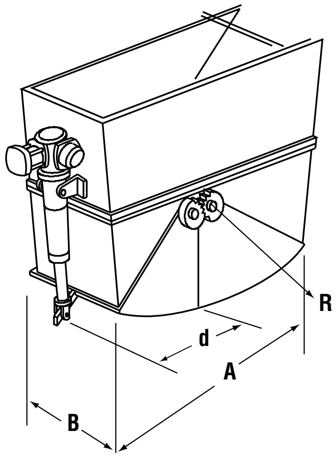
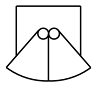
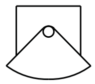
CLAM SHELL OR UNDERCUT GATES

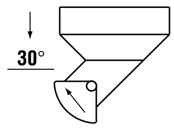




Clamshell Gate



Undercut Gate



Undercut Gate with an Angled Chute
(Use "H1" x .87)

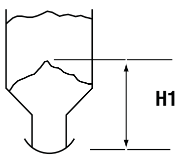


Fig 1
(Fully Loaded Hopper)

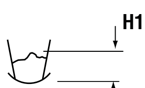


Fig 2
(Partially Filled Gates)

Formulas

$$H1 = \left[\begin{matrix}\text{Larger of A or B}\\ \text{dimensions}\end{matrix}\right] \times \left[\begin{matrix}\text{“h” factor from}\\ \text{Table 2}\end{matrix}\right] = \_\_\_\_\_\_ \text{ ft}$$

$$W2 = [A \text{ ft} \times B \text{ ft} \times H1 \text{ ft}] \times W1 \text{ (lbs/ft}^3) = \_\_\_\_\_\_ \text{ lbs}$$

$$BAf = \frac{[(W2 \text{ lbs} \times \mu 2) + W3 \text{ lbs}] \times R \text{ (ft)} \times a}{d \text{ (ft)}} = \_\_\_\_\_\_ \text{lbs}$$

$$Rf(avg) = \frac{[(W2 \times \mu 4) + W3 \text{ lbs}] \times R \text{ (ft)}}{d\text{(ft)} \times 1.75} = \_\_\_\_\_\_ \text{lbs}$$

Example

Determine the actuator force required to open a 4 ft. square coal refuse clam shell gate. The total weight of the gate is 750 lbs. No other dimensions are known.

$$W2 = 4 \text{ ft} \times 4 \text{ ft} \times (4 \text{ ft} \times 2.0) \times 45 \text{ (lbs/ft}^3) = 5760 \text{ lbs}$$

$$W3 = 750 \text{ lbs}, R = (4 \text{ ft}/2 \times 1.5) = 3 \text{ ft.}, d = 4 \text{ ft}/1.9 = 2.11 \text{ ft}$$

$$BAf = \frac{[(5760 \text{ lbs} \times .75) + 750 \text{ lbs}] \times 3 \text{ ft} \times 1.2}{2.11 \text{ ft}} = 8650 \text{ lbs}$$

$$Rf\ (avg) = \frac{[(5760 \text{ lbs} \times 0.5) + 750 \text{ lbs}] \times 3 \text{ ft}}{2.11 \text{ ft} \times 1.75} = 2950 \text{ lbs}$$

* Acceleration factor based on velocity of 3.5 in/sec or less.

Gate Operation: The maximum force required to operate a clam shell and undercut gates occur when opening from a fully closed position when material is resting on the gate blade. To move the gate, static friction ($\mu 2$) must be overcome. Once moving, the material weight on the gate is reduced, the coefficient of friction is lower and the required force is reduced proportionally as the gate opens.

Required Information: Dimensions A, B, d* and R,* material being handled, gate weight (W3) and approximate material height above the gate blade “H1”. *See legend if dimensions are not known.

Legend	
A	length of gate opening (ft)
B	width of gate opening (ft)
d	effective length of lever arm (ft) (If specific dimension is not known use length of gate “A”/1.9)
H1	effective height of material on the gate blade (ft). See Figure 1 and 2
R	radius of gate (ft). If specific dimension is not known use (A/2 x 1.5).
W1	average material specific weight (lbs/ft^3) (Table 2)
W2	material weight on gate blade (lbs).
W3	gate weight (lbs).
$\mu 2$ & $\mu 4$	coefficients of starting ($\mu 2$) and running ($\mu 4$) friction between the material in the hopper and the gate blade. (Table 2)
a	acceleration factor (Table 3)
Baf	required breakaway force (lbs)
Rf (avg)	average required running force (lbs)
Fig 1	Material in a hopper will start to bridge or support itself a certain height (H1) above the gate blade. To find “H1” use the “h” factor from Table 2, and the formula.
Fig 2	If the actual material above the gate blade is less than the calculated value of “H1” use the actual height in feet.

