GK-Rat

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41025020 Date ~~11/28/2012~~ 9-18-12 Initials RFT Region (A B C D)

Site _____ Location N of Exit 2

Q_{25} 16660 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 16660 (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

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

Bridge Width = 78 ft. Flow angle at bridge = 21 ° Abut. Skew = 25 ° Effective Skew = 4 °

Width (W_2) iteration = 78 _____ _____ flows abut to abut at Q25

Avg. flow depth at bridge, y_2 iteration = 8.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 72.82 ft* $q_2 = Q_2/W_2$ = 91.5 ft^2/s

Bridge Vel, V_2 = 10.7 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 2.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.9 ft road overflow occurs ≈ 10.5'

** 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. = _____ ft

Low Steel Elev. = 8.7 ft

n (Channel) = 0.040

n (LOB) = 0.032

n (ROB) = 0.032

Pier Width = 0.8 ft

Pier Length = 0.8 ft

Piers for 100 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 78 ft

Width of left overbank flow at approach, W_{lob} = 78 ft Average left overbank flow depth, y_{lob} = 3.3' ft

Width of right overbank flow at approach, W_{rob} = 78 ft Average right overbank flow depth, y_{rob} = 4.0 ft

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

x = 5.88 From Figure 9 W_2 (effective) = 71.2 ft y_{cs} = 6.6 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 2.61 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 11.13 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = .107 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, y_{cs} = 0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.65 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 3.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 ft right abutment, y_{aRT} = 4.0 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through Very eroded

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 12 and ψ_{RT} = 13.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41025020 Date _____ Initials _____ Region (A B C D)

Site _____ Location N of Exit 2

Q_{500}^{50} = 10300 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 9732 (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 = 78 ft. Flow angle at bridge = 21 ° Abut. Skew = 25 ° Effective Skew = 4 °

Width (W_2) iteration = 78 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 10.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 72.82 ft* $q_2 = Q_2/W_2$ = 133.6 ft^2/s

Bridge Vel, V_2 = 12.7 ft/s Final $y_2 = q_2/V_2$ = 10.5 ft Δh = 3.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.8 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.

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

Water Surface Elev. = _____ ft

Low Steel Elev. = 8.7 ft

n (Channel) = .040

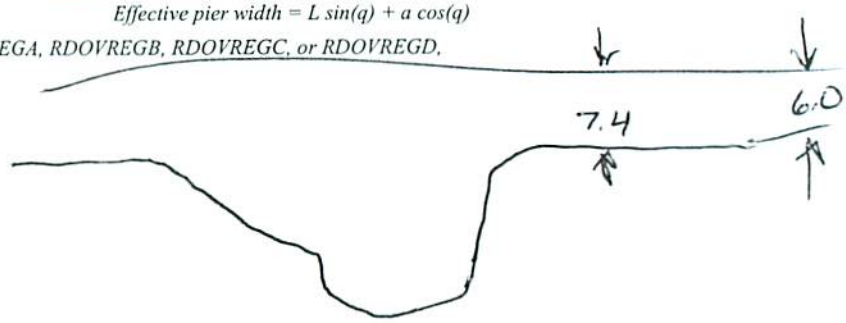
n (LOB) = .032

n (ROB) = .032

Pier Width = 0.9 ft

Pier Length = 0.8 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 78 ft

Width of left overbank flow at approach, W_{lob} = 78 ft Average left overbank flow depth, y_{lob} = 6.2 ft

Width of right overbank flow at approach, W_{rob} = 78 ft Average right overbank flow depth, y_{rob} = 6.7 ft

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

x = 11.96 From Figure 9 W_2 (effective) = 71.2 ft y_{cs} = 13 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 3.01 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 11.58 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = .147 ft If $D_{50} >= D_{c50}$, χ = 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} = 0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.69 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 3.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.2 ft right abutment, y_{aRT} = 6.7 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through Very eroded

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 17.2 and ψ_{RT} = 18.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.1 ft

Route Upper Redwater Rd Stream Redwater Blk River MRM _____ Date _____ Initials _____

Bridge Structure No. 41025020 Location N of Exit 2

GPS coordinates: N 44° 34.554' taken from: USL abutment ✓ centerline of ↑ MRM end _____

W 103° 59.998' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 540.96 sq. mi.

The average bottom of the main channel was 13.4 ft below top of guardrail at a point 18 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q~~25~~ = 6660			Q~~50~~ = 10300		
Estimated flow passing through bridge	6660			Q max scour 9732		
Estimated road overflow & overtopping	0			568		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓		✓		
Chance of Pressure flow		✓		✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

7	3
2	589
5	1940
10	3600
25	6660
50	10300
100	15200
500	34200

Riprap at abutments? ____Yes ____No X Marginal some riprap on left downstream abutment

Evidence of past Scour? X Yes ____No ____Don't know abutment scour under bridge

Debris Potential? ____High X Med ____Low some trees present upstream

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

Riprap ____Yes X 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 (D_{50})

Material	Silt/Clay X	Sand ____	Gravel ____	Cobbles X	Boulders ____
Size range, in mm	<0.062 overbanks abutments	0.062-2.00	2.00-64	64-250 channel	>250

Comments, Diagrams & orientation of digital photos

cobbles in channel bottom, but assume live bed for banks + overbanks + abut. under bridge

Str. no.

approach from bridge

LOB from bridge

ROB from LOB

Bridge from LOB

left abut. under bridge

right abut. under bridge

Summary of Results

	Q~~100~~ 25	Q~~500~~ 50
Bridge flow evaluated	6660	9732 ← Q max scour
Flow depth at left abutment (yaLT), in feet	3.3	6.2
Flow depth at right abutment (yaRT), in feet	4.0	6.7
Contraction scour depth (ycs), in feet	6.6	13
Pier scour depth (yps), in feet	3.6	3.7
Left abutment scour depth (yas), in feet	12	17.2
Right abutment scour depth (yas), in feet	13.3	18.1
1Flow angle of attack	21° (4° eff)	21° (4° eff)

See Comments/Diagram for justification where required