DAMS AS SEALING SYSTEMS IN ROCK SALT FORMATIONS - TEST DAM CONSTRUCTION -

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ABSTRACT

Dam constructions represent an essential component of the multibarrier safety concept for a repository for radioactive wastes in salt formations. As a joint task BGR, GSF and DBE will build a test dam (with the function of a bulkhead) in the Asse-salt mine to demonstrate the technical feasibility of tight sealing against elevated gas and fluid pressures. The design of the dam as well as the planned in situ investigations and rock mechanical computations are outlined.

INTRODUCTION

During the operation of a repository, the operational phase, and also after its closure, the post-operational phase, the exposure of the biosphere must not exceed the radionuclide release limits specified by law and the radiation protection ordinance.

In the Federal Republic of Germany, the safety concept for the enclosure of the disposed radionuclides consists of natural and engineered barriers.

Besides the tight host rock formation the components of the engineered multibarrier system are, as shown in Fig. 1:

- Borehole plug,
- backfilled drifts,
- dams
- shaft backfill and
- shaft sealing.

Dam construction with the function of a bulkhead represent an essential component of this multibarrier safety concept.

Based on experiences and the results of already performed investigations, a 1 : 1 scaled test dam suitable for a permanent repository is to be built in the Asse-salt mine. The project is a joint task of BGR, GSF and DBE:

- The BGR is responsible for design and test supporting rock mechanical computations,
- the DBE is responsible for planning and design of the dam construction as well as for planning and performance of construction activities
- and the GSF provides the Asse-salt mine and takes care of the mining of the galleries as well as of the scientific investigational program.

DESIGN OF DAM CONSTRUCTION

At present the following conditions are presumed for the design:

-In the operational phase:

- Limited brine inflow into the operating mine openings
- Limited inflow of solutions from the salt formations into backfilled and abandoned areas of the mine
- Gas generation due to radiolysis
- Natural gas inflow

-In the post operational phase:

- Water or brine inflow from the main anhydrite layers
- limited inflow of solutions from the salt formations
- Gas generation due to radiolysis
- Natural gas inflow

Dam constructions have to fulfill the following requirements in the operational and post-operational phase:

-Stability against rock pressure,

-stability against liquid and gas pressure,

-loading capability to both front sides of the dam,

-imperviousness to liquid and gas pressure during the operational phase,

-at the beginning of the post-operational phase the dam permeability against liquids should be lower than

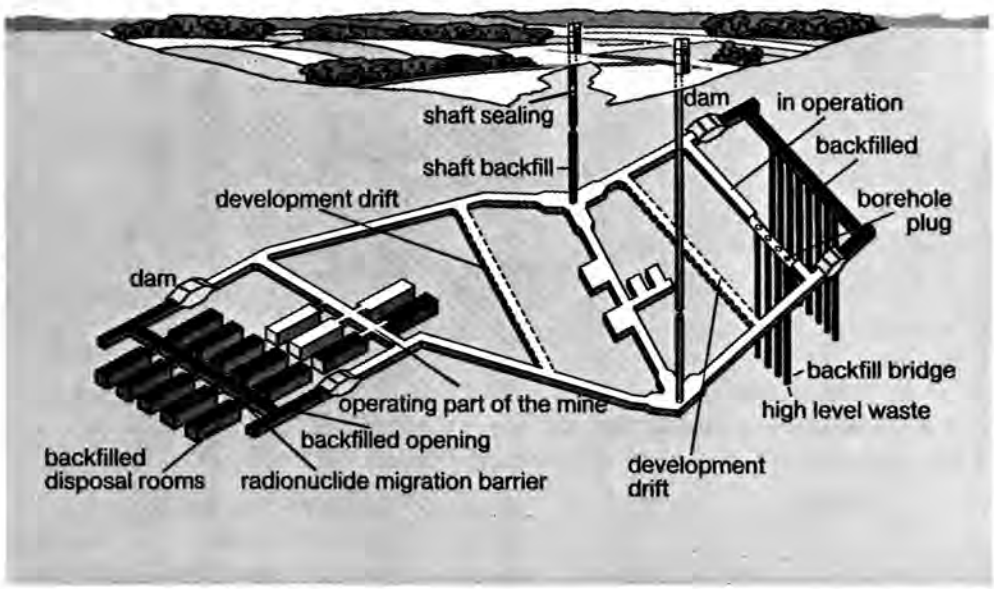

Fig. 1 . Engineered Multibarrier System.

