PIANC InCom – Work Group 29

Discussion on Filling and Emptying Systems

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Hydraulic system discussion

★ A GOOD F/E SYSTEM

★ SOME EXAMPLES

-- PARTIAL DISTRIBUTED SYSTEM

-- DOUBLE DITCHES ENERGY DISSIPATION SYSTEM

-- ENERGY DISSIPATION FOR SIDE PORT SYSTEM

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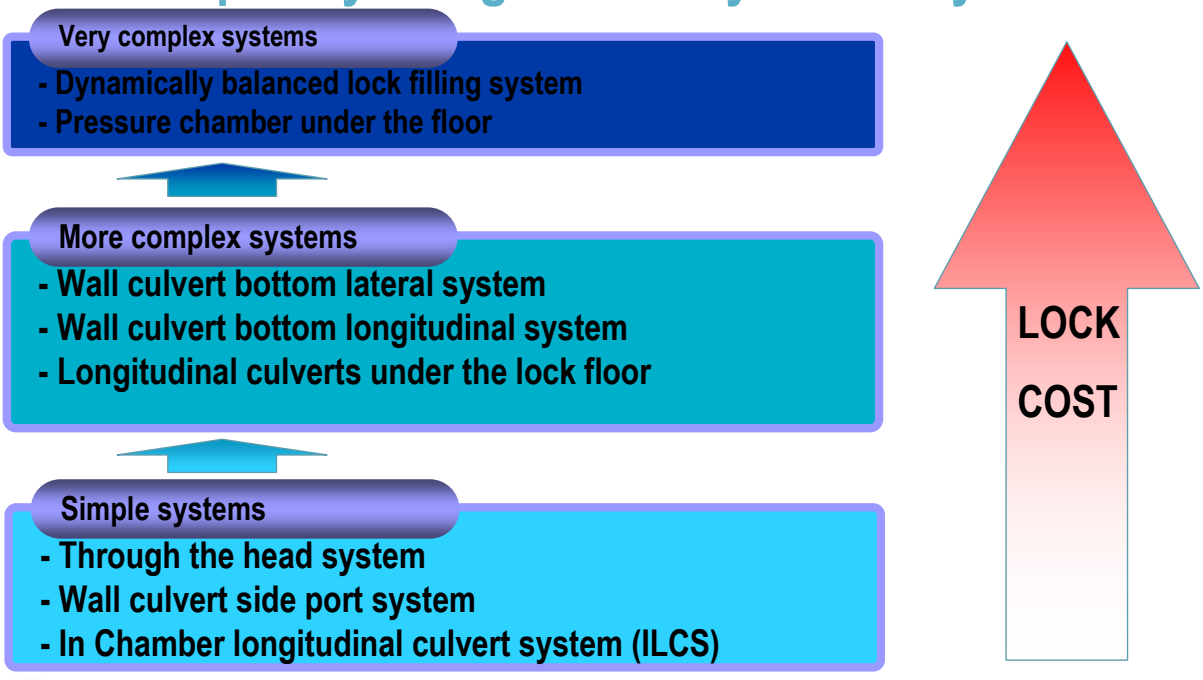
★ A GOOD F/E SYSTEM

A Good Filling and Emptying System

- could provide proper filling time (not as short as possible)
- Lock cost could be lower

Hydraulic system discussion

Complexity categories of hydraulic systems



Factors which influence the hydraulic efficiency:

- Lift height
- Permissible hawser forces
- Lock dimensions (lock chamber length, width and submergence)

Hydraulic system discussion

Chinese code

DWT of vessels	3000t	2000t	1000t	500t	300t	100t	50t
longitudinal horizontal components (kN)	46	40	32	25	18	8	5
Transverse horizontal components (kN)	23	20	16	13	9	4	3

Dutch criteria

VESSEL Class	Hawser force criteria (o/oo of total ship displacement)	
	In filling	At emptying or filling with floating bollards
CEMT Class III	1.50	2.00
CEMT Class IV	1.10	1.50
CEMT Class Va	0.85	1.15

