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Effect of submergence on flow characteristics and accuracy of measurement in semi circular contraction critical flow flumes

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ABSTRACT : Precise water management needs the irrigation water to be accurately measured and regulated at all important points in an irrigation system. Due to flatter gradients in fields, submergence is the major problem in irrigation channels, which affects the accuracy of measurement. To study the effect of percentage of submergence on flow characteristics like critical depth, location of critical depth and accuracy of measurement, the experiment was consisted with three different contractions (20%, 40% and 60%) were tested with three different discharges (10 ls^{-1}, 14 ls^{-1} and 18 ls^{-1}) and at four submergence levels (60%, 70%, 80% and 90%). Semi circular contraction critical flow flumes can be used for discharge measurement in open channels with best accuracy of ± 5 per cent. A single measurement of end depth in semi circular contraction critical flow flumes can be used for discharge computation through developed equations in open channels, if the submergence conditions are below 80 per cent in general. The side contracted flumes are found to be sensitive to higher submergence conditions (90%). The flumes can be easily fabricated and installed in field channels of farmer's fields to measure water.

KEY WORDS : Semi circular contracted flume, Brink depth, Critical depth, Submergence condition

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The rapidly increasing use of all available water resources and the increasing costs of on-farm irrigation development require economical use of irrigation water. Inequity in the distribution of water through the irrigation network cause lower irrigation efficiencies. To improve water management, it is strongly recommended that the irrigation water be accurately measured and regulated at all important points in an irrigation system. Cutthroat flume is one of the critical flow measuring devices for open channel flows.

It is extensively used in irrigation systems in India. But, the difficulty in the analysis of curvilinear flow, the complication in fabrication, the errors in installation, the economy and the sensitivity towards submergence have limited the use of these flumes. A circular flume is a cylinder installed axially in a prismatic channel can be used to measure discharge. However the circular flume, as presented by Hager (1985, 1986 and 1988) and Samani *et al.* (1991), has the disadvantage of trapping floating material, which affects reliability and function of structure. Starosolszky (1968) reported some important requirements to minimize the errors in flow measurement are critical flow conditions must be realized in the vicinity of the structure, the upstream side of the structure should be designed to eliminate sedimentation in the measuring cross-section and submergence by the tail water should be avoided as far as possible and its influence on discharge should not be higher than ±10 per cent . Samani and Megallanez (2000) developed a simple venturi flume for flow measurement in open channels, by combining the advantages of circular flume and cut throat flume. The flume was contracted using two half cylinders of PVC pipe which created a contraction. Samani *et al.* (2005) presented a report about detailed procedure of construction, installation and operation of simple flume (S-M flume) for open channels developed by Samani and Magallanez in 2000. The same flume was used for measuring discharges in sloping open channels by Baiamonte and Ferro (2007) and derived head discharge relationship for field conditions experiments for a different ranges of contraction ratios (0.17=r=0.33 and 0.48=r =0.81). The maximum error of measurement is within tolerable field applications, falls into the range of ±10 per cent . But the studies on occurrence of critical flow conditions under different flow conditions were not conducted. Present research work was carried out to test