การออกแบบระบบกวนเร็วแบบ *Parshall Flume*

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1 Parshall Flume Design

Item	Unit	Apply Unit	Unit
1.1 Power (P)	KW	W = N.m/s N = $kg.m/s^2$	$Kg.m^2/s^3$
1.2 Mass Density of water	kg/m^3	1000	kg/m^3
1.3 Flow rate (Q)	m^3/min		
1.4 Acceleation of gravity (g)	m/s^2	9.81	m/s^2
1.5 ΔH	m.		

1 Hydraulic Type

Theory

$$P = \rho g Q \Delta H$$

$$P = 1{,}000\frac{kg}{m^3}9.81\frac{m}{s^2}xQ(m^3/\min)\ x\Delta H(m)$$

$$P = 1{,}000kgx9.81\frac{m}{s^2}xQ(\frac{1}{\min}x\frac{\min}{60\sec})x\Delta H(m)$$

$$P = 1{,}000x9.81x\frac{1}{60}xQx\Delta H(kg.\frac{m^2}{s^3})$$

$$P = 1{,}000x\left(9.81x\frac{1}{60}xQ\Delta H\right)\left[kg\frac{m^2}{s^3}\right]$$

$$P = 1{,}000x(0.1635xQ\Delta H)\left[kg\frac{m^2}{s^3}\right]$$

$$P = 1{,}000(0.1635xQ\Delta H)\left[kg\frac{m}{s^2}\frac{m}{s}\right]$$

$$P = 1{,}000(0.1635xQ\Delta H)\left[N\frac{m}{s}\right]$$

$$\therefore \quad P = 0.1635Q\Delta H \quad [KW]$$

check the free-fall condition.

W, throat width	H_b/H_a ratio
3-9 in. (76-229 mm)	< 0.6
1-8 ft. (0.30-2.44 m)	< 0.7
10-50 ft. (3.05-15.2 m)	< 0.8

Under unrestricted flow conditions, the discharge through a Parshall flume is can be determined from Eq. (8.31) by using the reading of flow depth H_a.[44]

$$Q = 4WH_a^{1.522W^{0.026}} \tag{8.31}$$

where

Q = free-flow discharge, cfs
W = throat width, ft.
H_a = depth of water at upstream gauging point, ft.

TABLE 8.10 Free discharge as a function of throat width

Throat width, ft	Free discharge equation, ft³/s
0.25	$Q = 0.992\ H_a^{1.547}$
0.50	$Q = 2.06\ H_a^{1.58}$
0.67	$Q = 3.07\ H_a^{1.53}$
$1 \le W \le 8$	$Q = 4\ W\ H_a^{1.522W^{0.026}}$
$10 \le W \le 50$	$Q = (3.6875\ W + 2.5)H_a^{1.6}$

desirable to design the Parshall flume so that free flow occurs, under some flow conditions the hydraulic jump at the exit section will be submerged, and the free-flow condition will not exist. Nonfree discharge or submerged flow occurs when

$$\frac{H_b}{H_a} \ge 0.6 \qquad \text{for } W = 0.25, 0.50, 0.75 \text{ ft } (0.076, 0.15, 0.23 \text{ m})$$

$$\frac{H_b}{H_a} \ge 0.7 \qquad \text{for } 1 \le W \le 8 \text{ ft } (0.30 \le W \le 2.4 \text{ m})$$

and

$$\frac{H_b}{H_a} \ge 0.8 \qquad \text{for } 10 \le W \le 50 \text{ ft } (0.24 \le W \le 15 \text{ m})$$

