

OK RT

SCOUR ANALYSIS AND REPORTING FORM

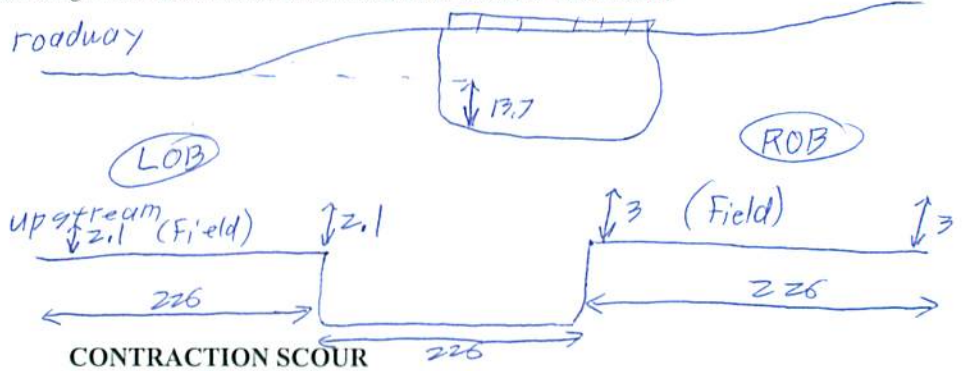
Bridge Structure No. 50192132 Date 9-12-10 Initials KAL Region (A B C D)
Site Location From Crook, 3.3E
Q100 = 33,200 by: drainage area ratio ✓ flood freq. anal. regional regression eq.
Bridge discharge (Q2) = 21,298 (should be Q100 unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 226 ft. Flow angle at bridge = 3 degrees Abut. Skew = 0 degrees Effective Skew = 3 degrees
Width (W2) iteration = 226
Avg. flow depth at bridge, y2 iteration = 13.7
Corrected channel width at bridge Section = W2 times cos of flow angle = 225.7 ft* q2 = Q2/W2 = 94.4 ft^2/s
Bridge Vel, V2 = 6.9 ft/s Final y2 = q2/V2 = 13.7 ft Delta h = 1 ft
Average main channel depth at approach section, y1 = Delta h + y2 = 14.7 ft
* NOTE: repeat above calculations until y2 changes by less than 0.2 Effective pier width = L sin(q) + a cos(q)
If y2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD.

PRGM: "RegionA", "RegionB", "RegionC", or "RegionD"

Water Surface Elev. = 4.5 ft
Low Steel Elev. = 14.8 ft
n (Channel) = 0.028
n (LOB) = 0.03
n (ROB) = 0.035
Pier Width = 2 ft
Pier Length = 32 ft
Piers for 100 yr = 4



CONTRACTION SCOUR

Width of main channel at approach section W1 = 226 ft
Width of left overbank flow at approach, Wlob = 226 ft Average left overbank flow depth, ylob = 2.1 ft
Width of right overbank flow at approach, Wrob = 226 ft Average right overbank flow depth, yrob = 3 ft

PRGM: Contract

Live Bed Contraction Scour (use if bed material is small cobbles or finer)
x = 1.98 From Figure 9 W2 (effective) = 217.7 ft ycs = 2.5 ft

PRGM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)
Estimated bed material D50 = ft Average approach velocity, V1 = Q100/(y1W1) = ft/s
Critical approach velocity, Vc = 11.52y1^(1/6)D50^(1/3) = ft/s
If V1 < Vc and D50 >= 0.2 ft, use clear water equation below, otherwise use live bed scour equation above.
Dc50 = 0.0006(q2/y1^(7/6))^3 = ft If D50 >= Dc50, chi = 0.0
Otherwise, chi = 0.122y1[q2/(D50^(1/3)y1^(7/6))]^(6/7) - y1 = ft From Figure 10, ycs = ft

PRGM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 16 Correction factor for flow angle of attack (from Table 1), K2 = 1.3
Froude # at bridge = 0.33 Using pier width a on Figure 11, xi = 8 Pier scour yps = 8.8 ft

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, yalT = 2.1 ft right abutment, yarT = 3 ft
Shape coefficient K1 = 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through
Using values for yalT and yarT on figure 12, psiLT = 8.6 and psiRT = 11.5
Left abutment scour, yas = psiLT(K1/0.55) = 8.6 ft Right abutment scour yas = psiRT(K1/0.55) = 11.5 ft

PRGM: Abutment

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50192132 Date 9-12-10 Initials RKL Region (A B C D)
 Site _____ Location From Crooks, 3, 3E
 $Q_{500} =$ 55,600 by: drainage area ratio flood freq. anal. _____ regional regression eq. _____
 Bridge discharge (Q_2) = 21,298 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 226 ft. Flow angle at bridge = 3 ° Abut. Skew = 0 ° Effective Skew = 3 °
 Width (W_2) iteration = 226
 Avg. flow depth at bridge, y_2 iteration = 13.7
 Corrected channel width at bridge Section = W_2 times cos of flow angle = 225.7 ft* $q_2 = Q_2/W_2 =$ 94.4 ft²/s
 Bridge Vel, $V_2 =$ 6.9 ft/s Final $y_2 = q_2/V_2 =$ 13.7 ft $\Delta h =$ 1 ft
 Average main channel depth at approach section, $y_1 = \Delta h + y_2 =$ 14.7 ft

* NOTE: repeat above calculations until y_2 changes by less than 0.2 Effective pier width = $L \sin(q) + a \cos(q)$
 If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD.

