# Pipe Loop Balancing by Hardy Cross (One Loop)

Corrected flows in a four-pipe loop by the Hardy Cross method from pipe resistances and assumed flows, with the loop correction and head loss.

**Method:** Hardy Cross (1936) method of balancing heads (Streeter and Wylie, Fluid Mechanics, ch. 11)

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Head-loss exponent (1.852 Hazen–Williams, 2 Darcy) | 1.8520 | |
| Resistance pipe 1 (h = rQ^n, SI) | 500.00 | |
| Assumed flow pipe 1 (clockwise +) | 0.060000 | m³/s |
| Resistance pipe 2 | 800.00 | |
| Assumed flow pipe 2 | 0.030000 | m³/s |
| Resistance pipe 3 | 600.00 | |
| Assumed flow pipe 3 | -0.040000 | m³/s |
| Resistance pipe 4 | 1,200.0 | |
| Assumed flow pipe 4 | -0.020000 | m³/s |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Balanced flow pipe 1 | 0.055097 | m³/s |
| Balanced flow pipe 2 | 0.025097 | m³/s |
| Balanced flow pipe 3 | -0.044903 | m³/s |
| Balanced flow pipe 4 | -0.024903 | m³/s |
| Total loop correction | -0.004903 | m³/s |
| Head loss in pipe 1 | 2.3310 | m |

### Notes for this case

• Assumed flows must satisfy continuity at every junction; the correction keeps it. Iterated to convergence, so the head losses around the loop sum to zero. Resistances from Hazen–Williams r = 10.67L/(C^1.852D^4.87) or Darcy r = 8fL/(gπ²D⁵).

## Formula and method

$$\Delta Q = -\frac{\sum rQ|Q|^{n-1}}{n\sum r|Q|^{n-1}}$$

### Variables

| | | |
|---|---|---|
| $n$ | Head-loss exponent (1.852 Hazen–Williams, 2 Darcy) | - |
| $r_1$ | Resistance pipe 1 (h = rQ^n, SI) | - |
| $Q_1$ | Assumed flow pipe 1 (clockwise +) | m³/s |
| $r_2$ | Resistance pipe 2 | - |
| $Q_2$ | Assumed flow pipe 2 | m³/s |
| $r_3$ | Resistance pipe 3 | - |
| $Q_3$ | Assumed flow pipe 3 | m³/s |
| $r_4$ | Resistance pipe 4 | - |
| $Q_4$ | Assumed flow pipe 4 | m³/s |

| | | |
|---|---|---|
| $Q_1'$ | Balanced flow pipe 1 | m³/s |
| $Q_2'$ | Balanced flow pipe 2 | m³/s |
| $Q_3'$ | Balanced flow pipe 3 | m³/s |
| $Q_4'$ | Balanced flow pipe 4 | m³/s |
| $\Delta Q$ | Total loop correction | m³/s |
| $h_1$ | Head loss in pipe 1 | m |

### Method and standards

Hardy Cross correction.

### Assumptions and limits

- Single loop; fixed resistances.
- Resistances r are in SI (h in m, Q in m³/s, h = rQⁿ); flows may be entered in any flow unit and are converted to m³/s.
- The iteration must converge (|ΔQ| below $10^{-12}$ of the flows) or the page reports failure.

### References

• Hardy Cross (1936) method of balancing heads (Streeter and Wylie, Fluid Mechanics, ch. 11)

## Report details

| | |
|---|---|
| Report reference | FCC-6FN0-548R (the same inputs always give the same reference) |
| Generated | 17 November 2026, 19:48 UTC |
| Calculator | Pipe Loop Balancing by Hardy Cross (One Loop) |
| Method last reviewed | 13 November 2026 |
| Software release | FireCAD Calc, release of 17 November 2026 |
| Release checks | 2 reference cases of this calculator, computed independently, are checked on every release |

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

### This calculator online

https://calc.firecad.com/civil/hydraulics/hardy-cross-single-loop

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.