2×10^{-16} m^2 resistance of construction materials against corrosive salt solutions and

-thermal stability of construction materials.

A dam construction planned to fulfill these requirements is outlined in Fig. 2. It is effective against liquid or gas pressure from both sides:

-The dam consists of a multiple prism-shaped abutment placed between two symmetrical sealing systems.

-The multiple prism-shaped abutment is loaded by rock pressure and gas or liquid pressure.

-The sealing systems have to maintain the sealing function of the dam and have to protect the construction materials against the corrosive brines or gases.

The sealing system has several functions with respect to its efficiency:

-the hydraulic sealing system is designed to become effective early after the construction of the dam

-the long-term seal has to sustain liquid or gas pressure occuring in the post-operational phase.

The hydraulic seal is built of asphalt, whereas the long-term seal consists of salt slack briquettes.

The material for the abutment is salt concrete, that means a cement/crushed salt aggregate and saturated brine as mixing water. The deformation behavior of salt concrete is similar to the behavior of rock salt.

TEST DAM CONSTRUCTION IN THE ASSE-SALT MINE

To demonstrate the technical feasibility of the dam construction (with all above-mentioned requirements) and to prove its in situ effectiveness for a permanent repository, a test dam is to be built on a 1 : 1 scale in the Asse-mine.

The general objectives for investigations and construction of the test dam and its distinct components are:

-Test and demonstration of construction techniques.

-Determination of permeability to gases or liquids during the operational phase and extrapolation to the post-operational phase.

-Validation of design supporting computations.

-Test of correct functioning of the total dam system and the several dam components, especially the sealing systems.

-Test of the construction materials.

-Identification of weaknesses.

-Comprehensive description of quality assurance measures necessary for later licensing procedures.

In order to attain all the goals of demonstration, the whole dam construction will be built in two parts (test dam

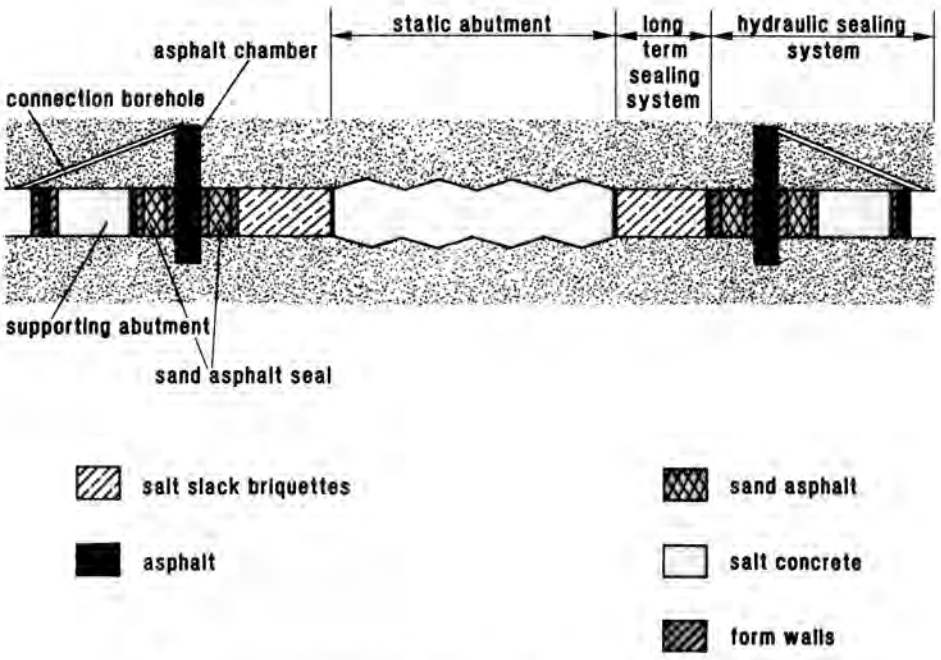

Fig. 2. Diagrammatic Sketch of Dam Construction (Vertical Section).

I and II) at separate locations. Dam I and II will be tested by different measurements. Both parts of the dam, consisting of abutment as well as long-term and hydraulic sealing system, will be constructed in the Asse-mine at 945 m depth. The position of the test dams I and II in the test field are shown in Fig. 3 as a diagrammatic sketch.

