CHAPTER II: Experimental Facility and Test Conditions

2.1. Experimental set-up

The experiment was carried out in a rectangular flume of 2.18 m length, with the test section 0.16 m in width, and 0.4 m in height. Figure 1 shows the side view and top view of the water flume. A sluice gate was located at the right-hand side of the flume. The thickness of the sluice gate was 0.02 m.

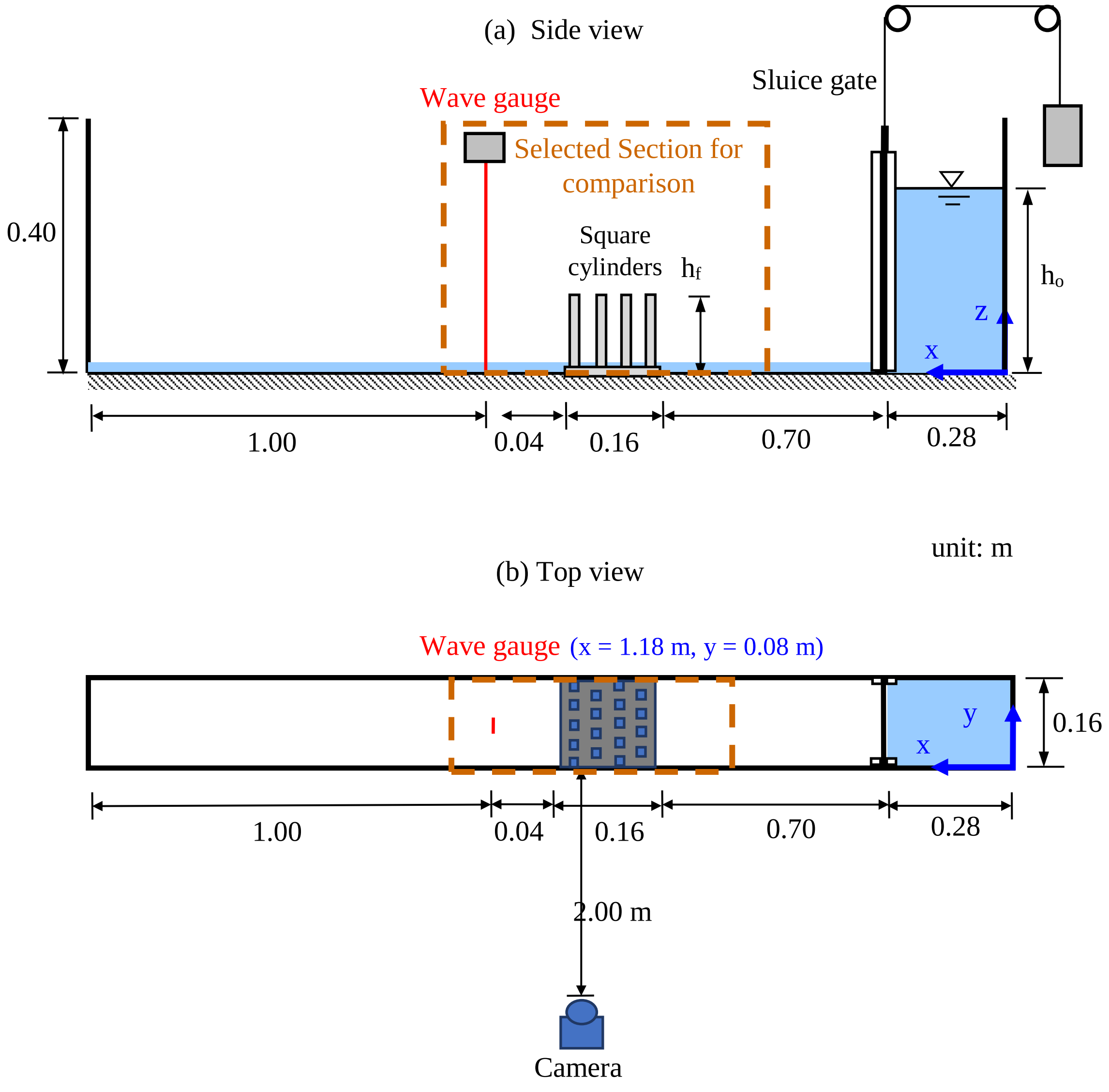
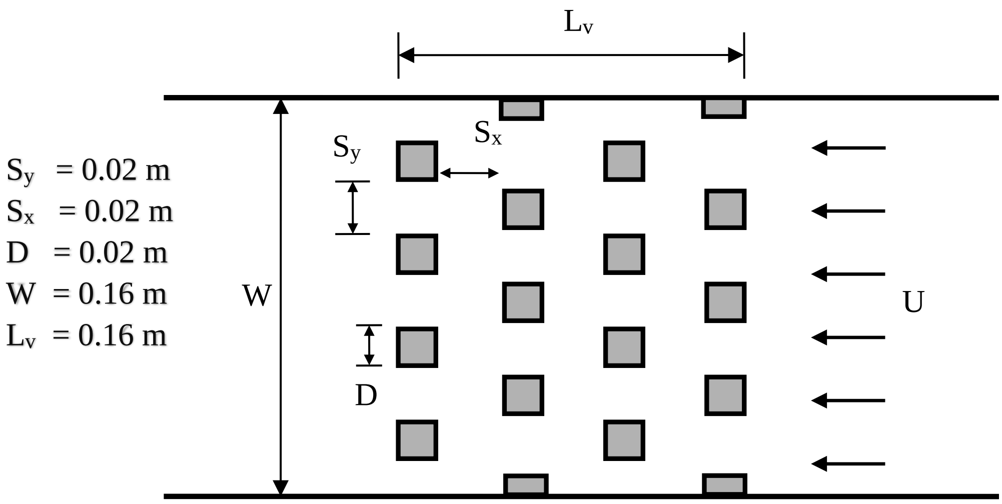