Reference Tables on Page 45.

APPLICATION NOTES

1. Select actuator according to breakaway force requirements.

ENGINEERING TABLES

TABLE 1

Guide Type	Coefficient of Friction Between Steel Plate and Various Type Guides			
	Dry		Lubricated	
	Starting ($\mu 1$)	Running ($\mu 3$)	Starting ($\mu 1$)	Running ($\mu 3$)
Ball Bearings	–	–	0.08	0.05
Steel Rollers	–	–	0.15	0.10
Bronze	0.45	0.20	0.2	0.15
Steel	0.4-0.8	0.2-0.4	0.2-0.4	0.15-0.2

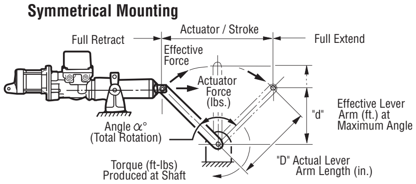
TABLE 2

Material	Coefficient of Friction Between Steel Plate and Various Materials		Specific Weights "W1" (lbs/ft3)	Column Height Factor "h"
	Starting ($\mu 2$)	Running ($\mu 4$)		
Ash (fly)	0.6-0.7	0.3	40-45	3.0
Ash (wet) (coal refuse)	0.75-0.95	0.5	45-50	2.0
Cement (portland)	0.6-0.65	0.3	95-100	3.0
Cement (clinker)	0.55-0.6	0.3	80-95	4.0
Coal (anthracite)	0.50-0.55	0.25	55-60	4.5
Coal (bituminous)	0.55-0.6	0.3	45-55	3.0
Coke	0.55-0.6	0.3	25-35	3.5
Grain	0.32-0.40	0.2	40-50	4.75
Iron Ore	0.55-0.65	0.3	125-180	3.5
Limestone (crushed)	0.55-0.65	0.3	80-90	3.5
Rock (crushed)	0.65-0.7	0.3	125-140	4.0
Sand (dry)	0.5-0.55	0.3	90-110	4.0
Sand (damp)	0.6-0.65	0.4	110-125	2.5
Slag (blast furnace)	0.4-0.45	0.2	80-90	5.5
Steel	See Table 1	See Table 1	490	–
Taconite	0.35-0.4	0.2	120-130	8.25
Wood chips	0.75-0.8	0.4	10-30	2.5

TABLE 3

Velocity (in/sec.)	0.1 to 3.5	3.6 to 6.4	6.4 to 12.2	12.3 to 25.0
Acceleration Factor (a)	1.2	1.3	1.4	1.5

Symmetrical Mounting



Non-Symmetrical Mounting

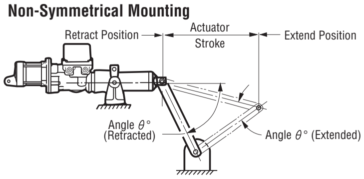


TABLE 4

Angle a	6" Stroke d'	6" Stroke D"	12" Stroke d'	12" Stroke D"	18" Stroke d'	18" Stroke D"	24" Stroke d'	24" Stroke D"
30°	.93	11.6	1.87	23.2	2.80	34.8	3.73	46.4
45°	.60	7.8	1.21	15.7	1.81	23.5	2.41	31.4
60°	.43	6.0	.87	12.0	1.30	18.0	1.73	24.0
90°	.25	4.2	.50	8.5	.75	12.7	1.00	17.0

Angle a	30" Stroke d'	30" Stroke D"	36" Stroke d'	36" Stroke D"	48" Stroke d'	48" Stroke D"	60" Stroke d'	60" Stroke D"
30°	4.67	58.0	5.60	69.5	7.46	92.7	9.33	115.9
45°	3.02	39.2	3.62	47.0	4.83	62.7	6.04	78.4
60°	2.17	30.0	2.60	36.0	3.46	48.0	4.33	60.0
90°	1.25	21.2	1.50	25.5	2.00	33.9	2.50	42.4

Angle Ø°	5°	15°	30°	45°	60°	75°	90°
Force Factor	0.09	0.26	0.50	0.71	0.87	0.97	1.00

Effective force (lbs) = Actuator force (lbs) x force factor
Effective lever arm (ft) = Actual length arm (ft) x force factor

NOTES

1. For non-symmetrical mounting the angle Ø° will change as the actuator moves through its travel. The angle Ø° is formed between the actuator drive rod centerline and the lever arm axis.

Torque (ft/lbs) = Effective lever arm (ft) x actuator force (lbs)
Force Required (lbs) = Torque (ft/lbs) ÷ Effective lever arm (ft)