OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 5024013 Date 6/25/12 Initials DAJ Region (A B C D)

Site _____ Location 2.8 E & 0.2 mi S of Midway on 478 Ave

Q_{100} = 3190 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3190 (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 = 75 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 70.48 ft* $q_2 = Q_2/W_2$ = 45.3 ft^2/s

Bridge Vel, V_2 = 4.8 ft/s Final $y_2 = q_2/V_2$ = 9.5 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10 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. = 0-1.4 ft

Low Steel Elev. = 11.2 ft

n (Channel) = 0.045

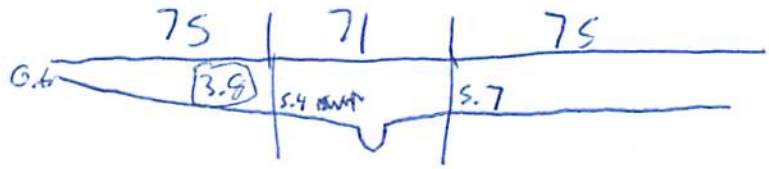
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~207~~ 71 ft 5.4 - 0.6 4.8 · 2/3 = 9.6 3.2+1

Width of left overbank flow at approach, W_{lob} = 75 ft Average left overbank flow depth, y_{lob} = 3.8 ft

Width of right overbank flow at approach, W_{rob} = 75 ft Average right overbank flow depth, y_{rob} = 5.7 ft

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

x = ~~7.66~~ 10.68 From Figure 9 W_2 (effective) = 66.5 ft y_{cs} = ~~8.5~~ 11.7 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.8 ft K_1 ~~0.55~~ right abutment, y_{aRT} = 5.7 ft $K_1 = 1$

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} = 12.9 and ψ_{RT} = 16.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 29.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50240113 Date 6/25/12 Initials RAT Region (A B C D)

Site _____ Location 2.5 E & 0.2 mi S of Midway on 478 Ave

Q_{500} = 4920 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. Y

Bridge discharge (Q_2) = 4442 (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 = 75 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 70.48 ft* $q_2 = Q_2/W_2$ = 63 ft^2/s

Bridge Vel, V_2 = 5.6 ft/s Final $y_2 = q_2/V_2$ = 11.2 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.8 ft

** NOTE: repeat above calculations until y_2 changes by less by 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. = 0-1.4 ft

Low Steel Elev. = 11.2 ft

n (Channel) = 0.045

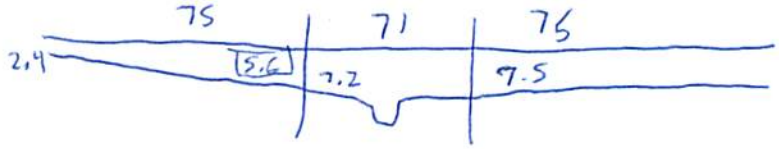
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 71 ft

Width of left overbank flow at approach, W_{lob} = 75 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 75 ft Average right overbank flow depth, y_{rob} = 7.5 ft

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

x = 15.95 From Figure 9 W_2 (effective) = 66.5 ft y_{cs} = 15.5 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.29 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 7.5 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} = 16.1 and ψ_{RT} = 19.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 35.2 ft

96° 39' 4.428"
43° 41' 10.14"

96.6513
43.6615

Route 474 Ave Stream Slip Up Ck MRM _____ Date 8/25/12 Initials RaT

Bridge Structure No. 50240|3 Location 2.8 E & 0.2 mi S of Midway on 478 Ave

GPS coordinates: N 43° 41' 9.41" W 96° 39' 4.21" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 16.9 sq. mi.

The average bottom of the main channel was 15.0 ft below top of guardrail at a point 35 ft from left abutment.

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

8/25

2	328
5	810
10	1240
25	1900
50	2460
100	3070
500	4650

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3190			Q_{500} = 4820		
Estimated flow passing through bridge		3190			4442	
Estimated road overflow & overtopping		0			378	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow		X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

16.9

6/15

2	346
5	849
10	1290
25	1980
~~50~~	
50	2560
100	3190
500	4820

Riprap at abutments? X Yes ____No ____Marginal - only on left abutment

Evidence of past Scour? X Yes ____No ____Don't know some contraction and under concrete on left abutment.

Debris Potential? ____High ____Med X Low minor pier.

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

Riprap	X Yes	____No	____Don't know	____NA rose quartz left abutment
Spur Dike	____Yes	X No	____Don't know	____NA
Other _____	X Yes	____No	____Don't know	____NA right abutment see pictures

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

Comments, Diagrams & orientation of digital photos

1). left OB
2) main channel
3). right OB
4). pier
~~5). right abutment~~
5-7). right abutment
8-9). left abutment
10). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	3190	4442
Flow depth at left abutment (yaLT), in feet	3.8	5.6
Flow depth at right abutment (yaRT), in feet	5.7	7.5
Contraction scour depth (ycs), in feet	~~6.5~~ 11.7	15.5
Pier scour depth (yps), in feet	6.6	6.6
Left abutment scour depth (yas), in feet	12.9	16.1
Right abutment scour depth (yas), in feet	29.6	35.2
1Flow angle of attack	20	20

See Comments/Diagram for justification where required