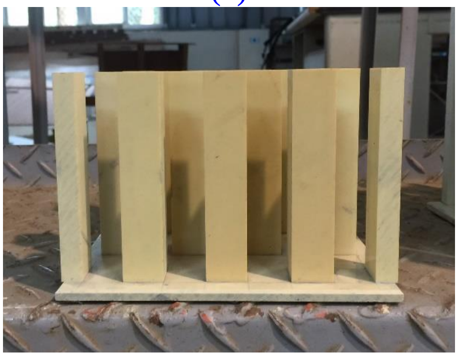
Figure 1. Side view and top view of the experimental setup.

The gate was suddenly lifted up by a heavy object, and the gate motion was recorded by a high speed camera (Exilim, Casio Inc.). The resolution of the photograph was 512 x 384 pixels with 100 frames per second (fps) video capture rate. The video images were analyzed using a Matlab code that can track the water surface at each frame.

(a)



(b)



(c)

Figure 2. (a) Schematic diagram of the square cylinders in staggered arrangement, (b) front view, and (c) side view of the obstacles.

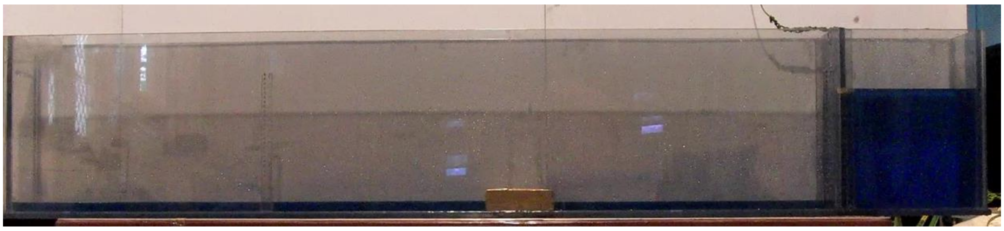
The resolution of the displacement was 0.32 mm in the horizontal direction, and 0.48 mm in the vertical direction. The experiments were conducted five times to ensure the repeatability of the experimental results. The initial water depth behind the sluice gate was 0.26 m, and the initial water depth in the flume was 0.02 m. The obstacle was a matrix of square cylinders (size 0.02 m) with the total length 0.16 m and total width 0.16 m. The cylinders are in two different heights, 0.10 m and 0.20 m. The square cylinders were installed in a staggered arrangement at downstream distance $x = 0.78$ m (Figure 2).