Water Surface Elev. = 4.5 ft
 Low Steel Elev. = 14.8 ft
 n (Channel) = 0.028
 n (LOB) = 0.03
 n (ROB) = 0.035
 Pier Width = 2 ft
 Pier Length = 32 ft
 # Piers for 500 yr = 4 ft

(see 100 yr pics)

CONTRACTION SCOUR

Width of main channel at approach section $W_1 =$ 226 ft
 Width of left overbank flow at approach, $W_{lob} =$ 226 ft Average left overbank flow depth, $y_{lob} =$ 2.1 ft
 Width of right overbank flow at approach, $W_{rob} =$ 226 ft Average right overbank flow depth, $y_{rob} =$ 3 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)
 $x =$ 1.98 From Figure 9 W_2 (effective) = 217.7 ft $y_{cs} =$ 2.5 ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)
 Estimated bed material $D_{50} =$ _____ ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1) =$ _____ ft/s
 Critical approach velocity, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3} =$ _____ ft/s
 If $V_1 < V_c$ and $D_{50} \geq 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.
 $D_{c50} = 0.0006 (q_2/y_1^{7/6})^3 =$ _____ ft If $D_{50} \geq D_{c50}$, $\chi = 0.0$
 Otherwise, $\chi = 0.122 y_1 [q_2 / (D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1 =$ _____ From Figure 10, $y_{cs} =$ _____ ft

PIER SCOUR CALCULATIONS

L/a ratio = 16 Correction factor for flow angle of attack (from Table 1), $K_2 =$ 1.3
 Froude # at bridge = 0.33 Using pier width a on Figure 11, $\xi =$ 8 Pier scour $y_{ps} =$ 8.8 ft

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT} =$ 2.1 ft right abutment, $y_{aRT} =$ 3 ft
 Shape coefficient $K_1 =$ 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through
 Using values for y_{aLT} and y_{aRT} on figure 12, $\psi_{LT} =$ 8.6 and $\psi_{RT} =$ 11.5
 Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55) =$ 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55) =$ 11.5 ft

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

PGRM: Contract

PGRM: CWCSNEW

PGRM: Pie

PGRM: Abutment

Route Mapleton Rd Stream Big Sioux River MRM _____ Date 9-12-10 Initials RAL
 Bridge Structure No. 50192132 Location From Crooks, 3.3E
 GPS coordinates: N43° 39.442' taken from: USL abutment centerline of ↑ MRM end _____
W96° 44.710' Datum of coordinates: WGS84 _____ NAD27 _____
 Drainage area = 3088.62 sq. mi.
 The average bottom of the main channel was 18.3 ft below top of guardrail at a point 58 ft from left abutment.
 Method used to determine flood flows: _____ Freq. Anal. drainage area ratio _____ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q ₁₀₀ = <u>33,200</u>			Q ₅₀₀ = <u>55,600</u>		
Estimated flow passing through bridge	<u>21,298</u>			<u>21,298</u>		
Estimated road overflow & overtopping	<u>11,902</u>			<u>34,302</u>		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
Chance of Pressure flow	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
Armored appearance to channel		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
Lateral instability of channel		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	

Riprap at abutments? _____ Yes _____ No Marginal
 Evidence of past Scour? Yes _____ No _____ Don't know
 Debris Potential? High _____ Med _____ Low

Does scour countermeasure(s) appear to have been designed?

Riprap _____ Yes _____ No Don't know _____ NA
 Spur Dike _____ Yes No _____ Don't know _____ NA
 Other _____ Yes No _____ Don't know _____ NA

Bed Material Classification Based on Median Particle Size (D₅₀)

Material Silt/Clay Sand _____ Gravel _____ Cobbles _____ Boulders _____
 Size range, in mm <0.062 0.062-2.00 2.00-64 64-250 >250

Comments, Diagrams & orientation of digital photos

- 1 - Bridge Deck
- 2 - Looking upstream
- 3 - Looking Downstream
- 4 - Left Overbank
- 5 - Right Overbank
- 6 - Left Abutment
- 7 - Right Abutment
- 8 - Piers

9 - old Bridge remnants
 10 - Low Road section
 notes: road is lower than low steel, Flow would go through ditch, over road, and back through other ditch, Road is gravel.
 Previous Bridge Parts still present.

Summary of Results

	Q100	Q500
Bridge flow evaluated	<u>21,298</u>	<u>21,298</u>
Flow depth at left abutment (yaLT), in feet	<u>2.1</u>	<u>2.1</u>
Flow depth at right abutment (yaRT), in feet	<u>3</u>	<u>3</u>
Contraction scour depth (yca), in feet	<u>2.5</u>	<u>2.5</u>
Pier scour depth (yps), in feet	<u>8.8</u>	<u>8.8</u>
Left abutment scour depth (yas), in feet	<u>8.6</u>	<u>8.6</u>
Right abutment scour depth (yas), in feet	<u>11.5</u>	<u>11.5</u>
Flow angle of attack	<u>3</u>	<u>3</u>

See Comments/Diagram for justification where required