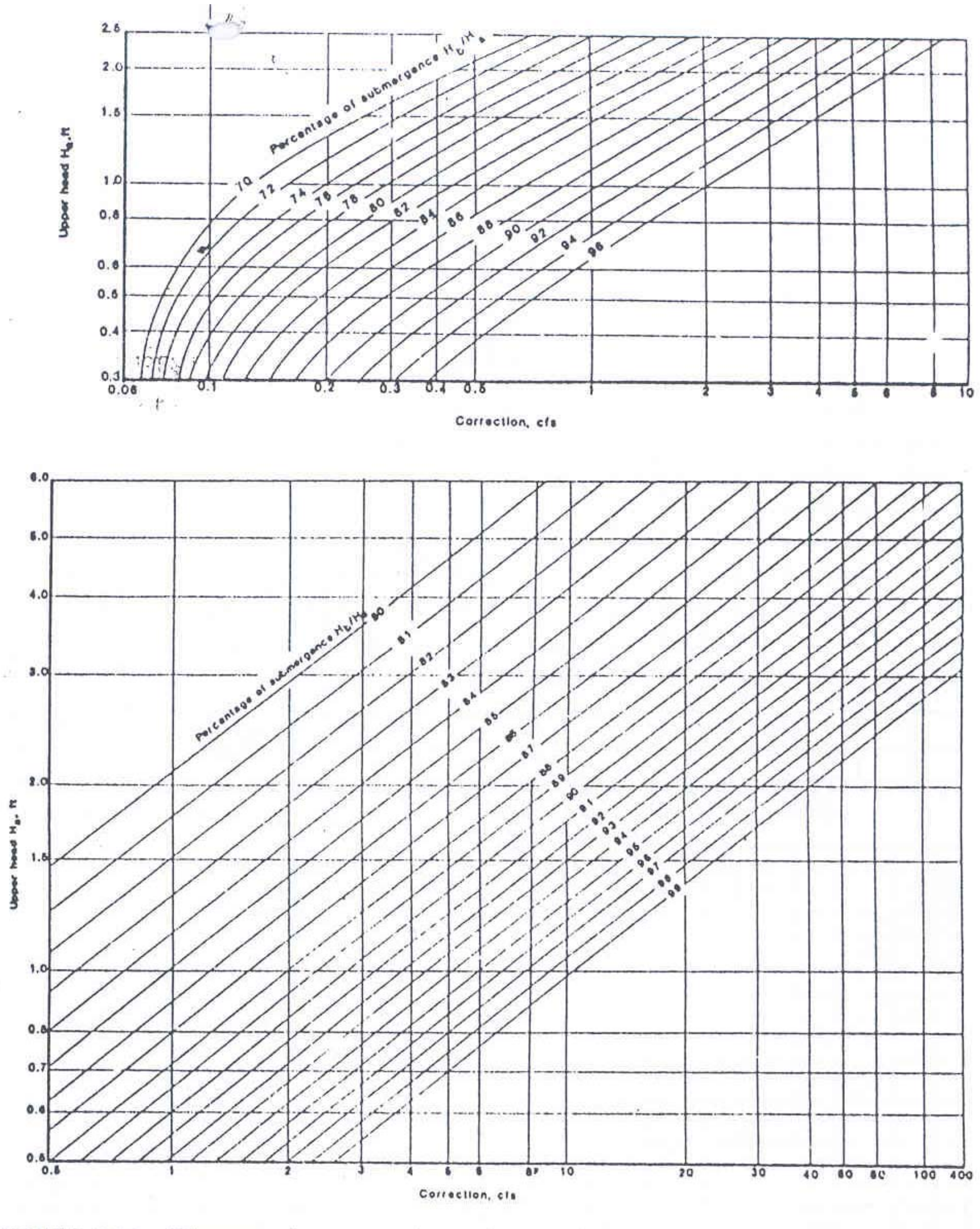


FIGURE 8.21 Diagrams for computing submerged flow through Parshall flumes of various sizes.

