# ESTIMATION OF DEPTH-AVERAGED VELOCITY FROM SURFACE VELOCITY IN THE OPEN CHANNEL FLOW

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The conventional methods for river-discharge measurement are considered to be ineffective and inaccurate, particularly for flood flows. Recently, therefore, efforts were made to estimate the river discharge with the surface velocity measured with LSIV, ultra-sonic surface velocity meter, etc. This kind of technique inevitably needs the relationship between the depth-averaged velocity and the surface velocity. However, this relation has not been established yet. In this study, therefore, velocity profiles were measured with PIV for various flow and bed conditions to illuminate the characteristics of velocity profile in the free-surface region and eventually to find a method for estimation of depth-averaged velocity from the surface velocity.

Experiments were carried out for various flow and bed conditions to investigate the characteristics of velocity distribution in the free-surface region. The results show that the existing equations cannot describe the actual velocity distribution, particularly the velocity-dip phenomenon, in the free-surface region.

A method to estimate the depth-averaged velocity from the measured surface velocity is proposed. In this method, the average velocity can be obtained by integrating a particular log-wake profile which produces the same surface velocity with the measured one. Simple application of the wake law without consideration of the velocity-dip phenomenon produces the velocity profile, which inevitably underestimates the average velocity. This problem can be solved by introducing dUs (see Fig. 1). The value of dUs might be defind as the amount to be added to the measured surface velocity, so that the log-wake profile derived with the corrected surface velocity (measured surface velocity + dUs) gives the same average velocity with the actual profile.

Experimental data were analyzed to find out the method for estimation of dUs associated with flow conditions. Fig. 2 depicts the variation of dUs/Us with Frs, the Froude number based on the surface velocity.

In order to see the applicability of the proposed method for estimation of the depth-averaged velocity from the surface velocity, the method is applied to some natural streams. The depth-averaged velocities obtained by the proposed method are compared with those by other methods and also with measured average velocities.

The methods used in estimation of average velocity from surface velocity are :
   1. method I : use of Um/Us=0.85

2. method Ⅱ : simple application of wake law without consideration of velocity-dip
3. method Ⅲ : proposed method with corrected surface velocity

Since the methods Ⅰ and Ⅱ do not consider the velocity-dip phenomenon, they underestimate the average velocity, and produce errors more than 10% in some cases. On the other hand, the method Ⅲ, which employs corrected surface velocity, estimates the average velocity more accurately than 2 other methods. The error of method III, the proposed method, remains within 6 %, which is considered to be small enough for practical use.
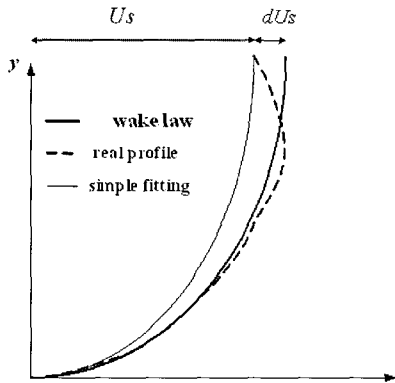


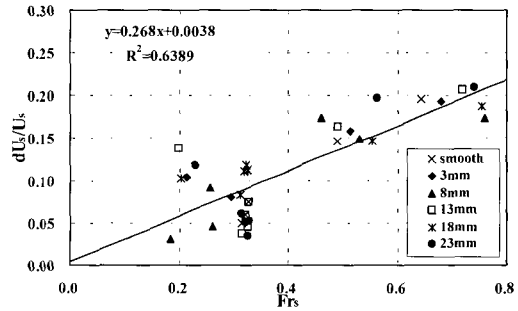Fig.1 Definition sketch of surface-velocity correction, dUs

Fig. 2 Variation of dUs/Us associated with Frs