Mosul Dam Mission Report

17 August 2016

Background

As part of its preparedness activities, the Logistics Cluster has been working on emergency preparedness for a potential Mosul Dam incident. Basing the work on the previous studies and efforts in this regard, specifically, the UNDAC mission and its report, the Logistics Cluster conducted a scoping mission to the Dam on the 17 August 2016.

The mission's purpose was to understand from the Dam officials their views regarding the structural threats present at the Dam.

List of meetings

Meeting with Ziravani security forces: including lieutenant colonel Nizar (head of Zarivani intelligence) and Brigader Major Bahjat Tamyes (brigade commander at the Dam).

Meeting with Dam officials: Riad Ezzulddin al Naemi (Mosul Dam Manager) and Mr. Hussam Deputy Director of Mosul Dam.

Figure 1: Picture of the Dam showing the bottom outlets and the power station

Purpose

The aim of the mission to the Dam was to get more information from the relevant authorities regarding the current conditions and the risks of failure to the dam, and the status of grouting, details of contract commencement with Trevi Company, and expected ways forward to ensure the stability of the structure.

Specific issues of risk as reported by previous assessment literature:

1. Voids beneath the grouting gallery
2. Visible sinkholes
3. Cracking and movement of the grouting gallery
4. Gypsum level in solution testing downstream
5. Inoperable left gate of the bottom outlet

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

Information provided by Dam manager

Mr. Riad provided the team with a historical overview of the Dam construction and challenges indicating that the Dam engineering is sound and that the threats being identified were well known during the design and building stage. He indicated that mitigating measures were taken into consideration during the initial phases of the construction and continue throughout the ongoing maintenance work.

Main Dam

The Mosul Dam has a cross section length of nearly 800 meters The main Dam is 3.6 Km long and the maximum height of the Dam is 113 meters. The maximum water retention is 330 Meters Above Sea Level (MASL) but the design can handle up to 340 MASL. The reservoir capacity at 330 MASL is 11.11 Billion cubic meters.

The grouting gallery

The grouting gallery at the bottom of the Dam is the location where most of the foundational grouting work is done. The length of the gallery is 2.16 Km, the width is 3 m and the height is 3.7 m. The gallery is subdivided into sections and has 11 rigs used for pumping cement. There is a bore hole every 1.5 m within the gallery and new holes are being drilled to look for any cavities or soft surface. The grouting pump is at a maximum depth of 110 m below ground, and it is believed that the deepest Gypsum layer is at a depth of 75 m.

Power Generation

The Dam has four power generators within the Hydro plant, which can produce at maximum capacity750 MW of electricity per hour. The discharge of water for each generator is 280 m^3 per second.

Bottom outlets

The bottom outlets are able to discharge 2600 m^3 per second at maximum elevation of 330 MASL. There are two doors compromising the bottom outlets of the Dam, with the left gate being currently out of work.

Spill way

The spillway of the Dam has five outlets and is able to discharge 5,750 m^3 per second at 330 MASL. The spillway only works when the water level is above 321 MASL. The Dam has been operating at 319 maximum lake levels since 2015 in order to reduce risks to the Dam.

Current discharge

Due to the low level of water intake, the current lake level is 311.13 MASL amounting to 5.2 billion m^3. The reported intake into the Dam is around 186 m^3 per second, making the power generators the only discharge needed at this stage. The director expects a drop of 10 cm every day in the water level until the intake picks up in the winter season. The month of March is usually the month with maximum intake, historically (around 2,075 m^3 per second).

Fuse plug

The fuse plug (otherwise known as the emergency spillway) is a gravity operated safety feature to prevent catastrophic overflowing in the dam; it is designed to allow water to come over it and discharge on a grand scale into downstream. The discharge through the fuse plug can reach 4,000 m^3 per second. This would happen at water levels in excess of 340 MASL which is not likely in the near future.

