

ok-Rat

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41163053 Date 9-19-12 Initials RFT Region (A)BCD
 Site _____ Location 1.1 mi S of St. Onge
 $Q_{100} = \underline{6220}$ by: drainage area ratio _____ flood freq. anal. _____ regional regression eq.
 Bridge discharge (Q_2) = 6220 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

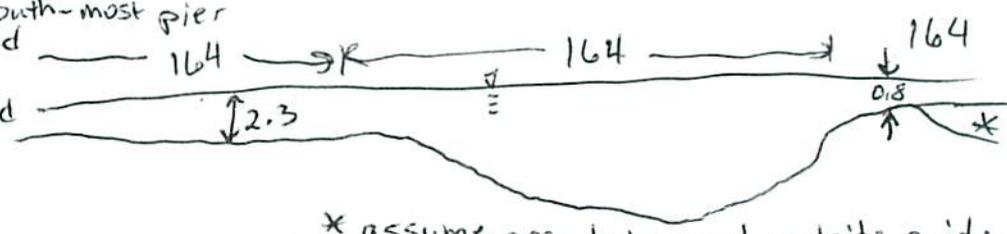
Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 164 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °
 Width (W_2) iteration = 164
 Avg. flow depth at bridge, y_2 iteration = 5.3

Corrected channel width at bridge Section = W_2 times cos of flow angle = 161.51 ft* $q_2 = Q_2/W_2 = \underline{38.5}$ ft²/s
 Bridge Vel, $V_2 = \underline{7.2}$ ft/s Final $y_2 = q_2/V_2 = \underline{5.3}$ ft $\Delta h = \underline{1.1}$ ft
 Average main channel depth at approach section, $y_1 = \Delta h + y_2 = \underline{6.4}$ 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. = dry ft
 Low Steel Elev. = 6.0 ft at south-most pier
 n (Channel) = 0.035 grazed
 n (LOB) = 0.035 alfalfa
 n (ROB) = 0.035 grazed
 Pier Width = 1.67 ft
 Pier Length = 1.67 ft
 # Piers for 100 yr = 4 ft



* assume area below and outside guide bank is ineffective flow

CONTRACTION SCOUR

Width of main channel at approach section $W_1 = \underline{164}$ ft
 Width of left overbank flow at approach, $W_{lob} = \underline{164}$ ft Average left overbank flow depth, $y_{lob} = \underline{2.3}$ ft
 Width of right overbank flow at approach, $W_{rob} = \underline{164}$ ft Average right overbank flow depth, $y_{rob} = \underline{0.8}$ ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)
 $x = \underline{1.82}$ From Figure 9 W_2 (effective) = 154.8 ft $y_{cs} = \underline{2.3}$ ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)
 Estimated bed material $D_{50} = \underline{\quad}$ ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1) = \underline{\quad}$ ft/s
 Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3} = \underline{\quad}$ ft/s
 If $V_1 < V_c$ and $D_{50} > 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.
 $D_{c50} = 0.0006 (q_2 / y_1^{7/6})^3 = \underline{\quad}$ ft If $D_{50} > D_{c50}$, $\chi = 0.0$
 Otherwise, $\chi = 0.122 y_1 [q_2 / (D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1 = \underline{\quad}$ From Figure 10, $y_{cs} = \underline{\quad}$ ft

PIER SCOUR CALCULATIONS

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), $K_2 = \underline{1}$
 Froude # at bridge = 0.55 Using pier width a on Figure 11, $\xi = \underline{7}$ Pier scour $y_{ps} = \underline{6.4}$ ft

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT} = \underline{2.3}$ ft right abutment, $y_{aRT} = \underline{0.8}$ ft
 Shape coefficient $K_1 = \underline{1.00}$ 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, $\psi_{LT} = \underline{9.4}$ and $\psi_{RT} = \underline{3.5}$
 Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55) = \underline{17.1}$ ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55) = \underline{6.3}$ ft

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

PRGM: Contract

PRGM: CWCSNEW

PRGM: Pier

PRGM: Abutment

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41163053 Date _____ Initials _____ Region (A)BCD
 Site _____ Location 1.1 mi S of St. Orgz
 $Q_{500}^{max\ scour} = 141,451$ by 11655 drainage area ratio _____ flood freq. anal. _____ regional regression eq.
 Bridge discharge (Q_2) = 11655 (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

