Innovation in Lock Filling and Emptying Systems

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Background
- New lock designs are being considered to save construction, and operation and maintenance costs
- 2 newest locks have used innovative designs
  - New McAlpine Lock, Ohio River
    (11.3m, 37' lift)
  - New Marmet Lock, Kanawha River
    (7.3m, 24' lift)

In-Chamber Longitudinal Culvert System (ILCS)
- ILCS design was briefly mentioned at the last PIANC workshop by Mr. Jerry Webb (Paper 5, Part A)
- Today’s presentation will
  - Provide details of ILCS design
  - Describe project features found on Marmet and McAlpine ILCS Locks

Location Map McAlpine and Marmet Locks

Planned Marmet Lock

Completed Marmet Lock
ILCS Design Philosophy

- Develop a system nearly as efficient as the side-port filling and emptying system
- Culverts in the chamber walls are replaced by culverts in the chamber floor

ILCS Offers Potential Cost Savings in Wall Construction

Hydraulic Efficiency: Lock Coefficient

$$C_o = \frac{2A_c \sqrt{H+\frac{d}{2}}}{A_c (T-U_t) \sqrt{2g}}$$

Where:
- $C_o$ = lock coefficient
- $A_c$ = plan area of lock chamber
- $H$ = initial head (i.e. lift)
- $d$ = lock chamber water level over-travel (or under-travel)
- $A_c$ = sum of culvert area at each operation valve
- $T$ = operational time required to fill (or empty) the lock
- $U_t$ = valve operation time
- $U$ = valve coefficient (0.45 ≤ U ≤ 0.55)
Lock Coefficients - Previous Model Studies

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<th>Project</th>
<th>Filling and Emptying System</th>
<th>Initial Head</th>
<th>Lock Coefficient</th>
<th>Reference</th>
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Permissible Filling Times

- Side-Port System Allows Faster Filling than ILCS

ILCS Design Guidance

- Spacing – chamber width dependent (~12m)
- Number – port-to-culvert ratio about 0.96
- 2 Groups – at 1/3 points of chamber length
- Extensions – needed on upstream group
- Wall Baffles: diffuse port jets near lock floor and inhibit upwelling along walls

ILCS – Filling Characteristics

- 11.28-m lift, 5.79-m submergence, 5-min normal valve

ILCS Manifolds

- Allow for alternative lock wall construction, such as RCC or in-the-wet construction
- Port extensions and wall baffles provide uniform distribution of flow and dissipate energy
Marmet Lock, Kanawha River

Questions?