Figure 3: Grouting along the side of the Spillway Chute

Field Observations

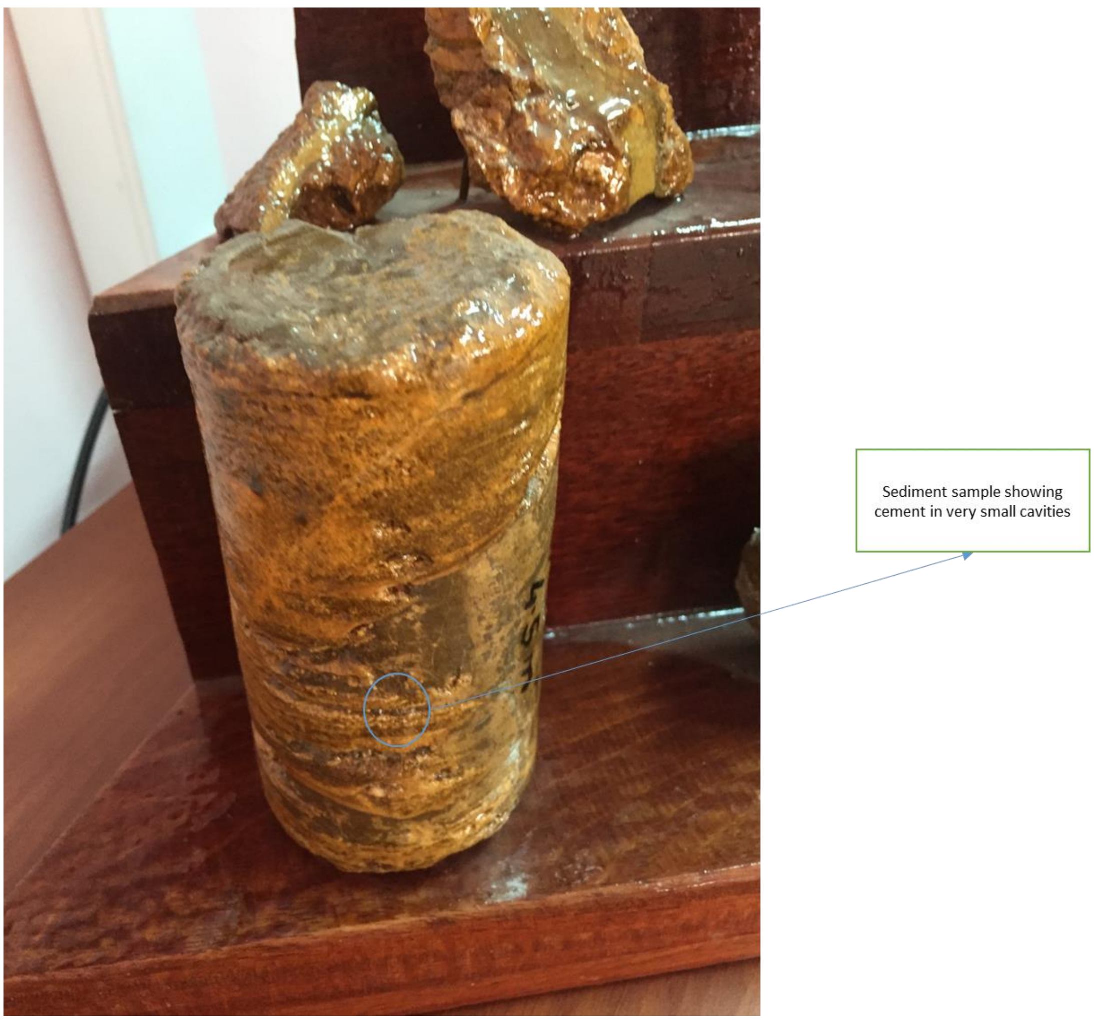
The Dam is secured by the Zarivani contingent and according to local authorities; the road to the Dam is safe, all except for a small patch of the road where the frontline is currently nearly a kilometer away. Most of the threat is from indirect fire and not IEDs. There has been no attacks on the Dam or shelling to the Dam in recent time and the threat does not seem serious. The Italian contingent was present and patrolling the Dam, although not all of the contingent is in place. The same goes for the Trevi team; according to the director the camp and accommodation facilities are being built and the procurement process for new Grouting rigs and instruments has started. New grouting work is being done along the spillway since some piezometer results indicated possible cavities in the ground. The power generators were working during the visit time and they supply the area with electricity. In addition, water to the Jazeera agriculture project continues to be supplied from the plant.

Answers to the specific concerns

The Dam Manger provided some additional information regarding the specific concerns mentioned earlier.

1. **Voids beneath the grouting gallery**
   The voids are natural occurrence due to the geological composition of the soil which has soluble layers below dam level. This risk is mitigated through grouting activities under the Dam. Due to extensive grouting activity regularly being implemented, the voids should not present any real danger to the Dam. The pressure being applied to pump the cement mixture is reaching the smallest voids as illustrated by available samples.

Figure 4: Sediment samples showing effect of grouting



2. Visible sinkholes

The Director pointed out on the model of the Dam that the sinkholes are present on the right side of the Dam, down the land bordering the channel produced by the power station; those sinkholes are caused by the water flow coming from beyond the lake, not directly caused by the Dam reservoir. The Schnabel report though indicates sinkholes development nearer to the Dam, but those were not commented upon during the visit. However, as mentioned before, grouting near the Chute alley has started.

Figure 5: Recent sinkhole development - Schnabel report 2016, p 20.

3. Cracking and movement of the grouting gallery

Reportedly instruments picked a movement in the dam of 1mm upwards and 4 mm downwards on 28 November 2015. However, the Dam manager stated that these movements are well within the acceptable margins and are not a cause for concern. He mentioned that there are more than 1,200 instruments measuring all the necessary parameters, and an additional 95 instruments installed by the Americans that broadcast information via satellite on a regular basis. The Dam management has access to these data and state that there is no cause for concern over any of the data so far.

4. **Gypsum level in solution testing downstream**
   The Dam manager mentioned that the piezometer results do not indicate significant levels of Gypsum and pointed out to the sample of sediments to demonstrate the effectiveness of grouting.

5. **Inoperable left gate of the bottom outlet**
   The left gate is a cause for concern as the bottom outlet are to be used to quickly lower the water level in the Dam in case of need; therefore, it is a high priority for the Dam management. The contract signed with Trevi has a provision to fix the gate as part of their expected outputs.

Figure 6: The power station and bottom outlets