Investigating the effect of skimming wall on controlling the sediment entrance at lateral intakes
Amir Moradinejad, Amir Hamzeh Haghabi, Mojtaba Saneie and Hojjatallah Yonesi

ABSTRACT
Sediment entering lateral intakes depends on flow pattern in intake entrance. Using a structure in front of intake entrance can change this pattern and as a result the entering sediment. One of the effective methods to change pattern and manage sediment entering lateral intake is using skimming wall. By removing the sediments, in deed will not exist any sediments which a structure such as skimming wall reduces it. To guide flow into the diversion canal and increase skimming wall performance a spur dike was utilized at the opposite side of the intake channel. In this study, the effect of skimming walls’ angle with the bank, a combination of spur dike and skimming wall and discharge changes on controlling sediments entering the intake, intake ratio and bed topography were investigated experimentally. The effect of skimming wall with three angles (10, 14, and 18 degrees) and a combination of skimming wall and spur dike on opposite side of intake were investigated. Conducting dimensional analysis, non-dimensional ratios were extracted and test variables were specified. Results showed that in the case of having a skimming wall combined with spur dike, the amount of sediment entering the intake has decreased for 81%, 78.5% and 76% on average in walls with angle of 10, 14 and 18 degrees respectively. Combining skimming wall and spur dike has a higher effect on reducing sediments entering intake compared to skimming wall alone for about 15%.

Key words | intake efficiency, sediment control, skimming wall, spur dike

INTRODUCTION
With regard to the importance of rivers as major source of water supply, taking water from rivers and branching flow from it is an issue encountered in hydraulics and river engineering (Habibi et al. 2014). Diverting water using lateral intake always accompanies the problem of sediments entering channels and water transport systems (Raudkivi 1993; Rajaratnam 1994; Wang et al. 1996). As the flow approaches intake, it accelerates along transverse direction and is divided into two sections as a result of suction produced by lateral intake (Best & Reid 1984; Hashid et al. 2015; Herrero et al. 2015). One part enters the intake and the rest flows in main downstream channel. One of the problems occurring in most intakes is accumulation and entrance of sediments into intake entrance (Weber et al. 2001; Barbhuiya & Dey 2004; Odgaard 2009; Mirzaei et al. 2014). Failure in controlling sediments entering intakes will result in their being transferred into irrigation channels and installations that creates many problems because of carrying sediments or their being settled in various sections (Nakato et al. 1990; Voisin & Townsend 2002; Mahgoub 2013). Complexity of flow and sediment control around intake entrance has caused researches in that area to be continued. In this study, angle changes of skimming wall and its role in controlling sediment entering intakes have been investigated.
Skimming wall is a structure consisting of two plates connected to the bank with an angle. Figure 1 shows its plan (a) and cross section (b).

Neary et al. (1999) developed a 3D numerical model of flow on a 90° branch in a channel with rectangular section and verified it using experimental results. According to their findings, as the flow diversion ratio increases, width of vortex area and its length decreases and increases respectively (5). Ramamurthy et al. (2007) demonstrated that increasing flow diversion ratio reduces length and width of flow separation zone in intake channel. In addition, the width of separation zone in intake channel is less in the floor compared to the surface (Hager 1992). Studies by Marielius & Sinha (1998), Marielius & Sinha (1998) and Kuhnle et al. (1999) showed that intensity of bed sediments entering intake can be negligible after installing submerged vanes only when discharge ratio of width unit of intake to discharge ratio of width unit of main channel (qr) is less than about 0.2. After experimental study, to increase qr and maintain efficiency of submerged vanes, two solutions were proved appropriate; first, embedding lateral intake next to submerged vanes and second widening intake entrance (Barbhuiya & Dey 2004). Ahmad (1953) showed that spur dikes inclined towards upstream have better performance in terms of flow strength and deposition. Attarzadeh et al. (2014) experimentally investigated the effect of sill, spur dike and submerged vanes on sediment control and bed topography in lateral intakes. Results showed that spur dike has a more prominent effect in controlling sediments. Considering literature, most studies have been conducted on submerged vanes, sill, spur dike or a combination of them in intakes. Therefore, more studies are required in this field especially when skimming wall is employed in front of intake. In addition, to represent the effect of skimming wall angle on the amount of sediment entering intake, it is required to use a combination of wall and spur dike and conduct a comparison of this state with a no-structure state. Therefore, the aim of this study was to use skimming wall in controlling sediment entering lateral intake with an angle of 60° from rectangular channel.

MATERIALS AND METHODS

Experiments were conducted in the Institute of Soil Conservation and Watershed Management in a flume with a length of 12 m, width of 1.5 m and height of 0.9 m having water and sediment circulation system. Intake was conducted using a lateral channel with a width of 0.6 m, length of 2.5 m and 60° angle relative to the flow direction in main channel. Intake channel is located 9 meters from upstream stilling basin and three meters from water level control gate at the end of flume (Figure 2). Water circulation system of flume is closed-circuit and water demand is supplied through underground connected tanks beneath the flume. Inlet discharge is controlled in pumping station by adjustable valves. Flow depth is regulated by a gate located at the end of each main channel and intake. To measure flow in main channels and intake, flow speed and direction, and water surface profile, rectangular and triangular sharp-crested weir, speedometer made by Delft Hydraulic Institution, and point gauge and profiler were used respectively. Skimming wall is composed of two branches. The first branch with a length of 75 cm and a height of 25 cm is connected to the intake one side of which is connected to the intake bank with angles of (10, 14, and 18°) and its other side is connected to the second branch. The second branch, parallel to the bank with a length of 111 cm and a height of 25 cm continues in line with the flow (Figure 3).