OK-RaT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 47110380 Date 9-19-12 Initials RET Region (A B C D)

Site _____ Location 1.2 mi N of HWY 34 on Nine Mile Rd

Q_{100} = 974 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 974 (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 = 102 ft. Flow angle at bridge = 7 ° Abut. Skew = 0 ° Effective Skew = 7 °

Width (W_2) iteration = 71 72 _____ _____

Avg. flow depth at bridge, y_2 iteration = 3.0 3.0 _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 71.46 ft* $q_2 = Q_2/W_2$ = 13.6 ft^2/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 3.0 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 3.4 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. = 9.0 ft

n (Channel) = .045

n (LOB) = .050

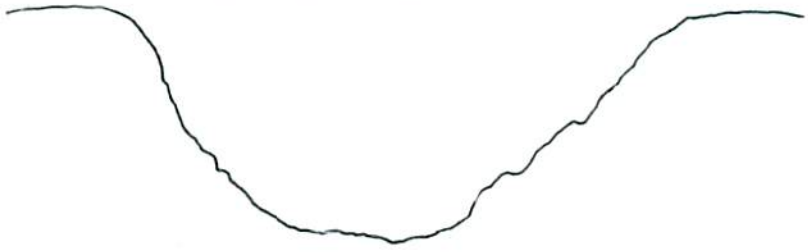
n (ROB) = .065

Pier Width = 0.81 ft

Pier Length = 0.83 ft

Piers for 100 yr = 2 ft

high left bank (no LOB-flow)



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 72 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = 0 ft

PGRM: CWCSNEW

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

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

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

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ 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} = _____ ft

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.46 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 3.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 0 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, ψ_{LT} = 0 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 47110340 Date _____ Initials _____ Region (A B C D)

Site _____ Location 1.2 mi N of HWY 34 on Nine Mile Rd

Q_{500} = 1870 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 1870 (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

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

Bridge Width = 102 ft. Flow angle at bridge = 7 ° Abut. Skew = 0 ° Effective Skew = 7 °

Width (W_2) iteration = ~~79~~ 81 _____ _____

Avg. flow depth at bridge, y_2 iteration = 4.1 4.0 _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 80.4 ft* $q_2 = Q_2/W_2$ = 23.3 ft^2/s

Bridge Vel, V_2 = 5.8 ft/s Final $y_2 = q_2/V_2$ = 4.0 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.7 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,

$y_1 > 6.8 \approx$ abutment to abutment flow

no LOB flow

Water Surface Elev. = dry ft

Low Steel Elev. = 9.0 ft

n (Channel) = .045

n (LOB) = .050 barn lot

n (ROB) = .065 trees

Pier Width = 0.81 ft

Pier Length = 0.83 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 81 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 15 ft Average right overbank flow depth, y_{rob} = 0.3 ft

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

x = 0.14 From Figure 9 W_2 (effective) = 78.8 ft y_{cs} = 0.2 ft

PGRM: CWCSNEW

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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ 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} = _____ ft

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.51 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 3.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 0.3 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, ψ_{LT} = 0 and ψ_{RT} = 1.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 1.4 ft

Route Nine Mile Rd Stream Spring Ck MRM _____ Date _____ Initials _____

Bridge Structure No. 47110380 Location 1.2 mi N of Hwy 34 on Nine Mile Rd

GPS coordinates: N 44° 29.420' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 103° 20.813' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 66.45 sq. mi.

The average bottom of the main channel was 13.7 ft below top of guardrail at a point 25 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 974			Q_{500} = 1870		
Estimated flow passing through bridge	974			1870		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓			✓	
Chance of Pressure flow		✓			✓	
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

713

2	64.4
5	159
10	262
25	459
50	695
100	974
500	1870

Riprap at abutments? ✓Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know contraction scour pool (dry) under bridge

Debris Potential? ____High X Med ____Low trees upstream, some debris on pier

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 (D_{50})

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

some cobbles in bottom of low-flow channel, but the rest is fines

Comments, Diagrams & orientation of digital photos

Str. no.
approach from bridge
high left bank
ROB from bridge
bridge from approach

left abut.
rt. abut.
debris on pier

Summary of Results

	Q100	Q500
Bridge flow evaluated	974	1870
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0	0.3
Contraction scour depth (ycs), in feet	0	0.2
Pier scour depth (yps), in feet	3.5	3.6
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	1.4
1Flow angle of attack	7°	7°

See Comments/Diagram for justification where required