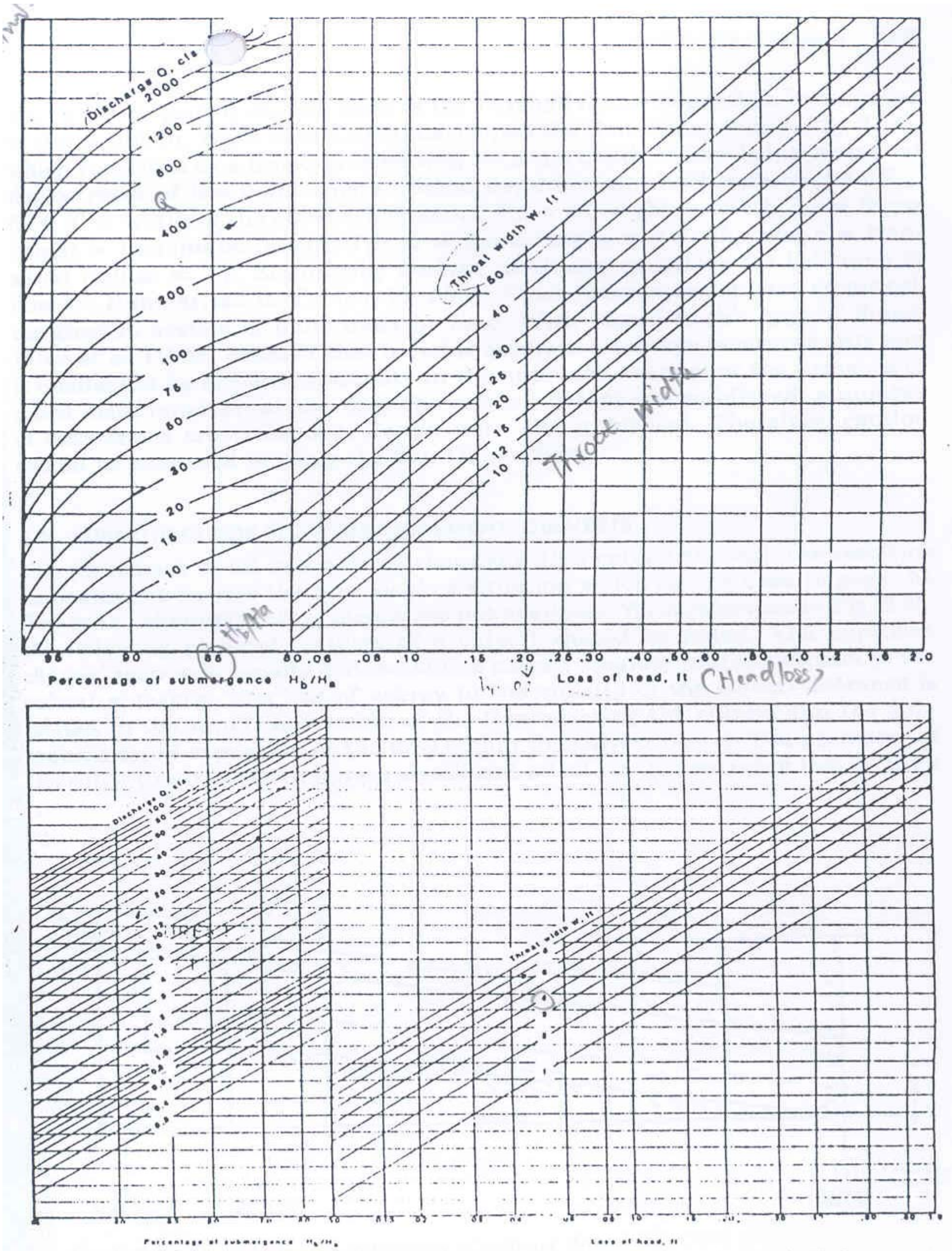
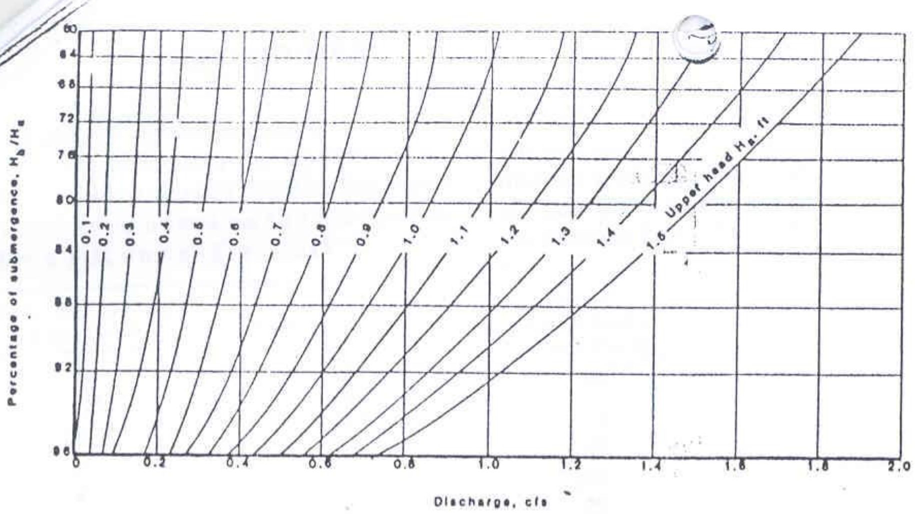
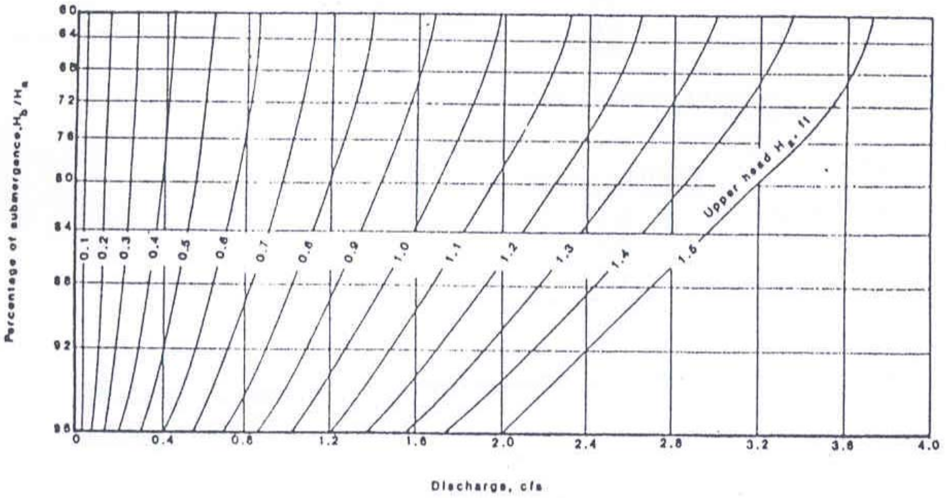
