

Conference reports

The 1st Symposium on Geotechnical engineering and the dams “problems and solutions”, Iraqi

The Iraqi Scientific Society of Soil Mechanics and Foundation Engineering held the 1st symposium at Ninawa governorate in cooperation with Civil Engineering Department/Al-Mosul University and the directorate of Mosul dam for two days from 13-14/3/2019. The symposium was held under the title of (Geotechnical Engineering and Earth Dams: Problems and Solutions). More than 120 members of the society attended this important symposium. This symposium was devoted to investigate worries over Mosul dam. The program of the 1st day included three sessions, the first session started with speech of Prof. Dr. Qusay Al Ahmadi / President of University of Al-Mosul followed by speech of Dr. Mahdi O. Karkush/President of the Iraqi Scientific Society of Soil Mechanics and Foundation Engineering. Then followed by a presentation about Mosul Dam presented by the expert Eng. Riyadh Al-Naemi/Mosul Dam Manger.

The second and third sessions included presentation of nine papers related to the behavior of gypseous rocks, dissolution of gypsum and anhydrite, and effect of dynamic loads on dams. The three sessions continued from 10 to 1:30 PM. Since Mosul city is located near one of the largest earth dams, Mosul Dam, and since most of the problems in the earth dams are considered very interested for geotechnical engineers, so the second day of symposium devoted to visit the Mosul dam by the society members and this day includes five presentations about the renovation of the dam, the geological of the dam, the grouting mechanism with the devices used and the new technology used in grouting. A lot of useful information and details are illustrated by the engineers and the experts of the dam. After this session the recommendations of the symposium were Announced. The members of society visited the grouting tunnel and examine the operating of grouting and mechanism with many practical details by the engineers was presented. Free tour to the reservoir of the dam and saw the amazing view and visited the outside grouting machines. Assembly photo in front of the administration building of Mosul earth dam is shown in Figure 1.

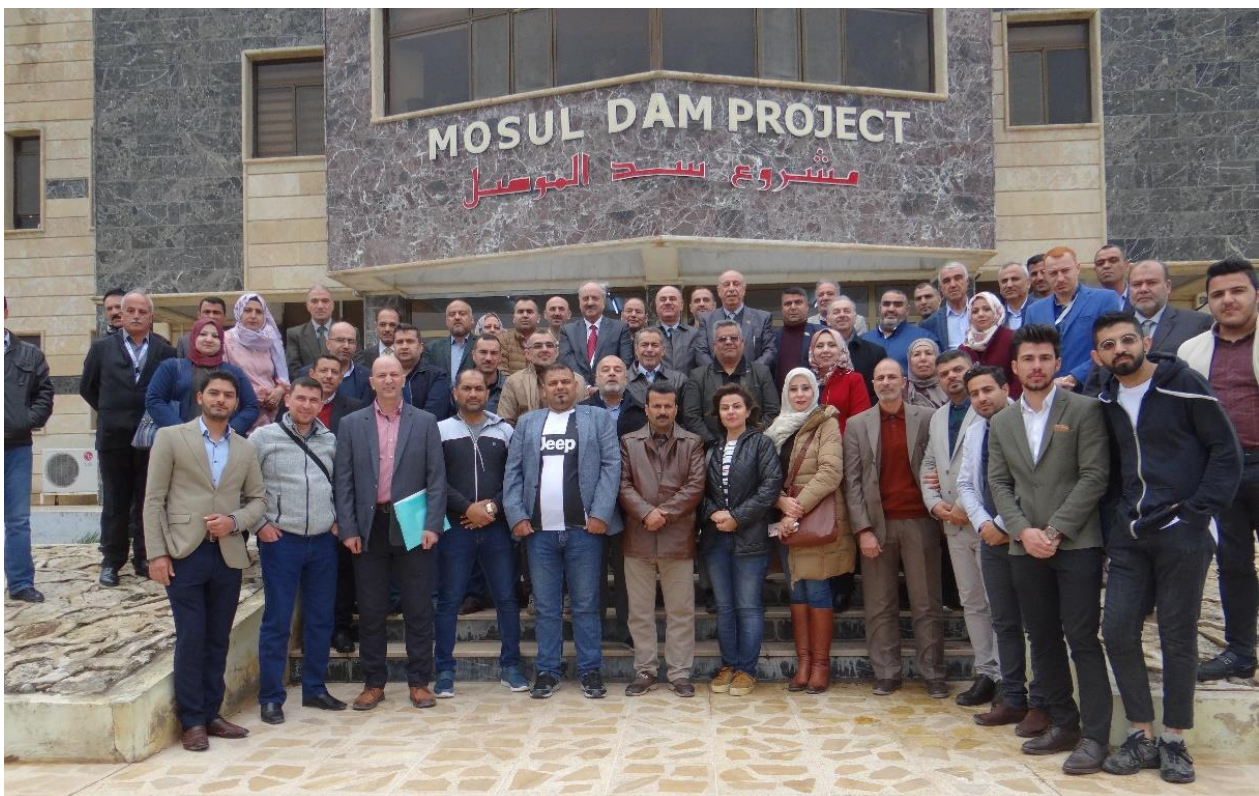


Figure 1: Assembly picture at the Mosul earth dam.

