Two sets of stepped spillways are experimentally studied for a range of discharges with critical depth/step height \((d/h)\) in the range of 0.4-5. The slopes of the step are of 45°, 30°, 20°, and 15° respectively, with the total drop heights of between 2.5 m and 0.47 m. These data are analysed and compared with other investigator's results to evaluate the onset and flow resistance of skimming flows under equilibrium conditions, and the time-averaged pressure on the step face. The relationship between the maximum time-averaged pressure, the flow rate, the total drop height, and the step height of the spillway is introduced. The patterns of dimensionless pressure distribution on the step face are determined. In addition, the relation of the flow friction factor and the maximum pressure acting on the step face in a dimensionless form is proposed.