Relocated Ryder Brook

Calculations of Shear Stresses on Channel Bottom

From FHWA HEC-15

Maximum permissible shear stress in straight section of relocated channel:

$\tau_d = \gamma d S_o$ (Eq. 3-1)

γ = 62.4 lb/ft^2

d = 1.16 ft back-calculated from 100-yr flow of 24 CFS

S_o = 0.013 ft/ft

τ_d = 62.4 x 1.16 x 0.013 = **<u>0.94 lb/ft^2</u>**

<u>From Table 2.3, maximum permissible shear stress of 3" gravel mulch (river stone) = 1.2 lb/ft^2*</u>

<u>Therefore, use a minimum avg. size 3" diameter river stone ins straight section of channel.</u>

*Extrapolated from Eq. 6.7:

$\tau_p = F_o (\gamma_S - \gamma) D_{50}$ where:

F_o = 0.047 (Shield's parameter)

γ_S = 165 lb/ft^3

γ = 62.4 lb/ft^3

D_{50}= 3" (0.25 ft)

Maximum permissible shear stress in bend and slope of relocated channel:

$\tau_b = K_b \tau_d$ (Eq. 3-6)

$\tau_d = \gamma d S_o$ (Eq. 3-1)

$\gamma = 62.4$ lb/ft^2

d = 0.61 ft back-calculated from 100-yr flow of 24 CFS

$S_o = 0.08$ ft/ft

$\tau_d = 62.4 \times 0.61 \times 0.08 = 3.05$ lb/ft^2

$K_b = 2.38 - 0.206(R_c/T) + 0.0073(R_c/T)^2$ (where $2 < R_c/T < 10$)

R_c = Radius of curvature = 22'±

T = channel top width = 4.72'

$R_c/T = 22/4.72 = 4.66$

$K_b = 2.38 - 0.206(4.66) + 0.0073(4.66)^2$

$K_b = 1.58$

$\tau_b = 1.58 \times 3.05 =$ **4.8 lb/ft^2**

From Table 2.3, maximum permissible shear stress of 12" broken stone (riprap) = 4.8 lb/ft^2

Therefore, 12" broken stone should be used at slope and bend of channel.

Manning's Eq for trap. Channels

Relocated Ryder Brook- Straight Section

Bottom Width	BW=	3.50
Side Slope	SS=	2.00
# of sides (1 for curb)		2.00
Depth of Flow	D=	**1.16**
Slope	S=	0.013
Manning's "n"	n=	0.040
Flow Area	A=	6.75
Wetted Perimeter	P=	8.69
Hydraulic Radius	R=	0.78
Spread	T=	4.34
Top Width	T=	5.82
Velocity (fps)	V=	3.59
Flow (cfs)	Q=	24.24

Relocated Ryder Brook- Slope & Bend

Bottom Width	BW=	3.50
Side Slope	SS=	2.00
# of sides (1 for curb)		2.00
Depth of Flow	D=	**0.61**
Slope	S=	0.080
Manning's "n"	n=	0.040
Flow Area	A=	3.44
Wetted Perimeter	P=	6.23
Hydraulic Radius	R=	0.55
Spread	T=	3.11
Top Width	T=	4.72
Velocity (fps)	V=	7.09
Flow (cfs)	Q=	24.37

protected. Therefore permissible shear stress is not significantly affected by the erodibility of the underlying soil. However, if the lining moves, the underlying soil will be exposed to the erosive force of the flow.

Table 2.3 provides typical examples of permissible shear stress for selected lining types. Representative values for different soil types are based on the methods found in Chapter 4 while those for gravel mulch and riprap are based on methods found in Chapter 7. Vegetative and RECP lining performance relates to how well they protect the underlying soil from shear stresses so these linings do not have permissible shear stresses independent of soil types. Chapters 4 (vegetation) and 5 (RECPs) describe the methods for analyzing these linings. Permissible shear stress for gabion mattresses depends on rock size and mattress thickness as is described in Section 7.2.

Table 2.3. Typical Permissible Shear Stresses for Bare Soil and Stone Linings

		Permissible Shear Stress	
Lining Category	Lining Type	N/m^2	lb/ft^2
Bare Soil[1] Cohesive (PI = 10)	Clayey sands	1.8-4.5	0.037-0.095
	Inorganic silts	1.1-4.0	0.027-0.11
	Silty sands	1.1-3.4	0.024-0.072
Bare Soil[1] Cohesive (PI $\geq$ 20)	Clayey sands	4.5	0.094
	Inorganic silts	4.0	0.083
	Silty sands	3.5	0.072
	Inorganic clays	6.6	0.14
Bare Soil[2] Non-cohesive (PI < 10)	Finer than coarse sand D_{75}<1.3 mm (0.05 in)	1.0	0.02
	Fine gravel D_{75}=7.5 mm (0.3 in)	5.6	0.12
	Gravel D_{75}=15 mm (0.6 in)	11	0.24
Gravel Mulch[3]	Coarse gravel D_{50} = 25 mm (1 in)	19	0.4
	Very coarse gravel D_{50} = 50 mm (2 in)	38	0.8
Rock Riprap[3]	D_{50} = 0.15 m (0.5 ft)	113	2.4
	D_{50} = 0.30 m (1.0 ft)	227	4.8

[1]Based on Equation 4.6 assuming a soil void ratio of 0.5 (USDA, 1987).
[2]Based on Equation 4.5 derived from USDA (1987)
[3]Based on Equation 6.7 with Shield's parameter equal to 0.047.

2.3 DESIGN PARAMETERS

2.3.1 Design Discharge Frequency

Design flow rates for permanent roadside and median drainage channel linings usually have a 5 or 10-year return period. A lower return period flow is allowable if a transitional lining is to be used, typically the mean annual storm (approximately a 2-year return period, i.e., 50 percent probability of occurrence in a year). Transitional channel linings are often used during the establishment of vegetation. The probability of damage during this relatively short time is low,