2.2. Measuring Technique and Calibration

Figure 3 are the photographs of the initial conditions of the water flume with the solid and porous obstacles before the flow began. The wave height was measured by a capacitance-type wave gauge (NET-030, Nijin Co.) installed at location x = 1.18 m. The resolution of the wave gauge was 0.03 mm.

(a)

(b)



(c)

(d)

Figure 3. Photographs of the flume experiment. (a) Water flume; (b) Solid obstacle; (c) Short porous obstacles; (d) Tall porous obstacles.

The variation of the water level at a fixed location, *x* = 1.18 m; y = 0.08 m, from the gate was measured by a wave gauge (Figure 4). The measured signal was processed by an amplifier (NET-406, Nijin Co.) and transmitted to a data logger (34970A, Agilent Inc.). First, the wave gauge has to be calibrated by several known, stationary water depths to determine the relationship between the water level and output voltage.

(a) (b)

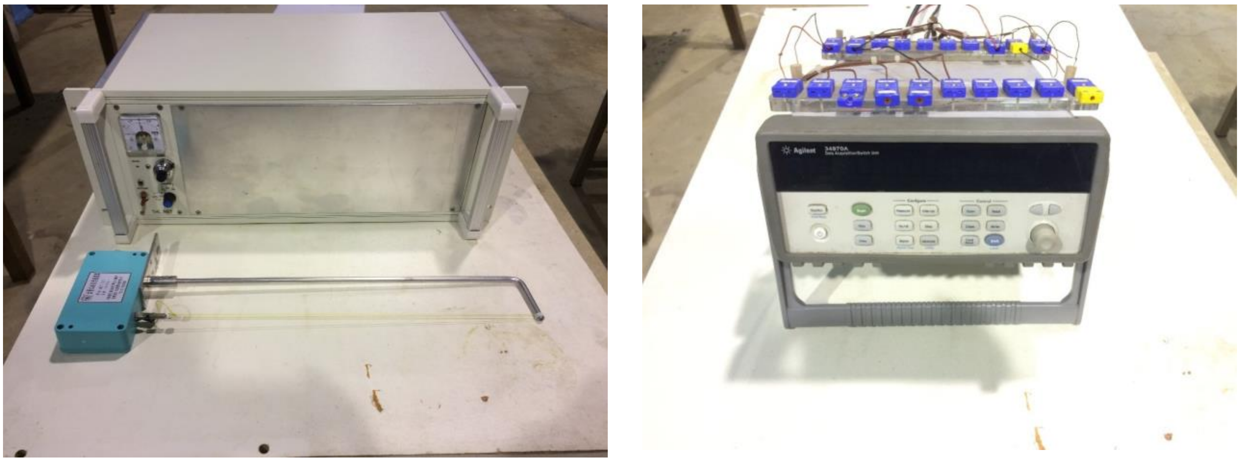


Figure 4. Photograph of the experimental instrument.

(a) Amplifier (NET-406, Nijin Co.) and wave gauge (NET-030, Nijin Co.); (b) data logger (Agilent 34970A).

The data were fitted to a straight line by linear regression (Figure 5). This calibration curve was used to determine the water depth in the flume. Figure 6 shows the photographs of dambreak flow in the flume at the same time t = 0.60 sec for all cases. There are four different cases of the laboratory experiment. Case 1 studies the dam break flow without obstacles in the flume. The results of measurements on this case can be seen in Figure 7.