USA: Allowable hawser force is 5t

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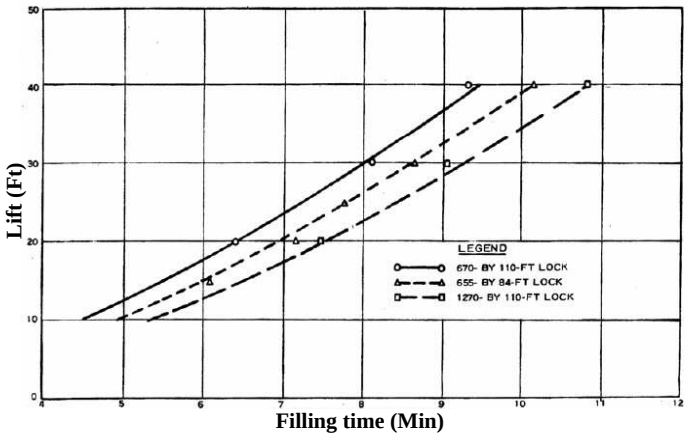
USACE EM1110-2-1604 Figure D-5(side port system)



Coefficient $M = T/H^{1/2}$ for side port system

Lift height (m)	Chamber length/chamber width		
	6.09	7.8	11.5
6.10m	2.59	3.28	3.77
9.14m	2.35	2.84	3.37
12.19m	2.15	2.58	3.09

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★ Example 1: Partial Distributed System

A hybrid system combined by through head system and through longitudinal culvert system.

Through head system can be used for locks with very low lift height (≤7m).

This system could be used to locks with low or intermediate lift height (about 10m).

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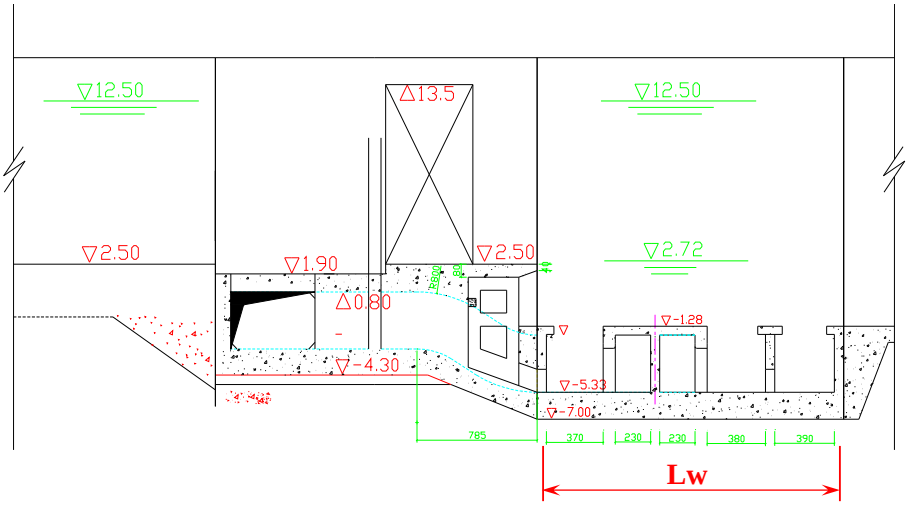

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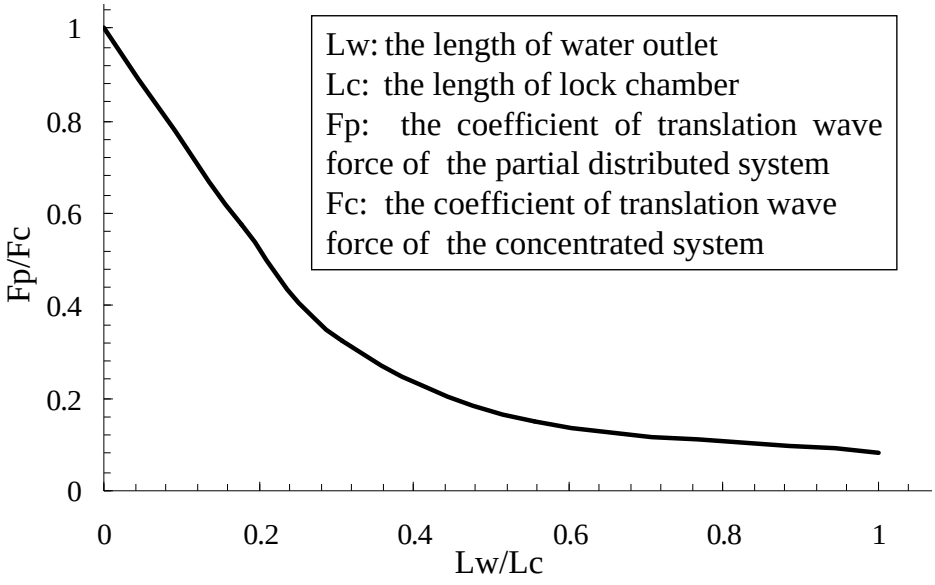

★ Example 2: Double Ditches Energy Dissipation System

To avoid dangerous currents at the outlets of filling and emptying system, measures should be taken for energy dissipation. Double ditches are effective system for energy dissipation.

