Injection Grouting

Wimbleball Dam

SOMERSET, UK

Remedial grouting works to buttress dam

Introduction

Bachy Soletanche Ltd., were employed by South West Water as main contractors to carry out remedial grouting in an attempt to mitigate the gradually increasing flow of water through a 28 year old grout curtain. Although the dam was in no danger of failure, the flow of water under the dam foundations would, if left unattended, have inundated the relief well system and interconnecting conduits, a consequence of which would be flooding of the turbine and valve halls located within the dam. Of particular concern was the environmental impact that the works might have on the surrounding countryside and river systems, particularly the multi-million pound fish farm located one mile downstream of the dam, in the event of grout seepage into the drainage network. Consequently the operations were tightly controlled with a full time monitoring team established to perform regular water quality tests.

Upstream view of buttresses of Wimbleball Dam

CLIENT:	South West Water
MAIN CONTRACTOR:	Bachy Soletanche
CONSULTING ENGINEER:	Kellogg Brown & Root
DURATION OF WORKS:	5 months

WORKS QUANTITIES

Drilling	1000 l m
Grout injected	350 cu. m
Computer design and control of grouting	
Water testing	
High penetration stable grouts	
Water quality monitoring	
Protection measures for pressure relief system	
Correction of drainage flow pH values	

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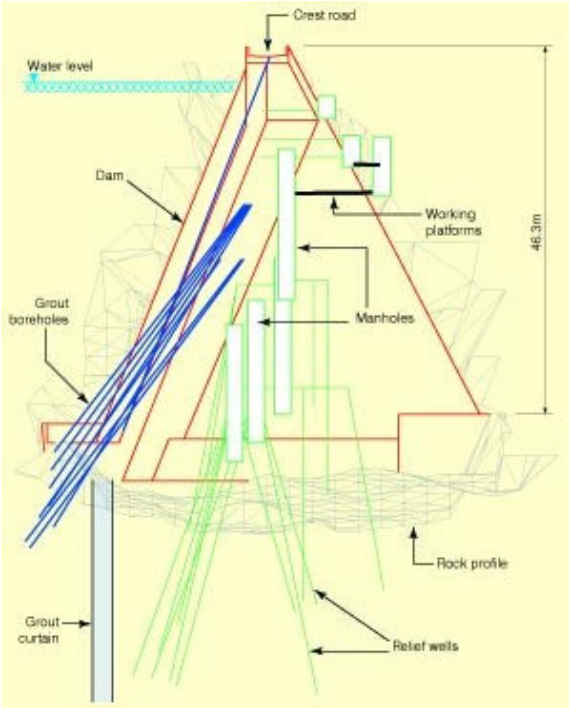

View along crest of dam

Design

Long term monitoring of the pressure relief well systems had identified a zone beneath 3 of the southern buttresses as the principle area of increased seepage through the original grout curtain. The increasing flows were attributed to progressive wash out of material from existing clay and/or grout filled fissures. Detailed study of photographs of the original rock excavation photo indicated the presence of joint sets and stress relief fractures that may not have been intersected and treated by the original curtain boreholes. For the remedial works 3D modelling of the complex dam geometry and borehole alignment was needed to target the boreholes upstream of the dam foundation and the existing but ineffective grout curtain.

Ground Conditions

The poor quality of the underlying rock towards the southern end of the dam was well documented both from the original dam and grout curtain construction (1975-79) and from subsequent attempts at mitigating the seepage through the original curtain. However, the exact locations and extent of the seepage paths through the rock were unknown at the time of commencement of the work on site, and could only be inferred from seepage monitoring. During grouting operations it became evident that there existed an extensive network of open interconnecting fissures passing through the original grout curtain, and linking together the various groups of pressure relief wells.

So poor was the rock quality in some areas that the injection of grout under low pressure diverted seepage flows by up to 40m to other relief wells.

Construction

Drilling and grouting operations were executed from three locations. Two of these were between the dam buttresses at a level of 25m below the reservoir head, requiring holes to be drilled through blow out preventers, and the third location was on the crest road 5-6m above reservoir water level. Once the drill rig had been set up in the correct position a hole was drilled through the concrete buttress and dam foundation (average depth 25m) and to the base of stage 1 in the rock.

Grouting was carried out by traditional descending stage methods, commencing at the dam foundation and progressing stage by stage to full depth of the borehole, with typical stage lengths of 3-5m, and with 6-8 stages per borehole. Within each drilled stage a modified, stable, cement-bentonite grout of low water cement ratio but high penetrability was injected. Injection grouting was carried out using a computer controlled electro-hydraulic grouting unit, the grouting instructions being downloaded daily from the site office computer to the grouting unit computer. Each injection was then fully automated in line with the given instructions, such that the injection was stopped once the pre-determined injection parameters had been reached. This gave an increased level of accuracy and control over traditional methods, vital on such a sensitive project. In some cases no increase in grout pressure was observed during injection,

clearly indicating the extent of fissures within the rock. To ensure that the relief well system did not become inundated with the grout, and thus contaminate the water flow into the downstream river, pneumatic packers were installed in various drains and relief wells during the grouting operation. As many of these drains were located 20m or so below the ground, access and subsequent work inside the chambers called for our labour to be trained and equipped to work in confined spaces. During grout injection, tests on pH, conductivity, temperature and solids content were carried out at each drain location to monitor the area of influence of the grout as it was injected. This monitoring gave valuable insights with regards to the interconnectivity between the location at which the grout was injected and where it subsequently appeared at the relief drains.

A cross section through the dam and work area is shown above. This is taken from the 3-D model and shows the upstream position of the grout boreholes relative to relief wells, manholes and working platforms.

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