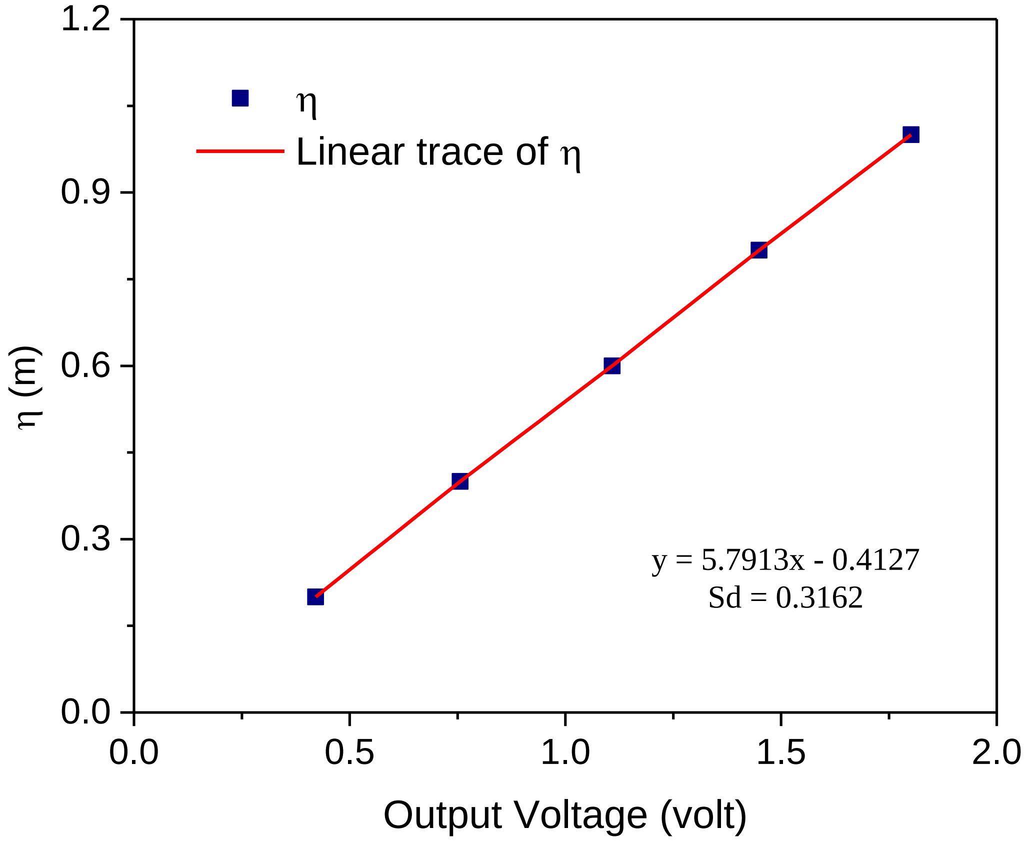
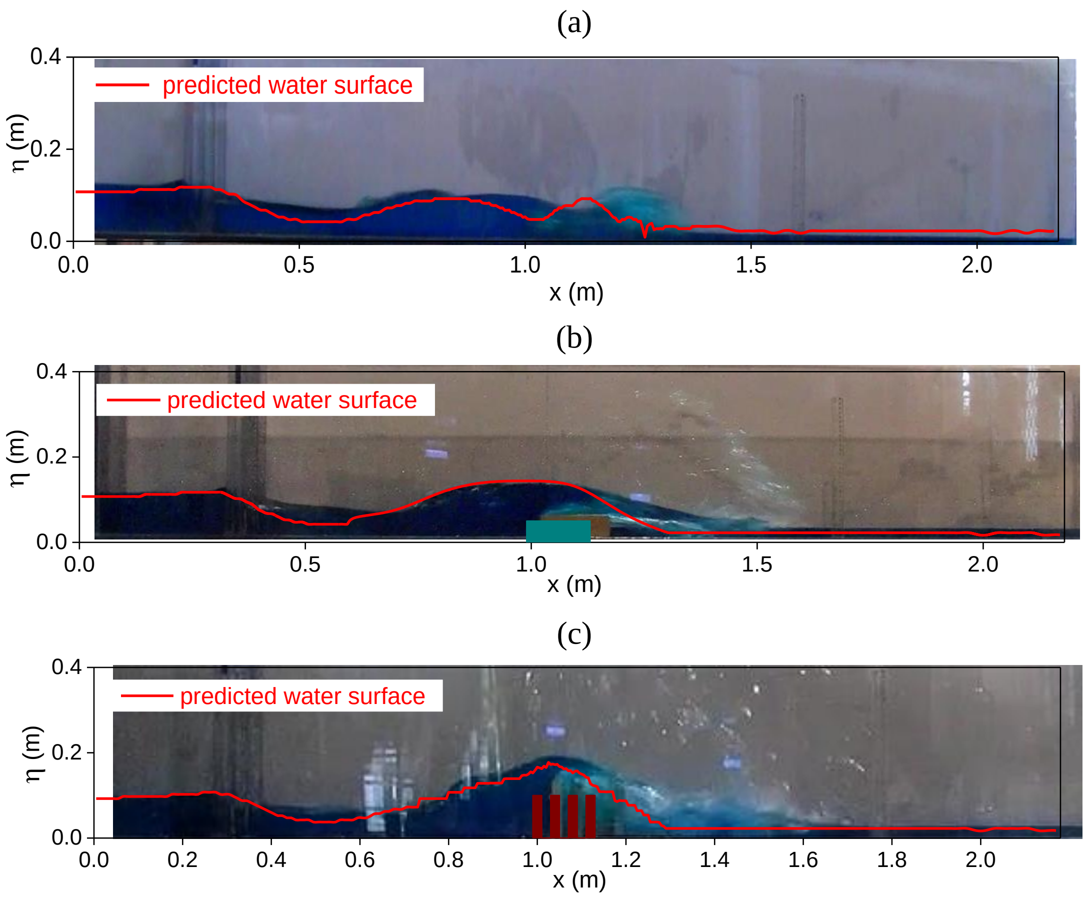


