

Background

As part of its preparedness activities, the Logistics Cluster has been working on emergency preparedness for a potential Mosul Dam incident since May 2016. A previous mission was conducted on 17 August 2016 to enquire about the key indicators at the Dam. Following the continued preparedness planning activities of the Logistics Cluster, a subsequent mission was planned with the added participation of the World Food Programme (WFP) emergency preparedness function. The joint mission of Logistics Cluster and WFP took place on 30 March 2017.

List of Meetings

Mosul Dam officials: Mr. Riad Ezzulddin al Naemi (Mosul Dam Manager) and Mr. Mohsen Hassan (Mosul Dam Deputy Director).

Trevi Geo Engineering: Pierluigi Miconi (Project Manager) and Aldo Longo (Security Manager).

Figure 1: The bottom end of the spillway, showing the power generation water storage and the bottom outlets.



Purpose

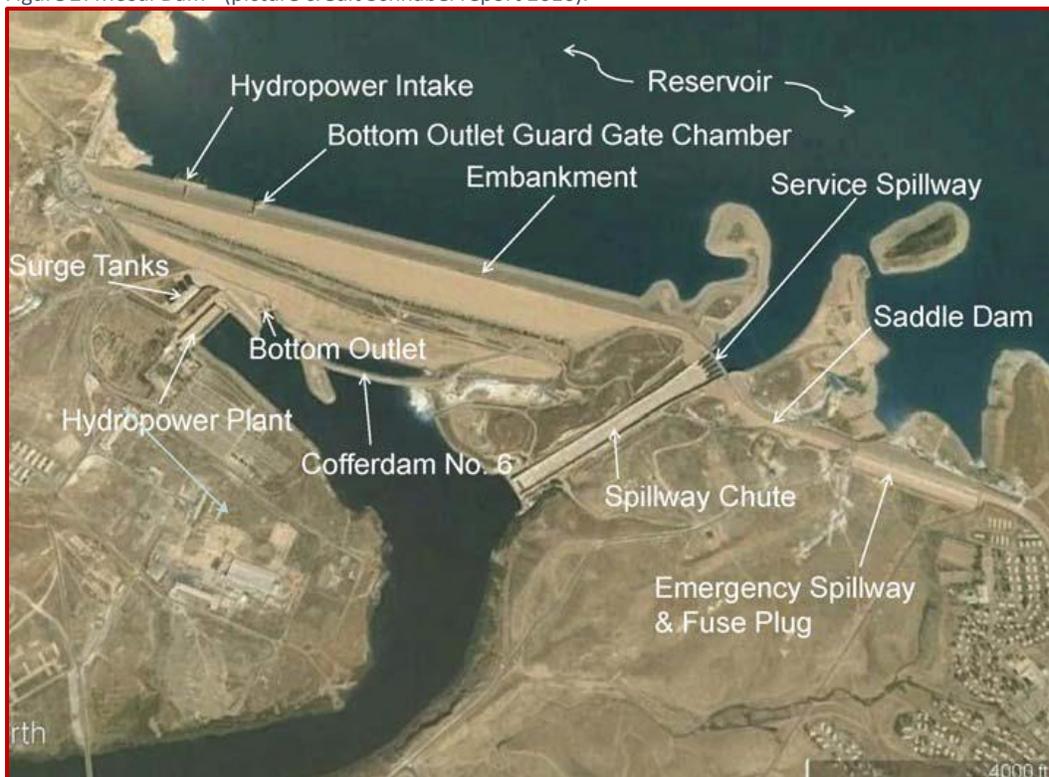
The aims of the mission were as follows:

- Obtain details and updated parameters on the management’s current risk perception of a Mosul Dam breach and an update on the progress of repairs that were commenced by Trevi Geo Engineering in October 2016.
- Promote greater information sharing between the Dam management (in particular with Trevi) and the Logistics Cluster/WFP on the status of Mosul Dam.

Specific issues raised with the Dam management during the mission were:

1. Movement and settlement of the Dam and grouting gallery;
2. Visible sinkholes;
3. Inoperable left gate;
4. Work of Trevi;
5. Level of water and discharge;
6. Water seepage;
7. Power generation;
8. Badush Dam;
9. Early warning systems.

Figure 2: Mosul Dam - (picture credit Schnabel report 2016).



Information Provided by Dam Manager

The Dam manager emphasised that all readings from the instruments in place indicate that the Dam is in good condition and improving due to Trevi's work currently being done at the Dam. A Geostatic Survey was finalized in March 2017 utilising satellite imagery and revealing satisfactory parameters for the Dam in general. This finding is corroborated by more than 1,250 piezometer sensors positioned around the Dam. See below for further detailed observations.