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Mosul dam was planned in 1950 to 1978, the geological investigation of Mosul earth dam continued by specialized companies to survey wide area in the north of Iraq. The last of which was a Swiss company approved the possibility of establishing the dam in its current area under a strict condition of a very intensive monitoring of the solubility of gypsum and anhydrite which could causes any defect in the foundations of dam. This should be followed by an immediate and quick treatment by cement/bentonite grouting. Hence, the grouting was planned to continue with the design life of the Mosul earth dam. The reason for this decision is the geology of the dam site which composed mainly of a highly variable strata of sedimentary rock consist of a highly soluble rocks of gypsum and anhydrite, with stratified layers of marl, and limestone. The present of such stratum in the foundation of hydraulic structure make the foundation becomes somewhat sensitive and require a continuous follow-up and raises the worries about the stability of the dam concerning the safety and performance.

The construction of dam started on 29/1/1981 and finished on 24/7/1986. Mosul dam is a large earth dam of length 3600 m and maximum height of 113 m. The full capacity of the dam is 11.11 billion cubic meters at a level of 330 m.a.s.l and the area of storage lake is 420 km². The elevation of top crest of the dam is 341.8 m.a.s.l. The current storage of the dam is 8 billion cubic meter and the height of water surface in storage lake is 322 m above the sea level. This dam designed for multi functions: storage of water, prevent the risk of flooding the cities in the downstream, producing electricity, and recreational area. The dam was designed with a more than 100 m depth grouting curtain located in the central longitudinal axis of the dam. The location of Mosul dam is shown in Figure 2.

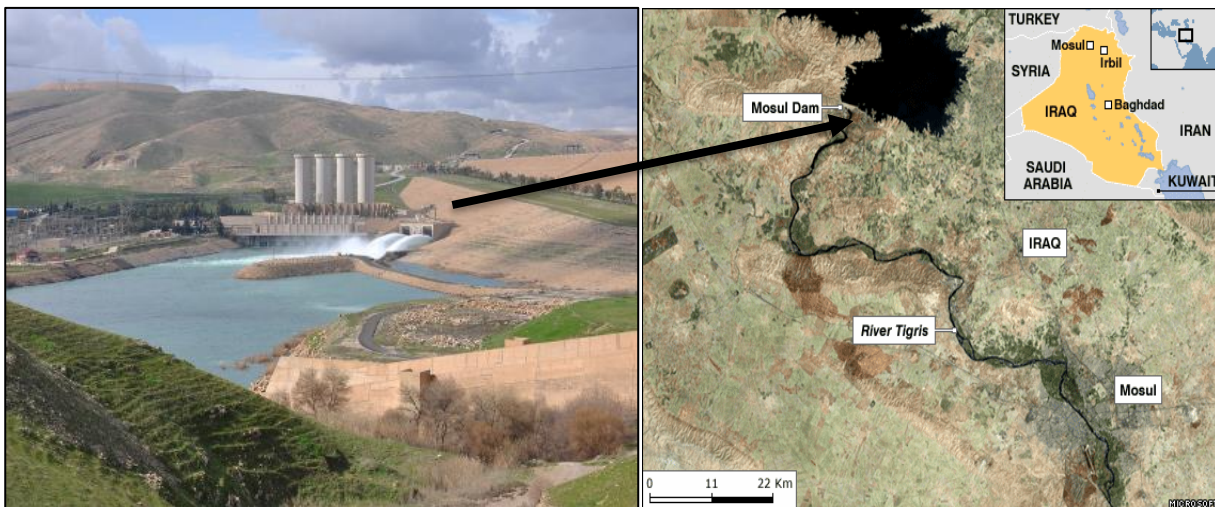


Figure 2: Location of the Mosul dam

The Mosul dam was constructed on highly variable strata which consist of gypsum, anhydrite, marl, and limestone, each of which is soluble in water under the hydraulic conditions of the dam at a faster rate than natural geologic processes. The presence of such stratum in the foundation of hydraulic structure make the foundation is very poor and raises the worries about the stability of the dam concerning the safety and performance. Increasing the storage capacity of the dam will increase the weakness of the dam foundation resulted from the dissolution of gypsum, anhydrite, marl, and limestone. A mineralogic variability within rock units resulted from original depositional processes that created interfaces and zones of weakness within individual beds, the geological strata under the dam are shown in Figure 3.