Figure 5. Calibration curve of the wave gauge.



(d)

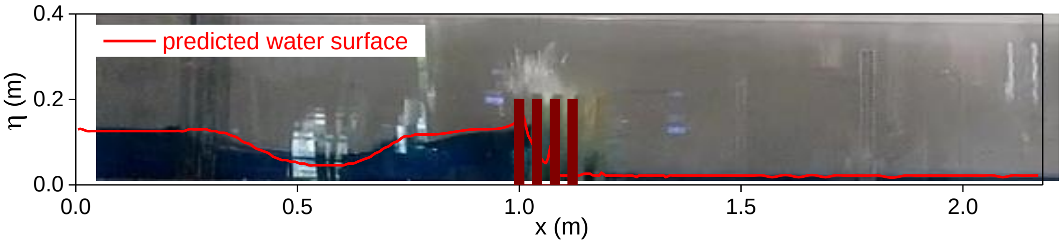


Figure 6. Photographs of the dambreak flows at time t = 0.60 sec. (a) Case 1 at t = 0.60 sec; (b) Case 2 at t = 0.60 sec; (c) Case 3 at t = 0.60 sec; (d) Case 4 at t = 0.60 sec.

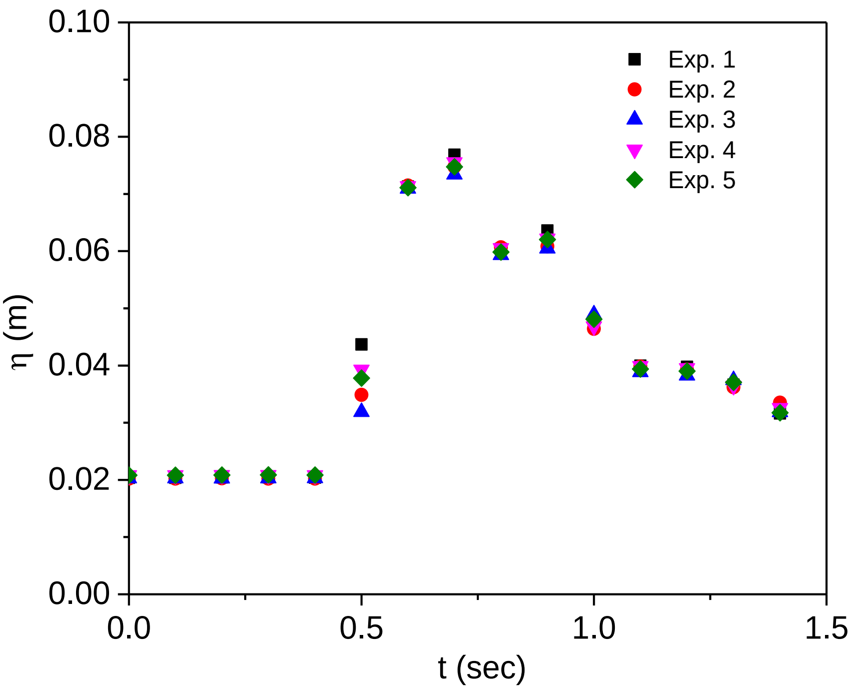


Figure 7. Measured wave heights at location x = 1.18 m and y = 0.08 m for Case 1 (without obstacle). The initial water depth behind the gate h_o = 0.26 m and initial water depth in flume h_1 = 0.02 m.

