

$$D_{50} = 0.2 D \left(\frac{Q}{\sqrt{g'} D^{2.5}} \right)^{4/3} \left(\frac{D}{T_w} \right)$$

In supercritical flow: $D \rightarrow D' = \frac{D + y_N}{2}$

$$\tau = \gamma (1) (s)$$

Line 1900

$$\text{Super critical, } D' = \frac{3.5' + 2.1'}{2} = 2.8'$$

$$Q = 51.3 \text{ ft}^3/\text{s}$$

$$g = 32.2 \text{ ft}/\text{s}^2$$

$$D' = 2.8'$$

$$T_w = .4(D) = 1.4'$$

$$D_{50} = .2 (2.8') \left(\frac{51.3 \text{ ft}^3/\text{s}}{\sqrt{32.2 \text{ ft}/\text{s}^2} (2.8')^{2.5}} \right)^{4/3} \left(\frac{2.8'}{1.4'} \right)$$

$$D_{50} = .56 (0.689)^{4/3} (2)$$

$$D_{50} = 0.68 \text{ ft or } 8.2''$$

$$\tau = (62.4 \text{ lb}/\text{ft}^3) (2.1') (.005)$$

$$\tau = 0.65 \text{ lb}/\text{ft}^2$$

Round D_{50} up to 12", Use MODOT Type 3

Per APWA Table 5607-1, MODOT Type 3 can handle shear stress at outflow.

Line 2200

$$\text{Supercritical, } D' = \frac{3.5 + 2.09}{2} = 2.80'$$

$$Q = 61.8 \text{ ft}^3/\text{s}$$

$$q = 32.2 \text{ ft}^3/\text{s}^2$$

$$D' = 2.8'$$

$$T_w = .4(D) = 1.4'$$

$$D_{50} = .2(2.8') \left(\frac{61.8 \text{ ft}^3/\text{s}}{\sqrt{32.2 \text{ ft}^3/\text{s}^2} (2.8')^{2.5}} \right)^{4/3} \left(\frac{2.8'}{1.4'} \right)$$

$$D_{50} = .56 (.830)^{4/3} (2)$$

$$D_{50} = 0.87 \text{ ft or } 10.5"$$

$$\tau = (62.4 \text{ lb}/\text{ft}^3)(2.09')(.005)$$

$$\tau = 0.65 \text{ lb}/\text{ft}^2$$

Round D_{50} up to 12", Use MODOT Type 3

Per APWA Table 5607-1, MODOT Type 3 can handle shear stress at outflow.

Other types of lining materials not specifically listed in Table 5607-1 may be used when approved by the City/County Engineer.

Concrete lined open channel bottoms are prohibited, unless a waiver to this criterion is granted by the City/County Engineer.

Table 5607-1: Permissible Shear Stresses for Lining Material

Lining Category	Lining Type	Permissible Shear Stress (lbs/ft ²)
General	Erosion Control Blankets	1.55-2.35
	Turf-Reinforced Matrix (TRMs): Unvegetated: Vegetated:	----
		3.0
	Geosynthetic Materials	8.0
		3.01
	Cellular Containment	8.1
	Woven Paper Net	0.15
	Jut Net	0.45
	Fiberglass Roving: Single Double	---
		0.60
		0.85
	Straw With Net	1.45
	Curled Wood Mat	1.55
	Synthetic Mat	2.00
Vegetative	Class A (see Table 5607-2)	3.70
	Class B (see Table 5607-2)	2.10
	Class C (see Table 5607-2)	1.00
	Class D (see Table 5607-2)	0.60
	Class E (see Table 5607-2)	0.35
Gravel Riprap	25 mm	0.33
	50 mm	0.67
Rock Riprap	150 mm	2.00
	300 mm	4.00
Bare Soil	Non-Cohesive	See Figure 5607-1
	Cohesive	See Figure 5607-2