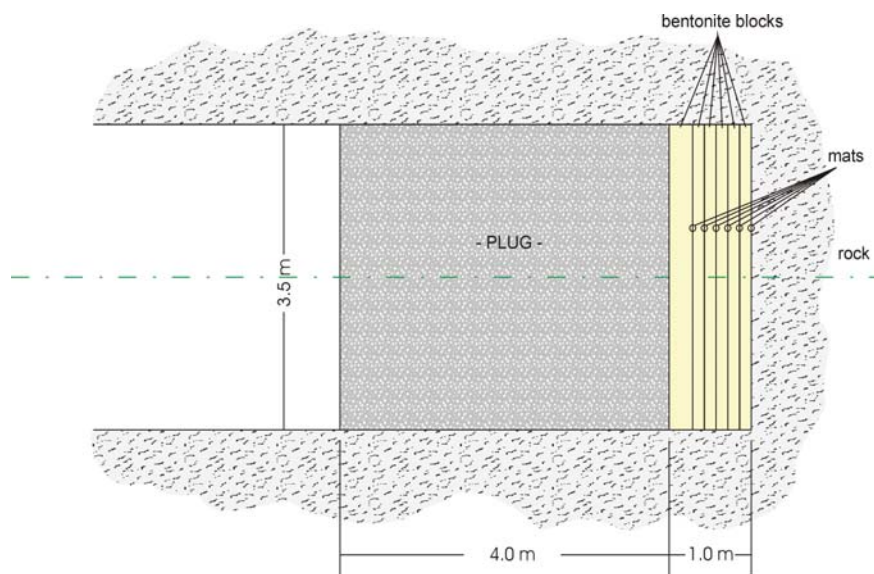
The proposed RTD activities intend to develop the formulations for a set of low-pH cementitious materials that could be used for different applications, in the construction of underground repositories for radioactive waste, adapting them to the specific technical requirements of each case. These materials have many advantages and are widely used in modern construction technology, as they are effective, cost-efficient and well characterised in terms of their mechanical and hydraulic behaviour.

This may have a very important impact in the construction technology of deep repositories, as it will enable a wider use of cement based materials, generating a number of benefits and advantages. Some examples could be the following:

- The possibility of using cement-based materials in the close vicinity of the buffer (thanks to the reduction of the plume effect) enables the systematic use of concrete in the deposition areas, either for roof reinforcement or for the construction of plugs. Also for the construction of auxiliary structures such as platforms, drainage channels, etc., that will help to simplify the emplacement operation.
- Using shotcreting techniques will make the construction of plugs and bulkheads simpler and faster, with a minimum impact on the rock. This technique also enables a remote operation, which simplifies operational safety procedures.

Therefore, this module addresses as well the issue of the compatibility of low-pH concrete with the available shotcreting techniques. The most appropriate composition of low-pH concrete will be elaborated and the shotcreting technique will be adapted or developed if needed.

Furthermore, the demonstration and validation of applying shotcreting techniques using the herein developed low-pH cementitious materials, for construction of repository plugs and rock support, is a clear target for this module. The demonstration objectives of the module are focused on the validation of low-pH cementitious materials and the required shotcreting techniques for construction of repository plugs and rock support under realistic conditions. Such demonstration exercises will be carried out at the Äspö HRL (Sweden) and the Grimsel URL (Switzerland).



**Sketch #4.3 Layout of the full-scale low-pH shotcrete plug test**