LOCAL DISSOLVED OXYGEN (DO) VARIATIONS IN THE VICINITY OF DIFFERENT BOULDER ARRANGEMENTS PLACED IN A FLUME

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In the hydrosphere, dissolved oxygen (DO) is an essential water quality parameter for the aquatic biota and environmental issues (Gulliver et al., 1998). In streams, DO content generally has low levels because of the waste water diffusion from point and non-point sources (Streeter and Phelps, 1925). Therefore, self-aeration mechanism is an important phenomenon for regaining the lost dissolved oxygen.

Water and air are well separated by a sharp interface area (Kobus, 1991). The transfer of atmospheric gases across this interface area is ensured by some local hydrodynamic processes such as: (1) hydraulic jump, (2) plunging jet or water fall, and (3) high-speed flows (especially on steep chutes and stepped channels) (Chanson, 1996). By this self-aeration, air is mechanically mixed with the water, what leads to an increase of DO concentration in the water up to a saturation limit.

In the literature, self-aeration studies generally conducted at hydraulic structures such as weirs, gated sills and stepped channels, etc. Also in high gradient (mountain) streams, there are morphological features resembling to these hydraulic structures such as water drops, step-pool sequences, and boulder cascades (Montgomery and Buffington, 1997).

In the present study, influence of three different boulder arrangements (BA) on local DO concentration variations has been examined in a 0.5 m wide flume with 4 different relative submergences with the Reynolds number range from $5*10^3$ to $5*10^4$. The study deals with the relative abundance of DO in different parts of flow around boulder structures.

The height of the boulder is defined as D and d/D ratio is expressed as relative submergence of the boulder. Another important dimensionless parameter used in the study is, blockage ratio of the boulder(s) and defined as: A_b/A_f, where A_b is the facing upstream cross sectional area of the boulder(s) which depends on the approaching flow depth (Cokgor and Kucukali, 2004), and A_f is the flow cross-sectional area.

Experimental results reveal that boulder arrangement is a very important parameter for determining the local hydraulic characteristics of a flow in a stream. When the flow hits the boulder, current patterns change and local hydraulic conditions such as hydraulic jump and plunging jet occurs at the downstream of the structure depending on the blockage ratio, relative submergence of the boulder(s) and flow conditions, which leads to create surface disturbances, hence provides to suction of air into water.

It can be shown in Fig. 1 that when the boulder submergence ratio exceeds1, local aeration efficiency (E_{20}) tends to decrease fall rapidly. This situation may be explained as: boulder effect on the flow conditions weakened as the relative submergence value exceeded 1. The negative correlation of the flow characteristics with the relative submergence agrees with the observations of Bayazıt (1976).

Maximum local aeration efficiency and blockage ratio of the boulder(s) related positively and described by a power function for $A_b/A_c < 0.7$ and Re > $5*10^3$ flow conditions with a correlation coefficient of 0.82 (Fig. 2).

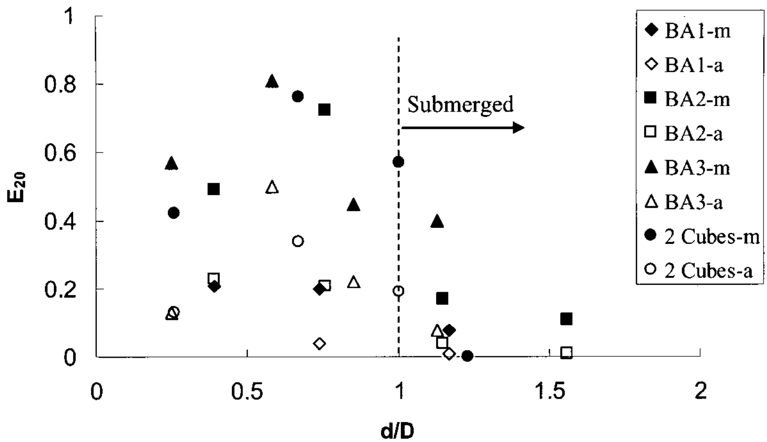

Fig. 1 Local aeration efficiency, E_{20}, versus relative submergence of boulder(s), d/D, at various boulder arrangements (m: maximum, a: average).

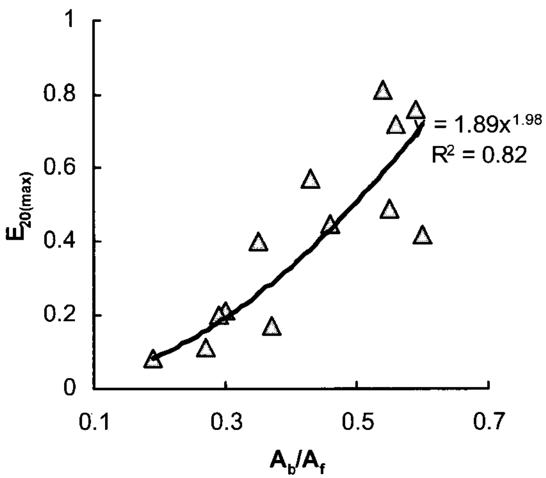

Fig 2. Maximum local aeration efficiency, E_{20}, as a function of blockage ratio, A_b/A_f.

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