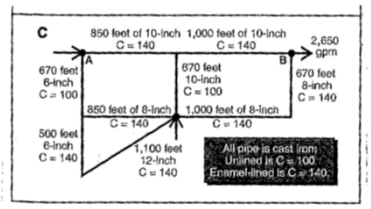
Fire Protection Hydraulics and Water Supply Analysis

FPST 2483 Chapter 6
Hardy-Cross Method Grids

1

Hardy Cross

- Step 1
- Make *a line drawing of system*, all in points and outpoints, pipe diameters, C factors, and lengths



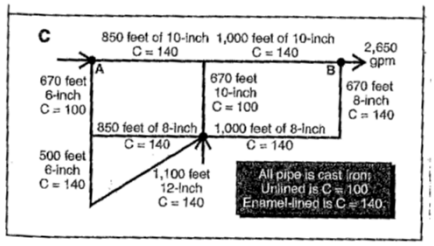
2

Hardy Cross

- Step 2
  - *Number each pipe line* with an Arabic numeral, each pipe of different flow, C factor or diameter must be numbered. A pipe common to two loops will have only a single number.
  - Copy information
    down in the right order.

3

Grid Example



4

4

Hardy Cross

- Step 3
  - Number Each Loop, including any imaginary loops
  - Copy all data to Hardy Cross worksheet
  - Every pipe must be shown in two loops (imaginary loops are used in multi-loop systems)
  - Imaginary loops will be on the outside of the system and will connect the inflow points

5

Hardy Cross

- Step 4
  - Estimate flows in every pipe (guess the first one in first iteration)
  - The flow exiting must equal flow entering
  - *Conservation of matter*

Flows must be shown as positive or negative
Clockwise are positive
Counter-clockwise are negative
Each pipe will never have the same sign in two loops

6

Hardy Cross

- Steps 5/6/7/8
  - With all data entered
  - *Calculate* friction loss from Hazen Williams formula or chart
  - Showing negative or positive results
  - Add up friction loss values for each loop

$$Pf = \frac{4.52 \times Q^{1.85} \times L_e}{C^{1.85} \times D^{4.87}} = \_\_\_\_\_ \text{ psi}$$

7

Hardy Cross

- Steps 7/8
  - Calculate 1.85*Pf/Q.
  - The values of 1.85*Pf/Q should all be summed

8

Hardy Cross

- Step 9
  - The sum of friction loss divided by 1.85Pf/Q
  - Step 9 is for systems without multiple loops.
    - This results in *a "correction" factor* which is added to each pipe. Steps 7, 8, & 9 repeated until the sum of the friction loss, Pf is less than or equal to 1.0 psi

9

Hardy Cross

- Step 10
  - Double correction is needed for multiple flows/loops
  - Create correction factor for each loop as detailed in Step 9
  - Create a 2nd correction factor for pipes in a second loop keeping sign (+ or -).
  - *Repeated in all loops until the sum of the friction loss Pf is less than or equal to 1.0 psi in ALL loops*

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