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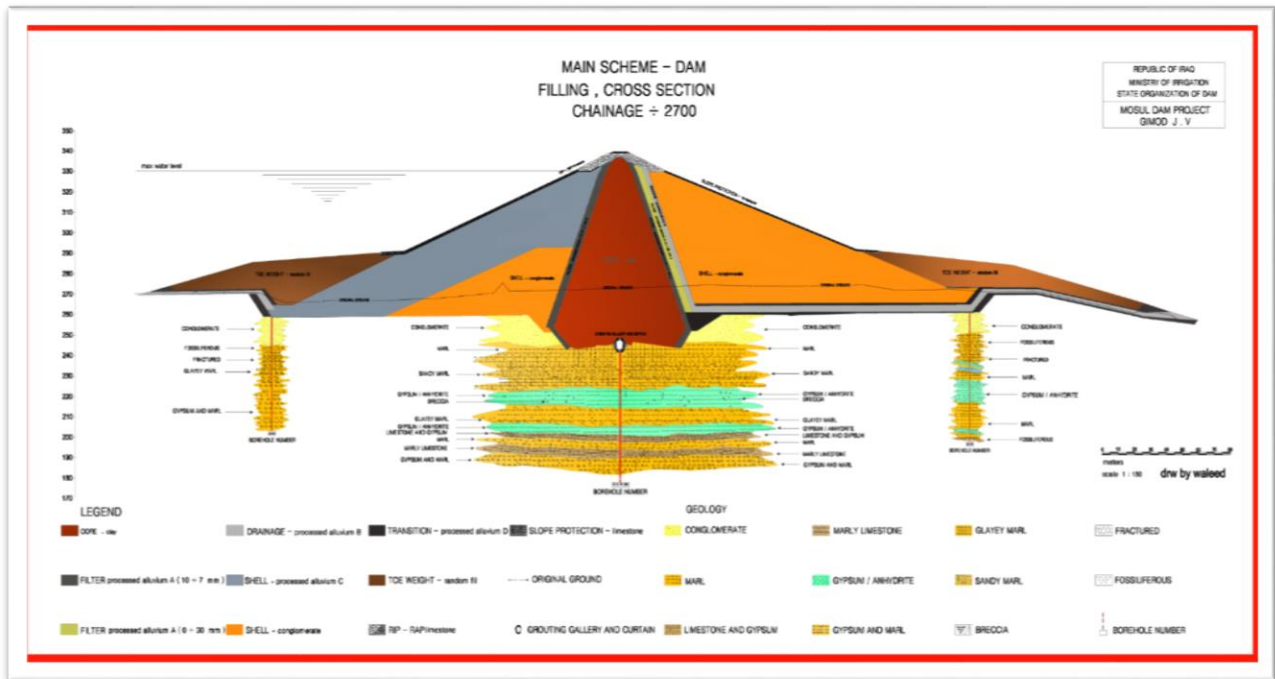


Figure 3: Geological strata of Mosul dam

The dam suffered from a delay in conducting the grouting operations because of the conditions experienced by the country and the most recent one was the occupation of the dam area by ISIS in 2014. This was accompanied by the presence of a few numbers of relatively old instrumentations of monitoring and surveillance sensors. One of these serious problems was takes place four years ago, sinkholes have reached the surface on the east abutment indicated a large-scale dissolution in the subsurface. The Iraqi staff of Mosul dam enabled from treating this big problem by dropping rocks of large diameter made in chain form inside the sinkholes and then covered with concrete.

The problem of the dam foundation can be controlled with continuous grouting. The grouting process did not attract the attention of specialists and political decision makers after 2003 and especially during the year 2014 due to the security situations in Mosul, therefore, the problem of dissolution of gypsum rocks increased rapidly. After that, the effort of political Iraq government supported by the US Army Corps of Engineers focused on this problem in 2016 and awarded the work of evaluating the hydraulic situation and performance of the dam to an Italian company. This company started the work immediately by collecting geological and hydrological data and put a plan to continue the grouting process and monitoring the foundation of the dam by installing different types of instruments used to measure the hydraulic head, cavitation, rate of gypsum rocks dissolution and vertical settlement of the dam. Nowadays, there are more than 1500 instruments and sensors installed in different locations of the dam for monitoring the hydraulic and geological conditions of dam. The grouting process is continuous for 24 hrs./day, electrical rigs used in the tunnel inside the dam and diesel rigs are used in the open area as shown in Figure 4. A digital software is used to prepare the grouting mixture and injection process. Also, a photogrammetry technique is used to evaluate the efficiency of the grouting process. The grouting depth is increased from 100 m in 2000 to reach 150 m in 2019.

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Figure 4: Drilling inside the tunnel and on the body of Mosul earth dam.

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