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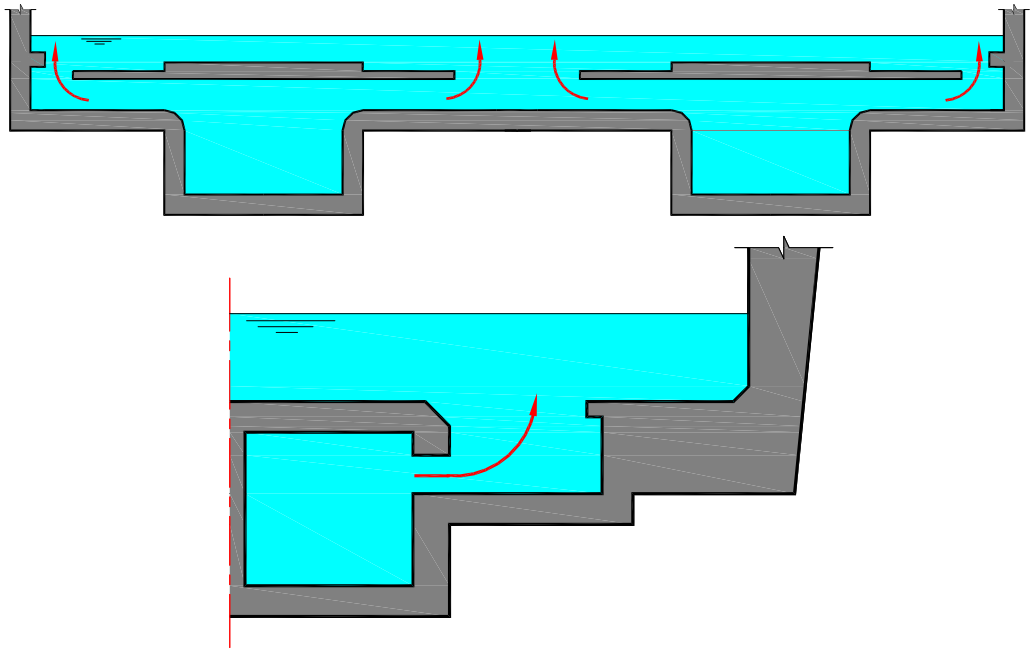

In-chamber Longitudinal Culvert System

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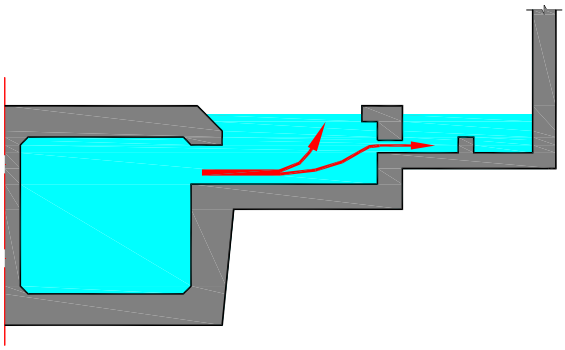
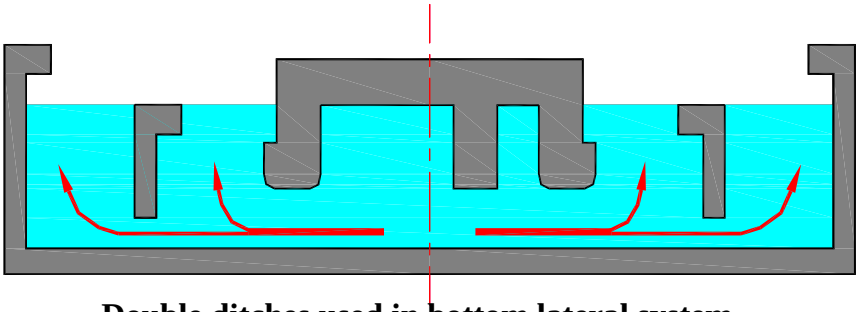


