

# PRESURE FORCE AT PIPE ENTRANCE DURING CLOSURE PROCESS



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## POND SAFETY

**FACTS:** Trash is often accumulated at the entrance of an outfall pipe.

If so, the pipe opening area is reduced,  
the flow at the entrance is accelerated,  
the pressure of the flow is reduced,  
the force or pressure difference increases, and  
subsurface currents and vortices create unseen hazards.



## PURPOSE OF STUDY

To quantify the pressure force when the pipe entrance is gradually clogged.

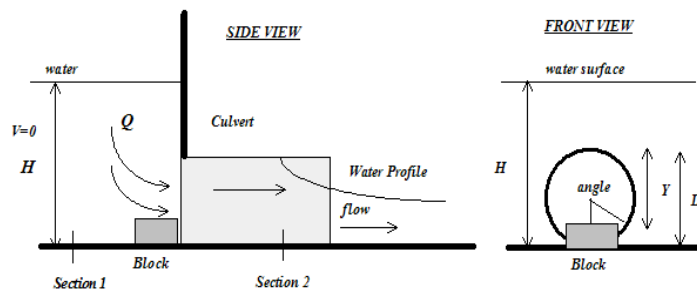
- to determine the extreme conditions
  - completely open
  - completely closed
- to calculate the continuous change of the force between two extremities

## PIPE HYDRAULICS

$$Y = D - \frac{D}{2}(1 - \cos \theta)$$

$$A = A_f \left[ 1 - \frac{1}{\pi}(\theta - \sin \theta \cos \theta) \right]$$

$$A_f = \frac{\pi D^2}{4}$$

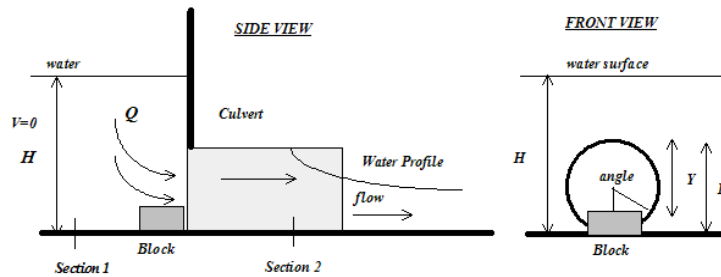


# FLOW AND FORCE at ENTRANCE

$$Q = C_v A \sqrt{2g(H - \frac{Y}{2})}$$

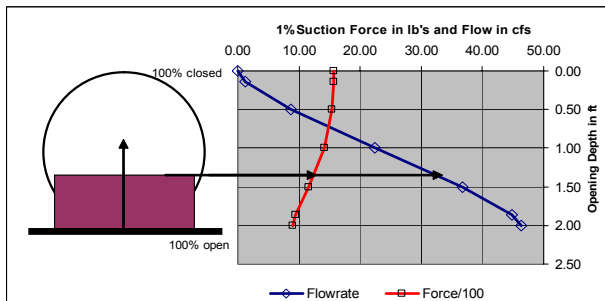
$$F = \gamma(H - \frac{D}{2})A_F - \rho Q V_F$$

$$F = \gamma(H - \frac{D}{2})A_F \quad \text{When } Q=0 \text{ and } V_F=0$$



## 24-inch Pipe under 9-ft Water

Clogging	Opening	Opening	Orifice	X-section	1.0% of
Angle	Area	Depth	Flow rate	Velocity	Pressure
radians	$ft^2$	$ft$	$cfs$	$fps$	$lb$
	Eq 2	Eq 1	Eq 4	Eq 5	Eq 6
0.000	3.14	2.00	46.35	14.75	9.06
0.524	3.05	1.87	44.82	14.27	9.49
1.047	2.53	1.50	36.70	11.68	11.53
1.571	1.57	1.00	22.44	7.14	14.13
2.094	0.61	0.50	8.63	2.75	15.45
2.618	0.09	0.13	1.26	0.40	15.68
3.142	0.00	0.00	0.00	0.00	15.68



## CONCLUSION

- Trash rack is often considered for debris control only.
  - In fact, a trash rack is the most economic measure to protect the outfall pipe from debris clogging and also to sustain a continuous flow through the outfall pipe.
- An inclined trash rack provides assistance for a person or a child to climb up above the water.

## CONCLUSION

- A vertical trash rack prevents a person, including a child, from plugging the pipe entrance.
- Once the outfall pipe begins to plug, the acting force quickly switches from the dynamic to hydrostatic.
- Case study indicates that the hydrostatic force of 4-foot water on a 24-inch clogged pipe can be lethal.
  - This is not to say that a lesser depth, in combination with smaller pipe outlet, could not be lethal also.