C-02: Hydraulic model investigation for evaluation of design criteria: Upper Kotmale diversion dam & intake

A D S Gunawardena, K S Jeyabalamoorthy
(Hydraulic Research Lab, Irrigation Dept, Colombo 7)

Upper Kotmale Hydropower project is located across Kotmale Oya at Talawakelle in Nuwara Eliya district. It consists of a 35.5 m high concrete gravity dam, intake structure, sand flush way, sand trap, 12.8 km long headrace tunnel and a surge tank. The catchment area of the reservoir is 310.6 km^2 and the effective storage capacity is 800,000 m^3 having an ogee type spillway consisting of 5 bays with radial gates (10m * 10m). The open channel type Sand flush way has a 5.5 m width rectangular section and its

channel gradient is 1/12.5. A vertical pressure shaft leads to an underground power cavern housing 2 Francis Turbines, the installed capacity being 150 MW having a maximum discharge of 36.9 m^3/s. The full supply level of the reservoir is 1194.00 m MSL and minimum operating level is 1190.00 m MSL.

The objective of the study is to evaluate design criteria for the spillway and the intake.

Model studies were carried out on a 1/50 geometric scale model to evaluate the design criteria of the spillway and the intake.

The hydraulic performance of the structure under different conditions including normal flow and flood flow were studied. The design discharge of 2000 m^3/s and the maximum probable discharge of 3300 m^3/s were employed for investigations under flood conditions.

In the movable bed model test it is necessary to have a similarity of bed materials and flow conditions in the river and the model. The average size (d_{50}) of river bed material deposited in Kotmale Oya is estimated to be 2 mm. According to the geometric similarity, model bed materials is equivalent to 0.04 mm. This size is too small to apply movable bed materials hence fine sand (d_{50}=0.2 mm) was used to analyse the phenomena of sediment movement in the reservoir, sand flush way and the sand trap. The results of these tests are qualitative.

Investigations were also carried out in respect of operation of weir gates, sand flush way, intake and sand trap.

When all the gates were fully opened under the design flood of 2,000 m^3/s, boiling was observed just upstream of the dam on the left bank due to the narrow river width and the meandering of the river stretch. This flow condition was induced by the outwards centrifugal force exerted on the flow at the meandered river stretch. The rapid surface flow before approaching the dam site runs towards the right bank of the river, i.e. the velocity at the concave side is bigger than that of the convex side. After passing the curved section, the direction of stream flow turns towards the left bank along the bottom of the pond and creates the boiling on the left bank. Finally, the

stream flow returns towards up stream of left bank and the boiling disappeared at the upstream of the dam. Under partial gate opening the amount of boiling was slightly decreased compared to that of full opening because the velocity in the pondage is comparatively small. The surface flow direction close to the dam is towards the down stream of the river.

The pressure distribution on the spillway overflow section measured under the full opening was below the allowable negative pressure of 3.0 m.

At F S L it was observed that the air is sufficiently entrained into the water entering sand flush way. The water flows over the submerged front wall and attacked the right side wall of the sand flush way. Then the water runs straight towards the sand flush conduit along the sediment guide wall. The pressure distribution along sand flush way soffit and invert satisfied the allowable maximum negative pressure of 3 m.

The flow pattern consequent to the construction of the structure was similar to that for the natural case where the bend effect could be utilized to locate a silt free intake hence no modifications to the right bank for improvements to other hydraulic parameters were considered.

Discharge rating curves as observed in the model are presented for all the different combinations of gate openings. The 10000 year frequency flood of 3300 m^3/s passes over the spillway at a pool elevation of 1194.0 m MSL when all gates are open.

The pressure distribution over the weir for the maximum probable discharge of 3300 m^3/s was within the allowable limits leaving no room for initiation of cavitation. Hence the weir profile was satisfactory.

The inflow channels were improved by effecting modifications to the side walls.

Sand flush way was satisfactory at the FSL and kept on improving as the water level went down 1190.0 m MSL (MOL).