Double ditches used in ILCS system



Double ditches used in bottom lateral system

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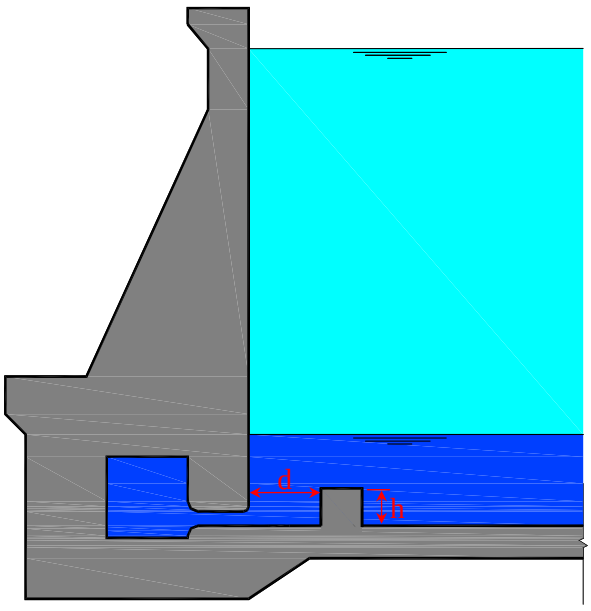
Compared with one ditch system the filling time was shortened. Using the same filling time, the maximum transverse hawser force of the double ditches system is small.

	Filling time	Max. transverse hawser force
Single ditch	**9min**	**56 kN**
Double ditches	**9min**	**11.2 kN**
Permissible transverse hawser force 20 kN		

★ Example 3: Energy Dissipation for Side Port System

For side port system enough submergence is required to prevent direct action of the port jets against the bottom of the vessel. But in many cases a little more submergence will lead to much cost.

Hydraulic system discussion



If port deflectors was arranged in chamber the jet into the chamber was spread by the deflectors evenly and the hydraulic condition was improved.

Side port system with port diflectors

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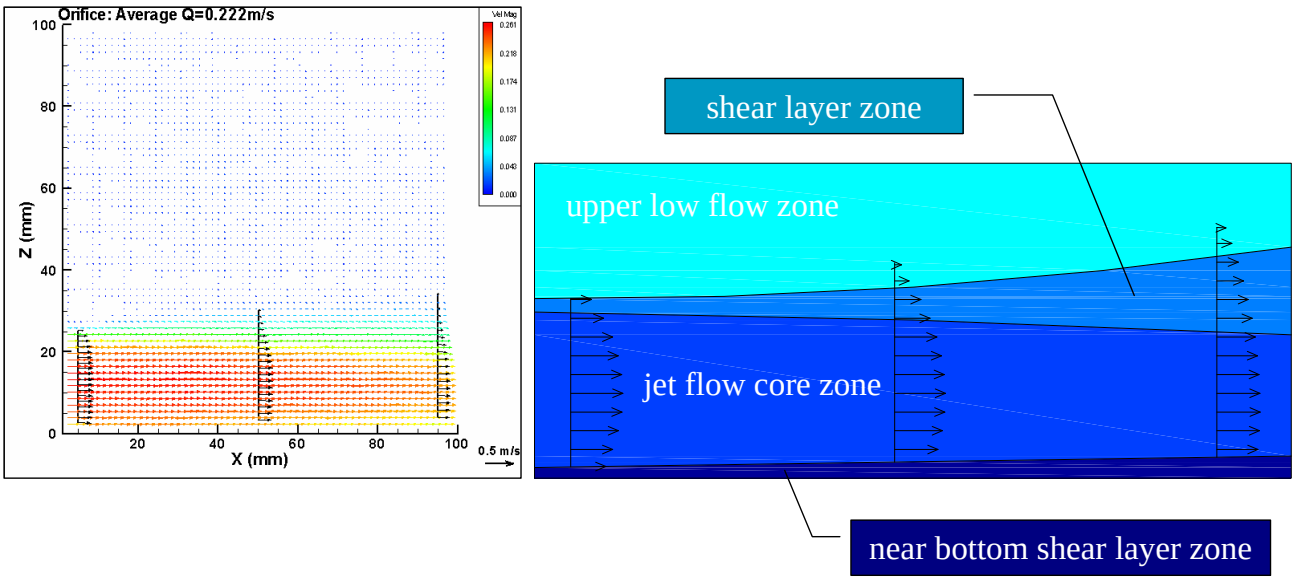
Flow distribution without deflectors



