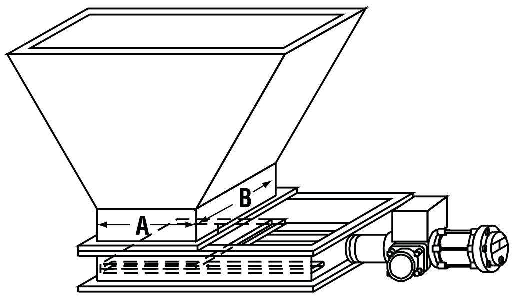
GENERAL APPLICATIONS

SLIDE GATES



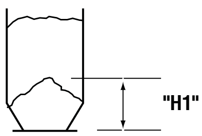


Fig. 1
(fully loaded hopper)

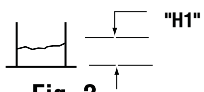


Fig. 2
(gate under a conveyor)

Gate Operation: The maximum force required to operate a slide gate occurs when opening from a fully closed position with material resting on the gate blade. To move the gate, static friction must be overcome ($\mu 1$ and $\mu 2$). Once moving, the material weight on the gate is reduced, the friction is lower and the required force is reduced proportionally as the gate opens.

Required Information: Dimensions A and B, material being handled, effective height of material on the gate blade “H1”, type of gate guide (steel plate, rollers, etc.)

Formulas

$$H1 = \text{Larger of A or B dimensions} \times \text{“h” factor from Table 2} = \_\_\_\_\_\_\_\_ \text{ ft}$$

$$W2 = A\text{ (ft)} \times B\text{ (ft)} \times H1\text{ (ft)} \times W1\text{ (lbs/ft}^3\text{) (material in the hopper)} = \_\_\_\_\_\_\_\_ \text{ lbs}$$

$$W3 = A\text{ (ft)} \times B\text{ (ft)} \times \text{Gate thickness (ft)} \times 490\text{ (lbs/ft}^3\text{) (steel)} = \_\_\_\_\_\_\_\_ \text{ lbs}$$

$$BAf = [(W2\text{ lbs} \times \mu 2) + ((W2\text{ lbs} + W3\text{ lbs}) \times \mu 1)] \times a = \_\_\_\_\_\_\_\_ \text{ lbs}$$

$$Rf\text{ (avg)} = \frac{(W2\text{ lbs} \times \mu 4) + [(W2\text{ lbs} + W3\text{ lbs}) \times \mu 3]}{1.75} = \_\_\_\_\_\_\_\_ \text{ lbs}$$

Example

Find the force required to operate a 3 foot square slide gate underneath a fully loaded 50 ft high storage hopper of grain. The gate blade is made of 1 inch thick steel supported on steel rollers.

$$W2 = 3\text{ ft} \times 3\text{ ft} \times (3\text{ ft} \times 4.75) \times 40\text{ lbs/ft}^3 = 5130\text{ lbs}$$

$$W3 = 3\text{ ft} \times 3\text{ ft} \times (1\text{in}/12\text{ ins/ft}) \times 490\text{ lbs/ft} = 368\text{ lbs}$$

$$BAf = [(5130\text{ lbs} \times 0.32) + ((5130\text{ lbs} + 368\text{ lbs}) \times 0.15)] \times 1.2^* = 2960\text{ lbs}$$

$$Rf = \frac{(5130\text{ lbs} \times .0.2) + [(5130\text{ lbs} + 368\text{ lbs}) \times 0.10]}{1.75} = 900\text{ lbs}$$

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

Legend

A	length of gate opening (ft) (also actuator travel)
B	width of gate opening (ft)
H1	effective height of material on the gate blade (ft). See Figure 1 and 2
W1	average material specific weight (lbs/ft) (Table 2)
W2	material weight on gate blade (lbs) (Table 2)
W3	gate weight (lbs) (Table 2)
a	acceleration factor (Table 3)
$\mu 2$ & $\mu 4$	coefficients of starting ($\mu 2$) and running ($\mu 4$) friction between the material in the hopper and the gate blade (Table 2)
$\mu 1$ & $\mu 3$	coefficients of starting ($\mu 1$) and running ($\mu 3$) friction between the gate blade and the gate guides. (Table 1)
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 as referenced.
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.
2. For rack and pinion slide gates use above forces.

ENGINEERING TABLES

TABLE 1

Guide Type	Coefficient of Friction Between Steel Plate and Various Type Guides			
	Dry		Lubricated	
	Starting ($\mu1$)	Running ($\mu3$)	Starting ($\mu1$)	Running ($\mu3$)
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

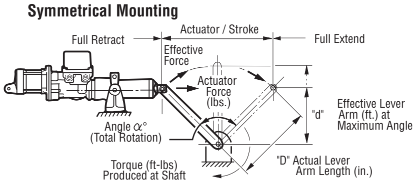
TABLE 2

Material	Coefficient of Friction Between Steel Plate and Various Materials		Specific Weights "W1" (lbs/ft3)	Column Height Factor "h"
	Starting ($\mu2$)	Running ($\mu4$)		
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

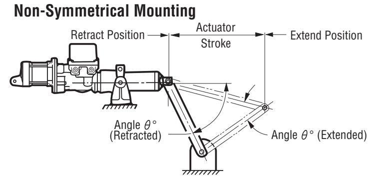


TABLE 4

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)