The experiments were repeated five times, and then calculated the average water level. Case 2 is the dam break flow with an impermeable, solid obstacle in the flume (see Figure 8). In the latter, dambreak flow through a porous medium in Cases 3 and 4. The difference between the Case 3 and Case 4 is the height of the obstacles, the obstacle height of Case 3 is h_f = 0.10 m and the measurement results can be seen in Figure 9. Case 4, the obstacle height h_f = 0.20 m and the measurement results can be seen in Figure 10. Figure 11 is the total of measurement results from all cases.

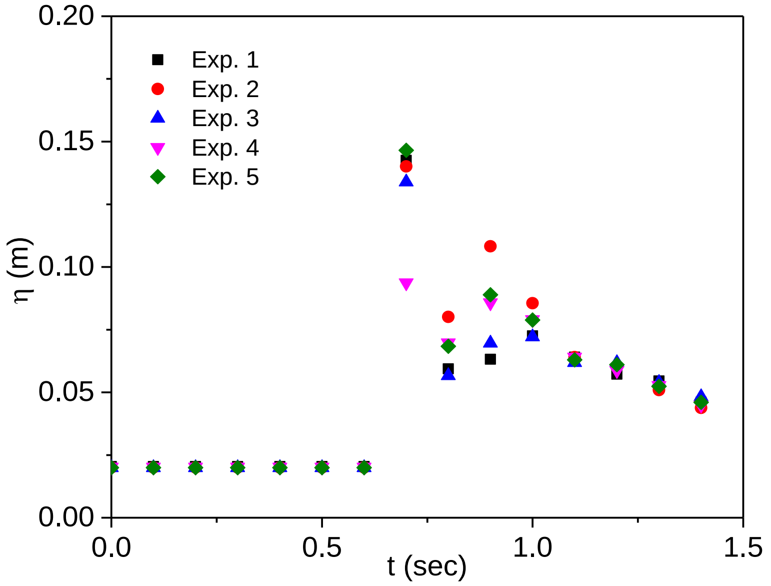


Figure 8. Measured wave heights at location x = 1.18 m and y = 0.08 m

Case 2 (solid obstacle, h_f = 0.05 m).

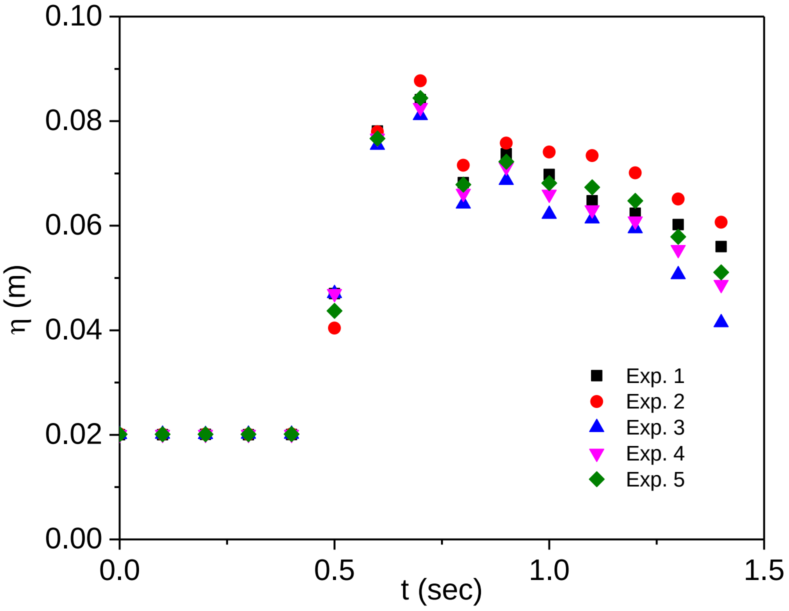


Figure 9. Measured wave heights at location x = 1.18 m and y = 0.08 m for Case 3 (short porous obstacles, h_f = 0.10 m).

