The effect of the functioning conditions on the transient behaviour of a water distribution system: Laboratory tests

Filomena Maietta YP[1]*, Caterina Capponi YP[2], Bruno Brunone[3] & Silvia Meniconi[4]

[1,2,3,4]University of Perugia, Perugia, Italy

*Correspondence YP: filomena.maietta@studenti.unipg.it

Abstract The operational water distribution systems are usually characterized by pressure transients. This paper shows some preliminary transient tests executed in a network installed at the Water Engineering Laboratory (WEL) of the University of Perugia (I). Specifically, it points out the effect of the functioning conditions during a transient. A transient test has been generated by the closure of a valve, for two different functioning conditions: the terminals are open simulating active users ("open network"), and the terminals are close ("closed network").Tests show that the maximum overpressure does not occur at the section where the maneuver is carried out and that it is necessary to monitor larger areas.

Keywords: transients, networks, functioning conditions, water distribution systems, laboratory tests.

Methods

The experimental setup is a pipe network with two loops simulating a District Metered Area (DMA), connected to a pressure tank by a DN110 supply pipe. The first loop of the DMA has four DN75 pipes (L = 100 m), whereas the second one has four pipes: one in common with the first loop and the other three with DN50 (L = 100 m). DN25 short pipes (L = 0.75 m) with a solenoid valve at the downstream end section are installed at nodes 4, 5, 6, 7, and 8 to simulate users. Eight measurement sections are installed along the pipes (i.e., 23, 34, 47, 87, 45, 58, 65, and 36). A transient test has been generated by the total closure of valve 5 (with a closing time of about 30 ms), for two different operating conditions. In the first condition, the terminals are open simulating active users (hereinafter "open network"), whereas in the second one they are close ("closed network"). For the open (closed) network the discharge at valve 5 is 2.60 L/s (3.70 L/s).

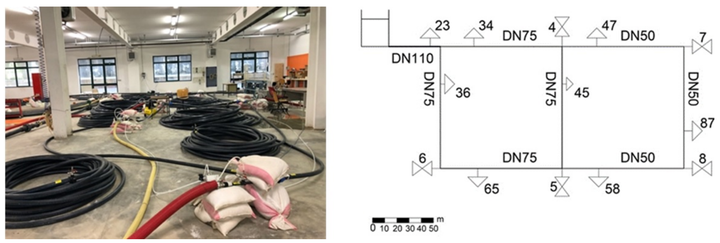

Figure 1: DMA at WEL: a) general view, and b) network layout.

Results

The acquired pressure signals, h, are shown in Figure 2a and 2b in the long term for the open and closed network, respectively. Specifically, for the open network, the pressure wave generated by the closure of valve 5 (Δh58 = 10.96 m) is smaller than that occurring in the closed network (Δh58=18.16m). Moreover, the pressure oscillations decay more rapidly in the open network than that in the closed one.

To go into more detail, Figure 2c and 2d show the pressure variations with respect to the steady-state pressure, h_0, during the first two periods for the open and closed network, respectively. For the closed network, pressure changes are larger than Δh58 in sections 87 and 47: 29.46 m and 27.62 m. On the contrary, the initial pressure variation decays rapidly in the case of the open network in sections 87 and 47: 3.46 m and 4.65 m.

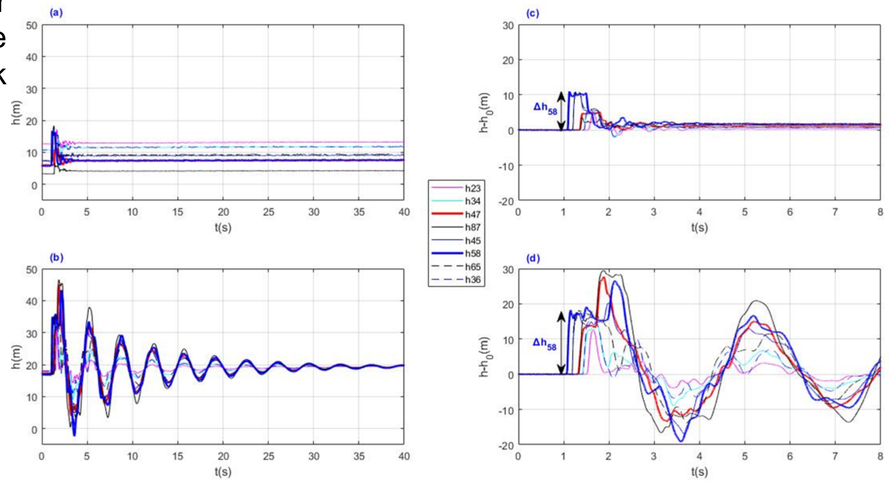

Figure 2: Pressure signals in the case of a) "open network", and b) "closed network".

Conclusions

- For a given maneuver, the decay of the pressure oscillations is faster in the open network than that in the closed one.
- To identify the most exposed to transient areas, it is necessary to monitor not only the node where the transient is generated, since its effects can be emphasized by the topology of the system and functioning conditions.

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