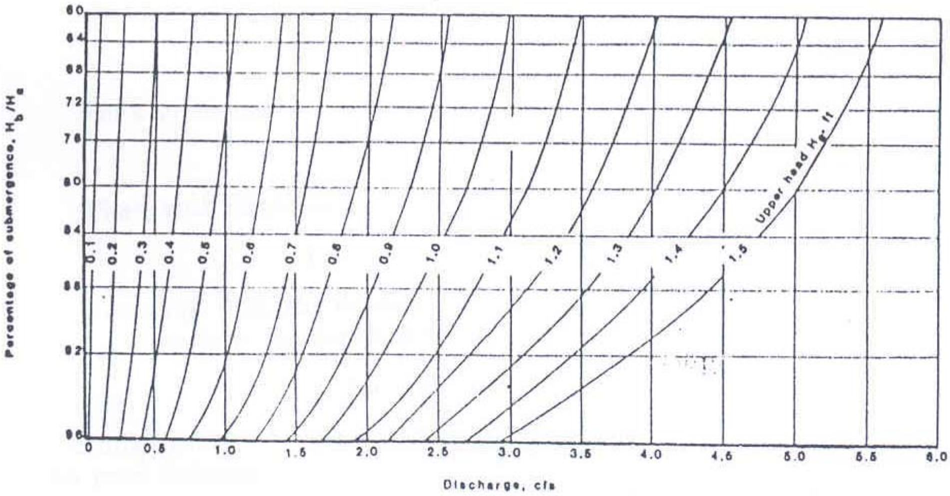
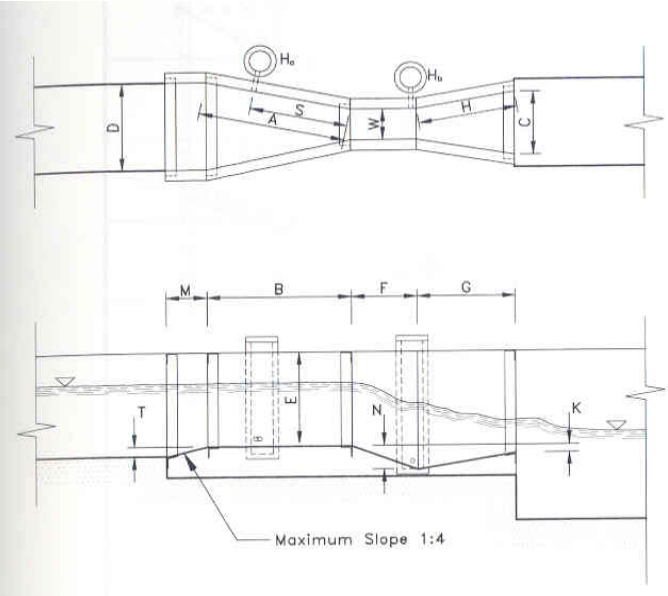


