Note on Geological Aspects–Kolidekh Artificial Lake Project, Champavat (Uttrakhand)

1. Background

The Kolidhek Artificial Lake Project envisages a 21m high (above foundation) and 125m long (at top) concrete dam structure across Lohawati River, near village Kolidhek in Champavat District of Uttrakhand. The reservoir/ artificial lake formed will be utilized for the purpose of drinking water, minor irrigation and for the promotion of tourism. The project is accessible from Lohaghat Town through Lohaghat – Devidhura road and is about 2 km from Lohaghat. The project area falls in Survey of India toposheet No. 63 C/3. The weir site is defined by geographical coordinates; longitudes 80°04'50.5" and latitude 29°24'3.2". The proposed length of the reservoir/ lake will be approximately 1.64 km and the total submergence area by the lake would be about 8.10 hectares. The total reservoir capacity at FRL is estimated to be 0.45 MCM.

2. Geology of the dam site

At the proposed dam site rocks are mainly exposed at the river bed and on the both banks along the river. The exposed rocks are hard, massive dark to light colored phyllites which belongs to Manila Formation of Kumaon Super Group. On the left abutment hard and massive grayish phyllites are exposed upto a height of about 1.5 to 2m from the river bed. Above these rocks the left abutment slope is covered by overburden material upto a height of 10 – 12m. The slope in general is gentle and is a barren land. The sub-surface exploration on the left bank at lower and middle portion of the proposed dam abutment reveals that thick overburden material comprising yellowish brown silt and clay is present upto a depth of 3 to 4m followed by layer of boulders of phyllites with a thickness of 2 m. Below this layer bed rock is present which is characterized as hard massive compact phyllites. The bed rock is slightly weathered upto a depth of 6 to 9m. The foliation plane in general varies from 40 to 60°. Near the extreme end of the proposed left abutment of the dam thick overburden material comprising reddish brown clayey silt with fine sand is present up to a depth of about 9m. Further below bluish grey to grey hard compact phillites are present. These phillites are moderately to slightly weathered for initial 30 cm thickness, beyond which they are fresh. The foliation joint in this reach dips at 60° and the rock in general is moderately to closely jointed. The rock quality designation (RQD) varies between 9 to 40%. Further, along the right bank at the dam site rocks are exposed along the river bed upto a height of about 2 to 2.5 m. In the lower reaches right bank slope is steep and thereafter it is moderately steep to gentle. In the upper reaches slope is covered by thick vegetation. The overburden thickness is about 2m which comprises reddish brown color silty clay. The bed rock is present at a depth of about 2m which comprises grey hard compacted phyllite. The rock is moderately to slightly weathered up to a depth of about 11m, beyond which fresh rock is present. The foliation joints dips from 50 to 75°. The RQD in general varies from 5 to 25%.

3. Geology of the reservoir area

The rocks present in the reservoir area are mainly grey hard compacted phyllites which belong to Manila Formation of Kumaon Super Group. The rocks are mainly exposed along the river banks up to a height of 2 to 10m. The exposed rocks generally strike N40° to 60°W – S40° to 60°E and dips 30° to 70° in North easterly directions. The major joint sets present in exposed rocks in the reservoir area are; N-S/55°, E - W/Vertical, N60°E - S40°W/60°SE, N40°E - S40°W/50°NW, N70°E - S70°W/60°NW, N45°W - S45°E/15°SW and N40°W - S40°E/50°SW.

4. Geological hazard due to reservoir impoundment

The main geological hazard associated with the dam reservoir projects is related to the stability problems of the reservoir rim slopes under anticipated adverse conditions. Any catastrophic slope failure in to the reservoir may result into wave generation which may overtop the dam and may possibly damage the structure and may result into flooding in the downstream region. Stability of the slope is concerned with the relationship between driving and resisting forces. Some factors contribute

for driving forces whereas others add to the resisting forces. Therefore, these governing factors are very important in defining the slope stability condition. The main internal governing factors are; geometry of the slope, slope material, potential failure plane/s characteristics, surface drainage and groundwater condition, whereas the external factors are rainfall, seismicity and manmade activities. These factors in combination will be responsible in defining the stability condition of the slope.

The main driving force acting on the slope is the gravitational force which is directly proportional to the slope inclination. Steeper slope will be more susceptible for instability. As the slope inclination increases, additional slope mass will add to the weight component, thus shearing stresses will increase and instability in the slope will be induced.

The proposed reservoir slopes of the Kolidekh project are mostly gentle along the left and right bank of the river (Plate 1). The slopes are mostly terraced and are covered by agricultural and barren lands. The right bank slopes near to the dam site and in the middle portion of the reservoir are partly covered by the forest land. The left bank slopes are relatively gentle, terraced and are covered by barren lands around the dam site, in the middle portion and in the uppermost portion of the reservoir (Fig.1).

Plate 1 View of dam site and reservoir area

Fig.1 Reservoir area of Kolidekh artificial lake project as seen through Google Earth image

The middle portion of the left bank and the upper middle portion of the right bank slopes are covered by the agricultural lands. Since most of the lands on the either banks of the reservoir are terraced and gently inclined slopes, the slopes in general are considered to be stable under anticipated adverse conditions. The slopes along the river banks in the lower most reaches are generally rocky and form steep sections of low height. In these sections possibility of isolated rock failure may exist wherever kinematic conditions would be satisfied. However, such small failure may not have a potential to generate destructive waves that may adversely affect the stability of the project. Moreover, these steeper rock slope sections would be partially or fully submerged under reservoir water. A horizontal thrust would be exerted by the reservoir water which may improve the stability of the slope. Further, during reservoir operation rising and drawdown may bring changes in the material properties, particularly changes in the shear strength that may affect the stability of the slope section within the fluctuating zones. The rising of reservoir will saturate the overburden material and the rock mass sections and on the same time a horizontal thrust will also be provided by the reservoir. During drawdown minor changes are expected that may possibly destabilize the slopes. However, it will depend on the slope inclination, slope material, landuse, kinematic conditions and the shear strength properties of the slope material.

5. Conclusions

Finally, based on the topographical and geological considerations, prima facie, it may be concluded that the filling of the reservoir may not affect the stability conditions of the reservoir slopes. Thus, there seems to be no possibility of generation of destructive water wave in the reservoir due to any major slope failure under anticipated adverse conditions that may possibly affect the stability of the dam. Further, in the reservoir area along the left bank three slope sections, marked as L1, L2 and L3 (Fig.1) may require slope protection works. These locations have habitations and a road section well above the reservoir level. Slope protection at these locations will add to the safety of these features.

The inference drawn in this note is based on the review of the Geological and Geotechnical investigations, as presented in the DPR and through the satellite image interpretation. No systematic detailed studies were made to come up with quantitative evaluation of ground conditions. However, suggestions/ recommendations are forwarded on various aspects, as specified above, relevant to assess the slope stability condition in the reservoir area of the proposed project.
