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A Study on Water Surface Profiles of Rivers with Constriction

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Water surface profile of rivers with constrictions is precious in both classic hydraulics and river management practice. This study was conducted to clarify the essences of the water surface profiles. 3 cases of experiments and 1D numerical calculations with different discharges were made in the study and analysis solutions of the non-linear basic equation of surface profile in varied flow without considering friction were derived. The manning's number was kept in the same in each case by using crosspiece roughness. We found a new type of water surface profile of varied flow from the results of 1D numerical calculation and that of experiments and named it as Mc curve because of its mild condition with constriction segment. This kind of curves appears as a nature phenomenon ubiquitously. The process of water surface forming is dynamic and bore occurs at the upper side of constriction during increasing discharge before the surface profile formed. As a theoretical work, 3 analysis solutions were derived included 2 physical-meaning solutions in the study by using Man-Machine system. One of the derived physical-meaning solutions was confirmed that it is validity by comparing to the results of 1D numerical calculation and that of experiments. The solution represents a flow profile from under critical condition at the upper side to super critical condition at the down side of constriction segment. The other derived physical-meaning solution represents a flow profile from super critical condition at the upper side to under critical condition at the down side of constriction segment. These two kinds of flow profiles exist in the nature but no theoretical solution can express the phenomenon. We find the depth distribution only concerned with unit width discharge distribution and critical depth under a constant discharge from the derived solutions. Therefor, the profile can be gained simply and precisely by using the theoretical solutions instead of numerical calculation even in practice.