FIGURE 8.22 Diagrams for determining the loss of head through Parshall flumes of


Percentage of submergence, H_b/H_a
60
64
68
72
76
80
84
88
92
96
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Discharge, cfs
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Upper head H_a, ft


Percentage of submergence, H_b/H_a
60
64
68
72
76
80
84
88
92
96
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
4.0
Discharge, cfs
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Upper head H_a, ft


Percentage of submergence, H_b/H_a
60
64
68
72
76
80
84
88
92
96
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Discharge, cfs
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Upper head H_a, ft

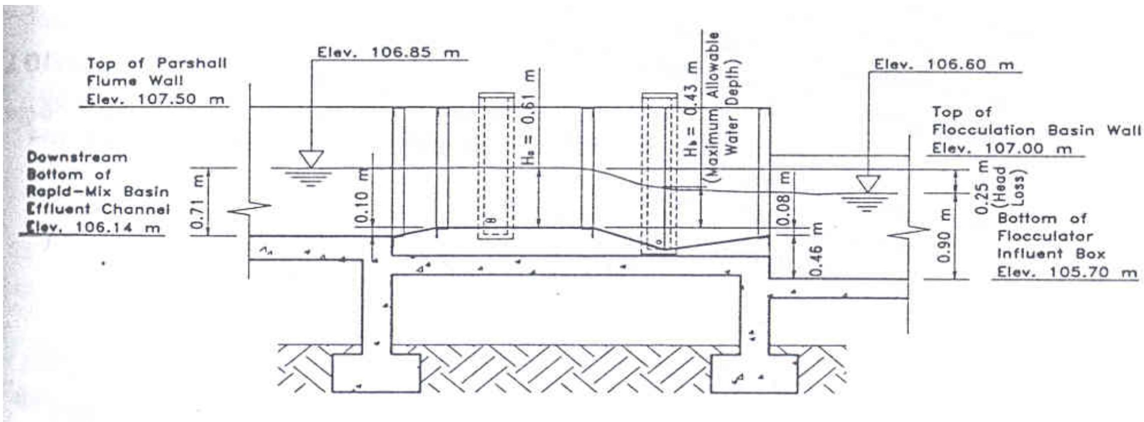


Standard Dimensions of Parshall Flume
W = 0.3 m (1 ft)

Section	Dimension, m
A	1.37
B	1.34
C	0.61
D	0.85
E	0.91
F	0.61
G	0.91
H	0.92
K	0.08
M	0.38
N	0.23
S	0.91
T	0.10
W	0.30

Flow Measurement

Maximum Capacity	456 L/s
Minimum Capacity	10 L/s



1 Calculate Parshall Flume

Give ΔH = 0.3 m.

Q = 4.86 m^3/s

= 291.6 m^3/min

$V(volume)$ = 20 m^3

μ = 0.000798 $N.s/m^2$ at 30 ^oC = Kg/m.s

ρ = 995.7 kg/m^3 30 ^oC

Throat width (W) = 10 ft

Theory $P = 0.1635Q\Delta H \quad [KW]$

= 14.30298 KW

= 14302.98 W = N.m/s

Theory
$$G = \sqrt{\frac{P(N.m/s)}{\mu(N.s/m^2)V(m^3)}}$$

G = 947 s^{-1}

2 Calculate H_b/H_a

Theory
$$G = \sqrt{\frac{P(N.m/s)}{\mu(N.s/m^2)V(m^3)}}$$

$$P = \rho g Q\Delta H$$

Then
$$G = \sqrt{\frac{\rho(kg/m^3)g(m/s^2)Q(m^3/s)\Delta H(m)}{\mu(kg/m.s)V(m^3)}}$$

$\therefore \Delta H$ = 0.301 m.

ΔH = 0.989 ft.

Then ΔH= 0.989 ft at Q= 4.86 m^3/s = 171.654 ft^3/s

and Throat width= 10 ft Calculate H_b/H_a= 0.8 (From Graph 8.22)

1 Calculation Velocity Gradient

Give Q = 4.86 m^3/s

= 171.65 ft^3/s

Throat width (W) = 10 ft

Theory 1

$$Q = 4WH_a^{1.522W^{0.026}}$$ (Water Works Engineering,Qasim,2000 Year)

Where :

Q = Free Flow discharge, ft^3/s

W = Throat width, ft

H_a = Depth of water at upstream gauging point, ft

$\therefore$ H_a = 2.4631 ft ⟶ (1)

Theory 2

$$Q = (3.6875W + 2.5)H_a^{1.6}$$ (Open-Chanel Hydraulic Book)

This Equation use for Throat width 10 < W < 50 ft and $\frac{H_b}{H_a} \geq 0.8$

Where :

Q = Free Flow discharge, ft^3/s

W = Throat width, ft

H_a = Depth of water at upstream gauging point, ft

$\therefore$ H_a = 2.5098 ft ⟶ (2)

(1) $\approx$ (2) OK

$\therefore$ H_b = 1.9705 ft

Theory

$$G = \sqrt{\frac{\rho(kg/m^3)g(m/s^2)Q(m^3/s)\Delta H(m)}{\mu(kg/m.s)V(m^3)}}$$

946.67 s^{-1}