Each test dam shall be loaded first with gas pressure and later on with brine pressure. The gas and brine pressure will be generated by compressors located in the observation drifts above the test dams. The dams are pressurized via two boreholes and the pressure chambers located in front of the test dams.

Experimental Investigations

It is intended to install monitoring instruments into the surrounding rock and into the test rooms in order to measure the resistance of the dam against the loads to be expected (rock pressure, gas and brine pressure).

The monitoring system is sketched in Fig. 4 and includes:

-Permeability measurements (gas and brine).

-Geotechnical measurements (stress and deformation behavior).

-Geophysical measurements (seismic, geoelectric).

The permeability measurements serve to determine the tightness of individual construction components, and eventually pathways in the construction and of the rock surrounding the dam. For this purpose a lot of differential measurements are performed in test dam I.

Test dam II is utilized exclusively to determine the integral permeability without the use of instruments inside the dam. Therefore, pathways via instrument leads have to be avoided.

Boreholes are drilled from the traversal drift for the installation of extensometers, inclinometers and stress monitoring stations which are to register the stress-deformation behavior throughout the entire test period. Furthermore, small flat jacks are inserted between the construction components and between the surrounding rock and the construction in order to determine the pressurization capacity of the rock as well as the pressure transfer through the construction. Moreover, temperature measurements are carried out in the construction and in the surrounding rock.

Changes in the strain-stress field or dilatancy respectively in the near field of the test dams are located by means of geophysical measurements. Two microseismic arrays and geoelectric profiles are installed in the surroundings of the test dams to determine the spreading of brine.

The measurement results are required for comparison with FEM-calculations and for the long-term safety analyses for a final repository in rock salt.

Rock Mechanical Computations

Numerical computations concerning the load-bearing capacity of the dam, as a prior condition of its safety, are of particular significance because the licensing procedure for

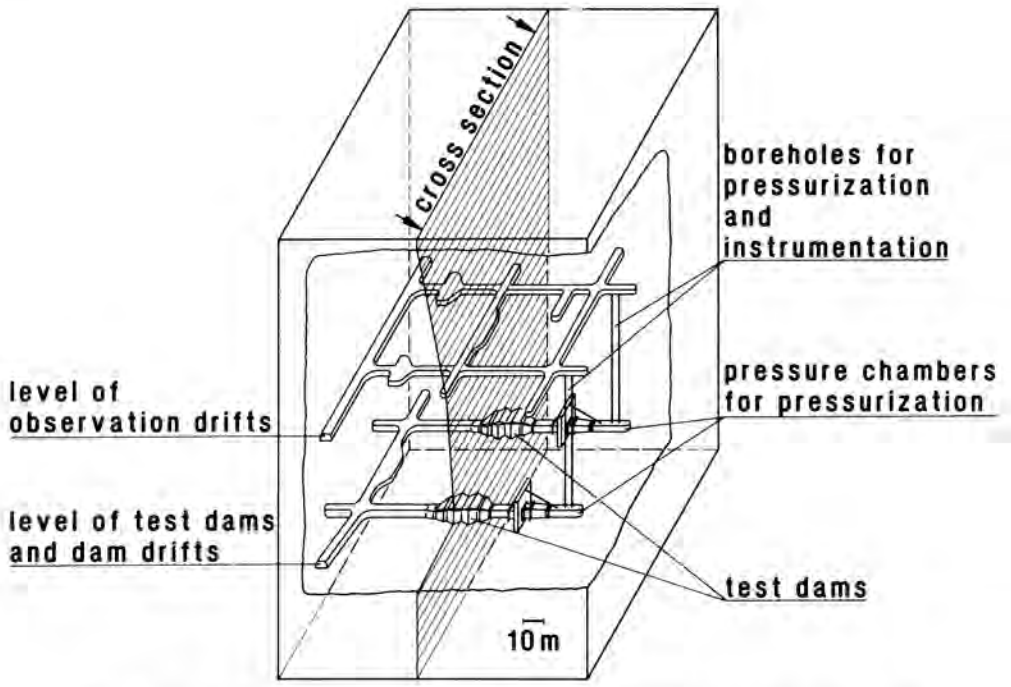

Fig. 3. Diagrammatic Sketch: Position of the Dams I and II in the Test Field.

the permanent repository requires a prior reliable and convincing demonstration of safety.

