Abstract— In this study local scour around submerged pipe during hydrograph was investigated by using advanced measurement techniques. Temporal variations of local scours were measured indirectly by means of Ultrasonic Velocity Profiler (UVP). Ultrasonic Level Sensor (ULS) was used to determine time dependent water depths during hydrograph. After the experiment the final bed bathymetry was obtained by using laser meter.

Keywords— Submerged pipe, local scour, flood hydrograph, UVP, ULS.

I. INTRODUCTION

A number of researchers widely investigated local scours around submerged pipes under the effect of steady current and oscillatory flow such as waves and tides.

In addition to several studies carried out in one and two dimensions, 3-D scour process around the submerged pipe has been investigated, recently. One of them is related to the scour propagation along the submerged pipe under the effect of steady currents where, time dependent scour rates were measured using specifically developed conductivity scour probes [1]. Alam and Cheng realized numerical solutions and they compared their theoretical results with those obtained from various experimental studies [2].

In literature, there exists a great deal of empirical relations about scour around submerged pipe under the effect of steady current. In most of these empirical equations the maximum scour depth is expressed in terms of pipe diameter and horizontal component of the incoming flow velocity near the pipe.

As the transducers of UVP are small and easy to fix to a desired configuration, the water flow and sediment transport are disturbed at least. In this study the scour due to an input hydrograph is investigated experimentally. The evolution of bed configuration is investigated and an approach is conceived by taking the advantages of Ultrasonic Velocity Profiler (UVP), in order to measure the scour depths versus time. Ultrasonic Level System (ULS) is used to determine the propagation of the input hydrograph in the flume. Once the scour process reached the equilibrium stage, the final bed topography is evaluated by means of a laser meter.

II. EXPERIMENTAL SET UP AND INSTRUMENTS

Experiments were carried out in a system involving a rectangular flume of 80 cm width and 18.6 m length. The transparent sides of the flume made from acrylic are 75 cm high. The unsteady flow experiments are conducted in the flume with a bottom slope of 0.005. The bed is fixed with small concrete blocks at the first 3 m of the flume. The total length of the mobile bed is 15.6 m. The sediment thickness is approximately 65 mm. The pump having a maximum capacity of 100 l/s, is connected to the pump rotational speed control unit which can control the flow rate by adjusting the settings. Bed material used in the flume is composed of graded material with $d_{50}=3.4$ mm. The general view of the experimental system is given in Figure 1. The submerged pipe has a diameter of 6.0 cm.

![Figure 1: General view of the experimental system.](image-url)
scours due to input hydrograph are measured with respect to
time.

The ULS-40D is an ultrasonic laboratory water level
measuring system. It has four independent channels. BNC -
voltage outputs (0-10V) makes integration into existing data
acquisition systems easy. The USS 20130 (Ultra Sound
Sensor) (Figure 4) is used with a measuring range of 130 cm.
The superior resolution up to 180 microns and the repetition
rate up to 50 Hz enable the detection of smallest and fastest
changes of levels. The beam angle of the sensor is less than
3°.

III. EXPERIMENTAL RESULTS

The input hydrograph was measured by means of a flow meter
located at the downstream of the pipe that provides water to
the flume. The base and peak flow rates of the generated
hydrograph are 8.5 l/s and 89 l/s, respectively as shown in
Figure 5. The rising and falling durations of the triangular
shaped symmetrical hydrograph are 5 minutes.

The water depths measured at upstream and downstream
parts of the submerged pipe are recorded by using ULS which
are located at points 30 cm far from the pipe (Figure 6).
The echo data received from UVP transducer was recorded
and stored in the computer. By processing this data, the local
scour depths versus time can be obtained. Figure 7 represents
the time varied distances between the transducer tip and the channel bottom which reflect the scour depth variations.

Figure 6: The water depths measured by ULS at points 30 cm far from the submerged pipe.

Figure 7: Distances between the transducer tip and the channel bottom with respect to time.

Figure 8 shows the final bed elevations in 3-D, measured by laser meter with an accuracy of 1 mm.

The final bed bathymetry near the submerged pipe is given in Figure 9. The erosion begins approximately at a distance six times diameter at upstream part and the maximum scour which is at order of 40 mm was observed under the pipe axis. This value is in accord with the empirical equation suggested by Fredsoe and all, [4]. A deposition was occurred at the downstream region of the pipe.

Figure 8: Bed elevations at the end of the experiment.

Figure 9: Final bed bathymetry.

IV. CONCLUSION

In this study, the main aim is to demonstrate the possibility of the use of UVP in order to measure time evolution of bed elevations even it is designed to obtain the flow velocity profile along an axis.

It is observed that the local scour under submerged pipe attains its final value in a short time interval. It also revealed that asymmetric erosion is followed by sediment deposition as reported by many other researchers. The maximum value of local scour is compatible with existing empirical relations.

It is intended to carry out future experiments to investigate the scours around a submerged pipe with various initial and boundary conditions.

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