Water Levels

The Mosul Dam has a cross section length of nearly 800 metres. The main Dam is 3.6 kilometres long with a maximum height of 113 metres. The maximum water retention is 330 Metres Above Sea Level (MASL), and the reservoir capacity at that level is 11.11 billion cubic metres of water. A maximum level of 319 MASL has been set as a precautionary measure in collaboration with the Ministry of Water Resources, and the water level at the time of the visit was 310.14 MASL. This has been done in order to create a contingency buffer of around 9 MASL during the melting of winter snow and subsequent raising water levels. The intention is to keep the level to a maximum of 319 MASL, which is higher than it was maintained at last year. The need for water in the area in summer is immense.

Current Intake and Discharge

The current intake in the Dam is 800 cubic metres per second. Notably, this is at a five year low and almost half of the normal intake. The reason given by the Dam manager for the reduced level of intake is the plethora of dam activities occurring in Turkey along the main Tigris and all tributary rivers. From June to July, the Dam manager forecasts that the intake could be as low as 50 cubic metres per second. The current discharge is 500 cubic metres per second; Mosul city alone needs 150 cubic metres per second.

Settlement of the Dam

There were concerns raised about the bottom gallery sinking in previous assessments of the dam, perhaps indicating structural problems. The geostatic survey seems to indicate that no worrisome settlement is taking place in the Dam. The original design was meant to accommodate an overall settlement of 3.4 metres. The total settlement so far since 1985 is 18 cm, well below the parameters, and the amount of settlement from the crest of the dam to the bottom of the grouting gallery is 88 cm, also well within the design parameters.

Power Generation

The Dam has four power generators within the hydro plant; they are currently only supplying the Dam facility with power as the Government has cut off the supply to Mosul city for the duration of the military operations.

Bottom outlets

The left gate that was out of work during the last visit was fixed by Trevi in October 2016. The gates are currently undergoing maintenance and only one

of them is operational, but once the maintenance is finished both are expected to be operational.

Seepage

Previous reports (Schnabel) confirmed seepage indicating leakages through the ground. New instruments have been placed along the seepage channels and monitoring is being done continuously with the instruments reporting data every ten minutes. According to Dam officials, no alarming data has been transmitted about the seepage outflow (the flow is within expected parameters).

Figure 3: Seepage measuring instruments (real time feedback).



Grouting

Grouting has intensified since Trevi commenced operations, with eight rigs in the grouting gallery now being operated by Trevi and two grouting stations being operated by the Iraqi authorities outside the gallery (to the left of the spillway chute and the fuse plug). Trevi is also operating a grouting station near the embankment. The current grouting is happening at two levels, at 60 metres along the lake and down to 125 metres below the grouting gallery.

Samples have been taken from a variety of locations at a depth of 150 metres and grout was found at those levels indicating, according to management, an effective grouting operation.

Sink holes

According to the management of the Dam, no new sink holes have been discovered since the last visit (17 August 2016).

Badush Dam

The team enquired as to the status of Badush Dam, and whether there were plans to reinstate the building of Badush Dam following its liberation to act as a precautionary measure in the case of Mosul Dam collapse. The Dam manager informed that a new study of Badush Dam has been commissioned to review the possibility of Badush Dam construction.

Early Warning Mechanisms

The Dam manager informed that UNDP have assisted the Iraqi Government in installing sirens and an alarm system to alert if the Dam is at imminent risk of collapse. The system is connected to the Governor of Ninewa and the Ministry of Water Resources. In the event of an imminent breach, a clear system of communication has been set up to relay the alert to the relevant Government authorities and security mechanisms, following which an official request for assistance could be made to the United Nations. A meeting between the Logistics Cluster, OCHA and the Political Advisor to the Prime Minister took place in Baghdad on 23 August 2016 where it was agreed that in case of a Dam breach, the Government will implement the emergency protocols to facilitate the delivery of assistance to Iraq.

The role of Trevi

Trevi has started full operations on the Dam. They have eight grouting rigs in the gallery and three more grouting stations in the embankment, as shown in Figure 4. According to the Dam manager, Trevi has introduced valuable technology and software services that will make the Dam maintenance operations more effective and efficient. A new specifically-designed software has been introduced by Trevi to allow for better monitoring and management of the water flow and pressure of the grouting operations. In addition, Trevi has introduced instruments into the grouting machines that allow a camera to be inserted into the grouting hole to determine the effectiveness of the grouting operation without the need for the expensive and cumbersome sample extraction method used earlier. Trevi is also training the Iraqi engineers and staff to maintain the Dam without their support and have introduced small changes to the grouting mix. The current contract for Trevi expires on 27 November 2017 and it is expected that the equipment left behind will be operated by the Iraqi maintenance crew who are currently working side by side with Trevi.

Figure 4: Trevi grouting on left side of embankment.



Recommendations

The recommendation for the Logistics Cluster and UN agencies is to continue developing an emergency plan and a concept of operations for the potentiality of a Mosul Dam failure, as well as to monitor the Dam water levels over the coming months. Although the information from Dam management is reassuring, the level of water now (above 309 MASL) is worrisome in the case that a disaster occurs, as the level of water is quite high and is likely to be higher in April, May and the beginning of June.

Figure 5: The power station and bottom outlets.