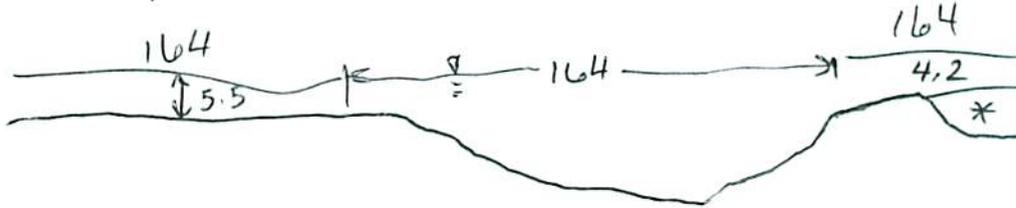
Bridge Width = 164 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °
 Width (W_2) iteration = 164
 Avg. flow depth at bridge, y_2 iteration = 7.5
 Corrected channel width at bridge Section = W_2 times cos of flow angle = 161.51 ft* $q_2 = Q_2/W_2 = 72.2$ ft²/s
 Bridge Vel, $V_2 = 9.6$ ft/s Final $y_2 = q_2/V_2 = 7.5$ ft $\Delta h = 1.9$ ft
 Average main channel depth at approach section, $y_1 = \Delta h + y_2 = 9.4$ 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.

road overflow will begin south of bridge at $y_1 \approx 7.5'$. Assume $Q_{max\ scour}$ is at $y_1 = 7.5'$

Water Surface Elev. = dry ft
 Low Steel Elev. = 6.0 ft at south most pier
 n (Channel) = .035
 n (LOB) = .035
 n (ROB) = .035
 Pier Width = 1.67 ft
 Pier Length = 1.67 ft
 # Piers for 500 yr = 4



CONTRACTION SCOUR

Width of main channel at approach section $W_1 = 164$ ft
 Width of left overbank flow at approach, $W_{lob} = 164$ ft Average left overbank flow depth, $y_{lob} = 5.5$ ft
 Width of right overbank flow at approach, $W_{rob} = 164$ ft Average right overbank flow depth, $y_{rob} = 4.2$ ft
 * assume area below and outside guide bank is ineffective flow

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

$x = 7.23$ From Figure 9 W_2 (effective) = 154.8 ft $y_{cs} = 8.0$ 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3} =$ _____ 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.

$D_{c50} = 0.0006 (q_2/y_1)^{7/6} =$ _____ 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 = 1 Correction factor for flow angle of attack (from Table 1), $K_2 = 1$
 Froude # at bridge = 0.62 Using pier width a on Figure 11, $\xi = 7$ Pier scour $y_{ps} = 6.5$ ft

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT} = 5.5$ ft right abutment, $y_{aRT} = 4.2$ 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, $\psi_{LT} = 15.9$ and $\psi_{RT} = 13.6$
 Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55) = 28.7$ ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55) = 24.7$ ft

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

PGRM: Contract

PGRM: CWCNEW

PGRM: Pier

PGRM: Abutment

Route St. Onge Rd Stream False Bottom Cr MRM _____ Date _____ Initials _____

Bridge Structure No. 41163053 Location 1.1 mi S of St. Onge

GPS coordinates: N 44° 31.687' taken from: USL abutment centerline of ↑ MRM end _____

W 103° 43.435' Datum of coordinates: WGS84 NAD27 _____

Drainage area = 63.54 sq. mi.

The average bottom of the main channel was 10.2 ft below top of guardrail at a point 29 ft from left abutment.

Method used to determine flood flows: ___ Freq. Anal. ___ drainage area ratio regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q ₁₀₀ = <u>6220</u>			Q _{scour} ^{max} <u>scour 11655</u>		
Estimated flow passing through bridge	<u>6220</u>			<u>11655</u>		
Estimated road overflow & overtopping	<u>0</u>			<u>0?</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"/>	

713
 2 123
 5 474
 10 997
 25 2200
 50 3830
 100 6220
 500 16600

Riprap at abutments? ___ Yes No ___ Marginal
 Evidence of past Scour? ___ Yes No ___ Don't know none obvious
 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 guide bank on rt. ___ 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

str. rd.
approach from bridge left abut.
LOB from Ditch rt. abut.
ROB from bridge
right guide bank
bridge from approach

Summary of Results

	Q100	Q500 max scour
Bridge flow evaluated	<u>6220</u>	<u>11655</u>
Flow depth at left abutment (yaLT), in feet	<u>2.3</u>	<u>5.5</u>
Flow depth at right abutment (yaRT), in feet	<u>0.8</u>	<u>4.2</u>
Contraction scour depth (y _{cs}), in feet	<u>2.3</u>	<u>8.0</u>
Pier scour depth (y _{ps}), in feet	<u>6.4</u>	<u>6.5</u>
Left abutment scour depth (y _{as}), in feet	<u>17.1</u>	<u>28.7</u>
Right abutment scour depth (y _{as}), in feet	<u>6.3</u>	<u>24.7</u>
Flow angle of attack	<u>10°</u>	<u>10°</u>

See Comments/Diagram for justification where required