DIFFICULTIES ARISING FROM THE INTERACTION BETWEEN THE EMBANKMENT AND THE FOUNDATION AND REMEDIAL MEASURES

DIFFICULTES PROVENANT DE L'INTERACTION ENTRE LA LEVEE DE TERRE ET LA FONDATION – LEUR REDRESSEMENT

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Many embankment failures have been caused by the interaction between the embankment and the foundation. Such failures are usually considered as foundation failures.

The three different foundation types – rock foundation (especially soft rock), permeable soil foundation and soft foundation – each have their characteristic difficulties.

Most problems of interaction are related to seepage conditions. A soft foundation may cause cracking, whereas soft rock and permeable soil may result in internal erosion, piping and bulk heaving. Some of the problems may be due to a combination of different effects.

As foundation conditions vary from one place to another it is difficult to cover all the different conditions with site investigations and laboratory tests. The seepage conditions in the foundation are allways different from those that prevailed before the dam was constructed and the water level was raised. As the seepage pressure will be higher than before, it is imperative to ensure that the interaction between the embankment and the foundation and between the different foundation leyers is correct.

As to the interaction between the embankment and the foundation, there are two different design options to ensure the proper conditions. One is to make the embankment and the foundation act separately by constructing a conrete slab or other tight structure between them. The other is to make the foundation serve as a filter for the embankment, for instance, a soft rock face on the dry side of the cutoff can be covered with a filter structure. Seepage problems can also be handled with an upstream blanket or relief well on the dry side of the embankment. In the rock foundation the grout curtain will reduce the seepage of water through the foundation. Close attention must be paid to the interfaces of the curtain. Care must be taken that concentrated seepage or leaks cannot initiate piping at the ends of the curtain. Likewise care must always be taken whenever then the dam structure undergoes changes. Segregation of the dam material and the solubility of the foundation material must also be taken into account.

A typical case illustrating the difficulties that can arise from the interaction between the embankment and the foundation is the Teton dam, where a cutoff trench was made into the rock foundation, and the failure was caused by piping.

Another example of the difficulty caused by the interaction between the dam and the foundation is the Uljua dam in Finland, (which was reported at the ICOLD Congress in Vienna in 1991) (Fig. 1), where piping occurred in a glacial till foundation and weathered bedrock. In this case, reconstrunction of the dam (Fig. 2) included grouting, a bentonite clay mattress and enlargement of the core structure (Kuusiniemi 1991).

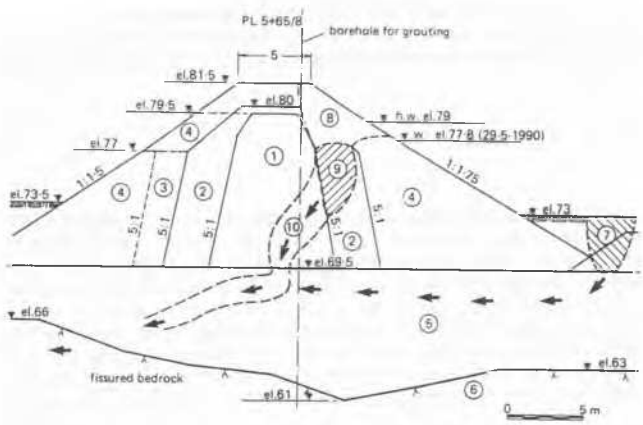

Fig. 1. Uljua earth dam. Cross section of the dam failure, where: 1 = core of glacial till; 2 = filter of sandy gravel; 3 = coarser filter; 4 = supporting rockfill; 5 = glacial till; 6 = weathered bedrock; 7 = crater; 8 = sinkhole; 9 = cement and grouting equipment; and, 10 = gravel tube.

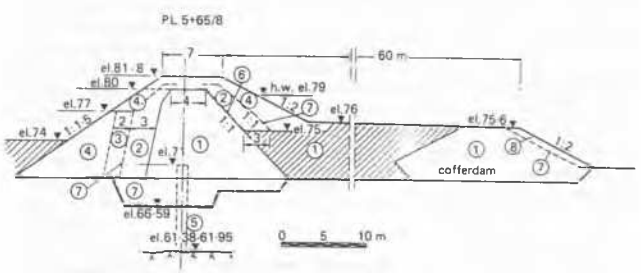

Fig. 2. Uljua earth dam. Cross section of the reconstructed dam, where: 1 = core of glacial till; 2 = filter of sandy gravel; 3 = coarser filter; 4 = supporting rockfill; 5 = diaphragm wall; 6 = bentonite clay mattress; 7 = geotextile; and, 8 = riprap.

REFERENCES

Kuusiniemi, R., Internal erosion of the Uljua earth dam. 17th ICOLD Congress, Vienna, Austria, 1991, Q65, Vol. 5.