The main objectives of computer simulations, carried out by the BGR, on this aspect are:

-Assessment of the functions of the dam construction through design supporting computations,

-presentation of predictive data for better interpretations of measurements,

-model validation and demonstration of stability and

-demonstration that the test results can be applied to the Gorleben permanent repository for radioactive wastes.

The results of all the investigations and computations are planned to be available already for the licensing procedure Gorleben in the mid-nineties.

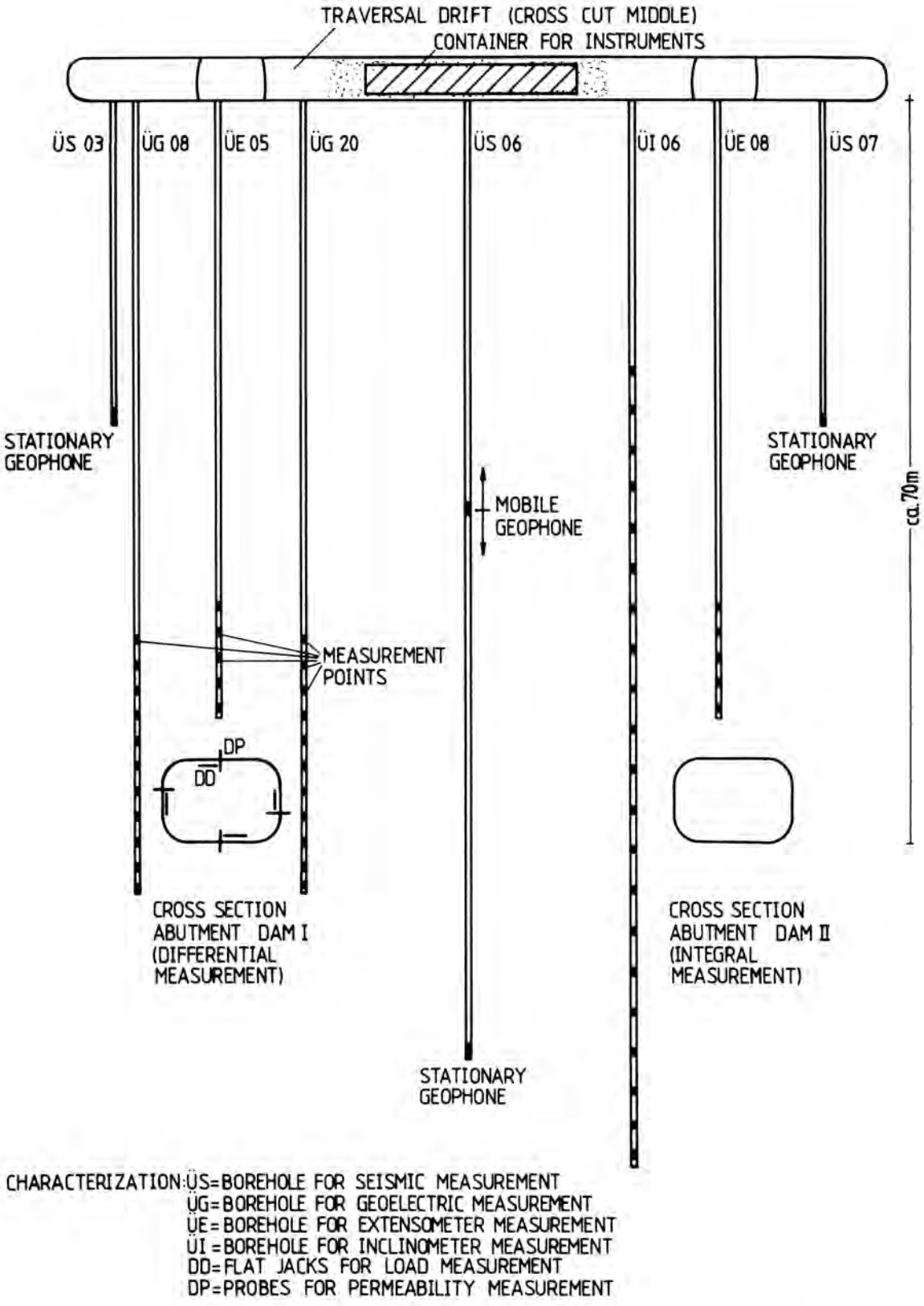

Fig. 4. Cross Section of the Dam Test Field(see Fig. 3) with the Instrumentation