Sheet E4 · Experimental validation · CALIBRATED

Steel and HDPE in series: 7 configurations (Warsaw)

Source : Kubrak et al., Water 2022, 14, 3107 (open access, CC BY 4.0), table 1 and figure 5

1. The question

When a steel pipe is extended with HDPE, the pressure rise drops as the HDPE length grows. After a single adjustment on the all-steel pipe, does CBELIER predict the pressure rise of the six other configurations?

2. The case

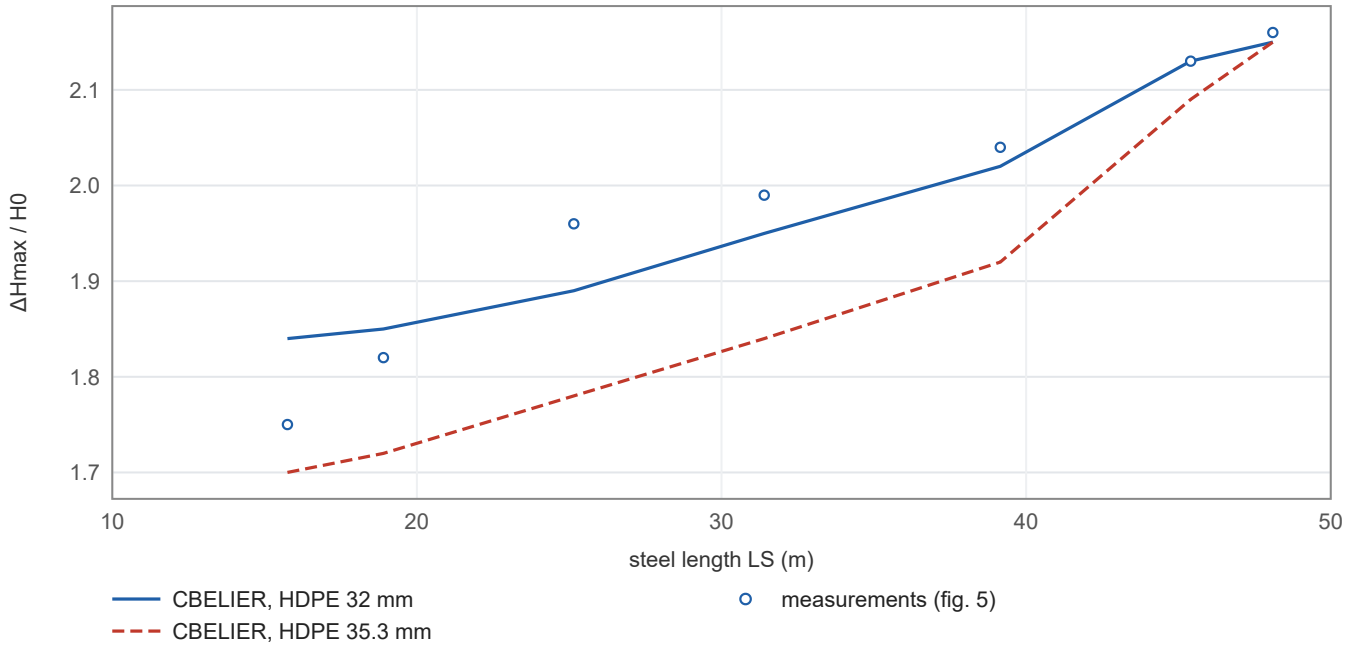


A pressurised 48.1 m test rig: 53 mm steel on the reservoir side, HDPE on the valve side, in varying proportions (7 configurations). The valve closes quickly; the maximum pressure rise relative to the initial head, ΔHmax/H0, is compared.

3. Data and status

Data	Value	Status
Total length; steel lengths LS	48.1 m; table 1	PUBLISHED
Steel: D, wave speed	53 mm; 1,195 m/s	PUBLISHED
HDPE: wave speed; Kelvin-Voigt J, τ	300 m/s; $2.2 \cdot 10^{-10}$ Pa^{-1}, 0.034 s	PUBLISHED
Flow; initial head	0.917 L/s; 42 m	PUBLISHED
HDPE diameter: 32 mm written, 35.3 mm derived from the velocities	both	DERIVED
Measured ΔHmax/H0 (figure 5, ± 0.02)	7	READ FROM FIGURE
Closure time tc, on configuration no. 7 (steel only)	0.1 s	CALIBRATED

4. Results



Relative maximum pressure rise versus steel length: CBELIER with both HDPE diameters (lines) and measurements (circles). Only configuration no. 7 (LS = 48.1 m) is used for the adjustment.

5. Differences

Indicator	CBELIER	Reference	Difference
Maximum predicted difference, no. 1 to 6, HDPE 32 mm	5.1 %	—	target 10 %
Maximum predicted difference, no. 1 to 6, HDPE 35.3 mm	9.2 %	—	target 10 %
Configuration no. 1 (most HDPE), 32 mm	1.84	1.75	5.1 %

After a single adjustment on the all-steel pipe, the six other configurations are predicted within 5 % with the written diameter (32 mm) and within 9 % with the derived diameter (35.3 mm). The trend (lower pressure rise with longer HDPE) is reproduced.

6. Limitations and assumptions

- The closure time, not published per test, is adjusted on configuration no. 7.
- The ambiguity on the HDPE diameter changes the difference from 5 to 9 %: it is shown as is.
- The computation without the viscoelastic model gives almost the same maximum pressure rise: this case validates mixed pipes, not the Kelvin-Voigt model.
- The measured values are read from a figure (± 0.02).