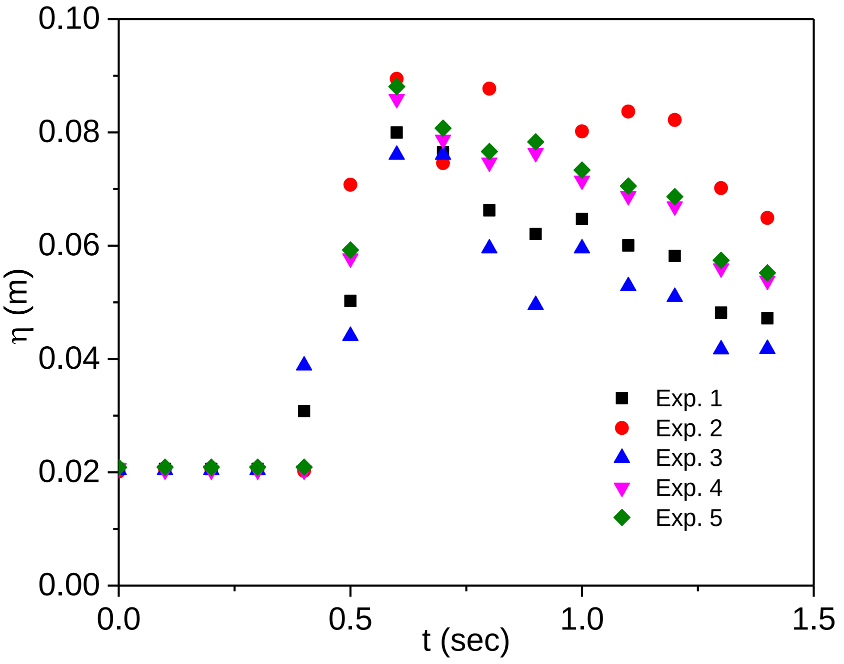


Figure 10. Measured wave heights at location x = 1.18 m and y = 0.08 m for Case 4 (tall porous obstacles, h_f = 0.20 m).

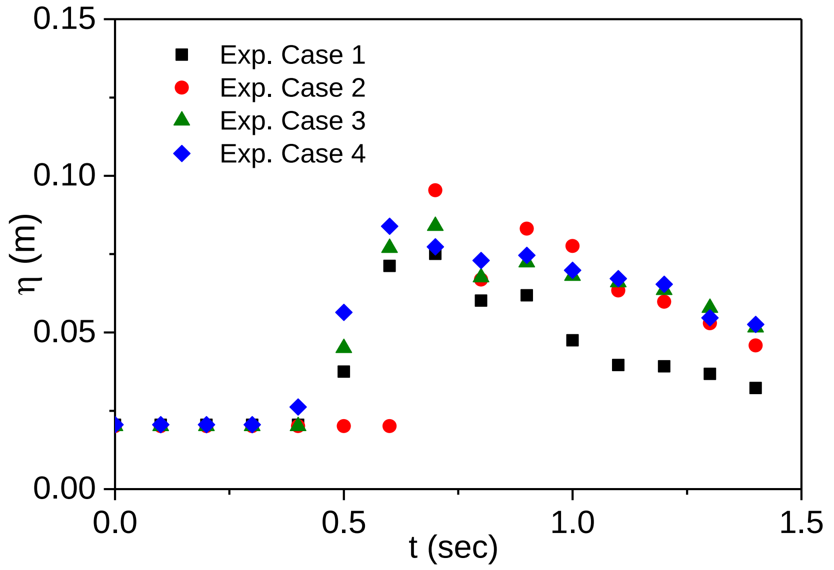


Figure 11. Comparison of averaged-measured wave heights at location x = 1.18 m and y = 0.08 m for all cases, initial water depth h_o = 0.26 m and h_1 = 0.02 m.