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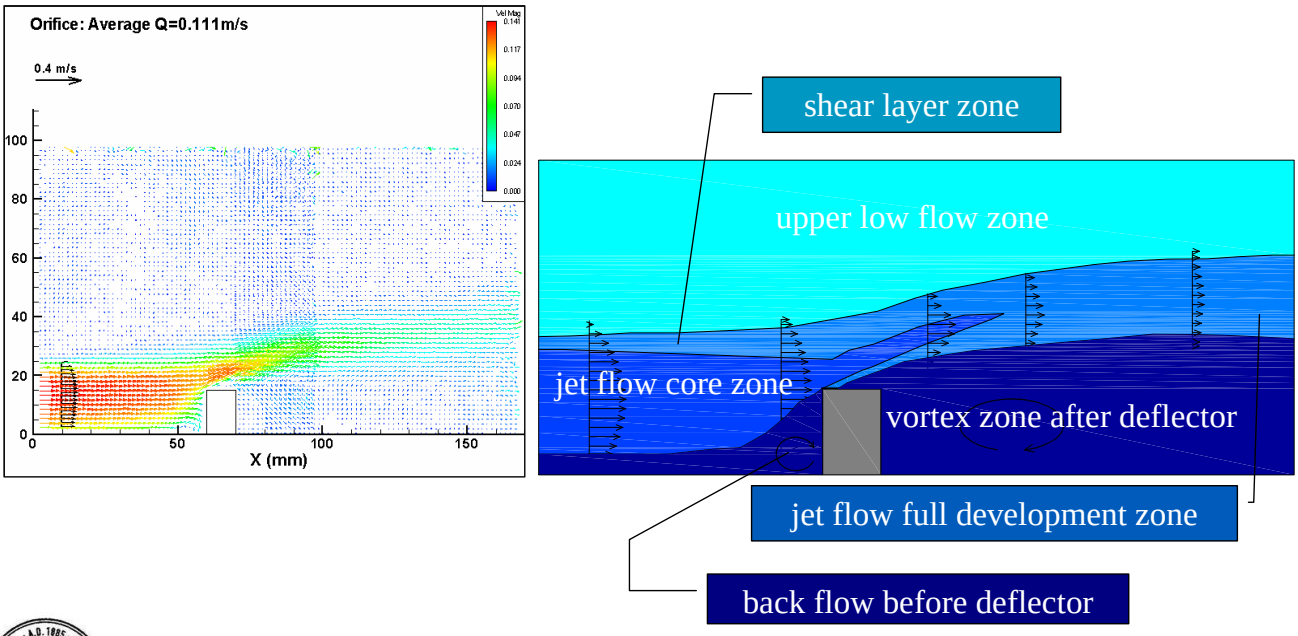
Flow distribution with deflectors

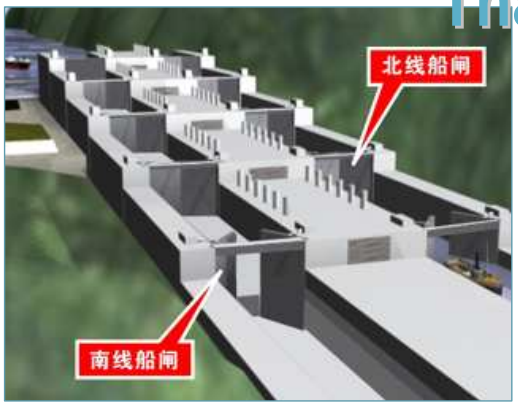


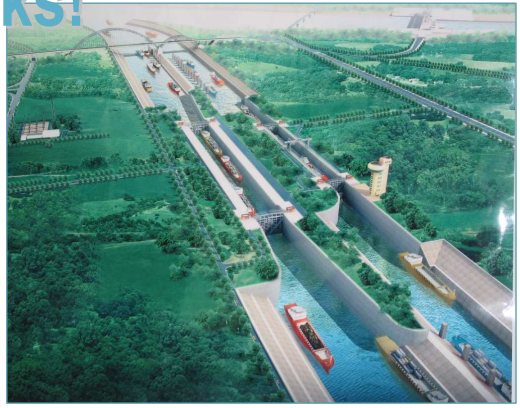
Hydraulic system discussion

- In design stages, the selection of proper hydraulic system need enough knowlege and experience.
- There is no one-size-fits-all approach.
- As the development of hydraulic simulation, we can validate all possible measures to make asymmetric system more balanced and more efficient.

Hydraulic system discussion

Thanks!





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