# ABSTRACT

The Northern Areas of Pakistan are famous for its rocky mountain. These mountains stand tall on the sides of stream bed, form wide and narrow valleys which are abundant in one of the most important and cheapest natural resource “Water” for the power generation. The water conveying channels thus formed have steep slopes and drops which depict huge hydropower potential in this region. From last one decade, Pakistan is severely affected by huge lag of electric power between the demand and supply. Presently, development of power generation to overcome the power demand is one of the challenging issued faced by any government of Pakistan. Therefore it is the need of time that huge benefit must be achieved from one of the cheapest Source of electricity (Hydroelectric Power Generation) which is generously distributed in North West Frontier Post. To achieve this goal, thorough planning and proper site selection should be carried out in these areas which are rich in Hydropower potential as well as show huge irrigation and agriculture potential.

Kurram Tangi Dam is among one the schemes presently under consideration by Water and Power Development Authority (WAPDA) of Pakistan. The dam consists of two diversion tunnel to pass 991.1 cumecs flood during the event of dam construction. The physical modeling of Kurram Tangi Complex has been carried out. In order to make advantage of these diversion tunnels, it was proposed to convert one diversion tunnel into power tunnel by connecting it through an inclined tunnel/ shaft of 4267 mm diameter while the other tunnel will remain as such to accommodate the irrigation release under condition when it is not feasible to discharge water through power tunnel. The diversion tunnel has been modified to power tunnel via a power intake whose invert is about 9.14 m below the dead storage level. Power Tunnel Intake, dead storage level, normal conservation level and power tunnel invert before the entering to power house are at

El. 600.46, El. 610.09, El. 648.31 and El. 555.96 respectively. Tunnel is supposed to meet the water shortage during Rabi Season by delivering 42.76 cumecs and 31.72 cumecs during Kharif and Rafi season respectively. There are five power houses in the Kurram Tangi Dam and the scope of the study is confined to the evaluation of hydraulic performance of power tunnel for Power House #1.

The study is carried out to evaluate the controlling parameter that may contribute to the Hydraulic Performance of Power tunnel like major and minor losses in tunnel, vortex formation, cavitations, aeration demand for power tunnel and tunnel operation. This will help to ascertain the hydraulic behaviour of power tunnel and hydropower potential will be assured.

Physical modeling is carried out to simulate the effects of above mention variables governing the hydraulic performance of the power tunnel. Keeping in mind all the limits and guidelines, firstly a physical model of scale ratio of 1:30 was constructed in the Model Tray Laboratory of Center of Excellence in Water Resource Engineering premises. Unfortunately this model collapsed during its operation. The damage to the model and the vicinity was such that it was unable to be repair. Subsequently a new model constructed in Hydraulic Laboratory at 1:70 scale due to space constraints The new model was fitted to the size of existing rectangular flume which was 610 mm wide and 635.33 mm high. The invert level of the power tunnel was raised by 6.71m. Thus the power tunnel invert was shifted from El .556.26 to El. 562.97.

Prototype flow regime in the model corresponds to low Reynold's number. However, flow regime in the model in fully rough turbulent zone. The results depicted that the major and minor losses in the power system were more than losses calculated on theoretical basis. The surface roughness of model was towards higher side while the modelling simulation demands that it should be quite smooth. The flow regime in model just entered the rough turbulence zone but Reynold's number is less than $10^6$, therefore the model results will be some what towards lower range.

The loss of coefficients for entrance came out to be 5.7% while in the design procedure the adopted value is 10%. The tapered enlargement and bend loss coefficient did not come up with a reliable figure ($\zeta_b$ = 0.15 % and $\zeta_t$= 0.34 %). One reason for this discrepancy may be the incapability of physical model to detect hydraulic head correctly. In the case of bend loss coefficient, may be the bend geometry was capable enough to minimize the pressure head loss or it was inability of the model not to detect the pressure head loss correctly.

The intake was prone to vortex formation. Although the water seal provided to suppress the vortex formation was more than the minimum critical submergence criteria formulated by a number of renowned researchers. A reason may be because the intake is a bit inclined to the horizontal which was more susceptible to water seal. During model investigations at design discharge by varying reservoir water level, the intake was found to be free from vortex formation at El. 613.26.