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Check

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 40143150 Date 7/25/12 Initials RAJ Region (A B C D)

Site _____ Location 0.3 mi W of HWY 19 on 235 St

Q_{100} = Q5 2080 1320 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2080 1320 (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 = ~~80~~ 55 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ 54.16

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~66.94~~ ft* $q_2 = Q_2/W_2$ = ~~30.2~~ ft^2/s

Bridge Vel, V_2 = ~~3.49~~ 3.5 ft/s Final $y_2 = q_2/V_2$ = ~~10.78~~ ft ~~7~~ Δh = ~~2.30~~ 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~8.08~~ 7.2 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. = 3 ft

Low Steel Elev. = ~~6.45~~ 6.6 ft

n (Channel) = 0.045

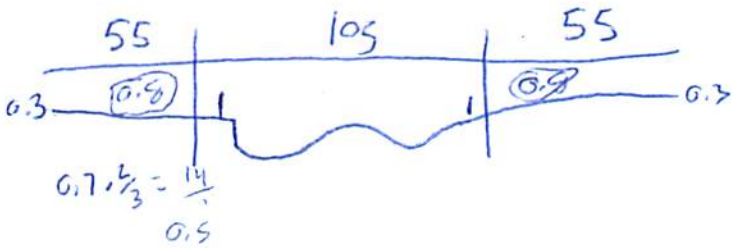
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.3 ft

Pier Length = 1.3 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = ~~70~~ 55 ft Average left overbank flow depth, y_{lob} = ~~10.07~~ ft 0.5

Width of right overbank flow at approach, W_{rob} = ~~70~~ 55 ft Average right overbank flow depth, y_{rob} = ~~10.07~~ ft 0.5

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

x = 8.05 From Figure 9 W_2 (effective) = 51.6 ft y_{cs} = 8.9 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = 0.23 Using pier width a on Figure 11, ξ = 5.6 Pier scour y_{ps} = 4.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.8 ft right abutment, y_{aRT} = 0.8 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} = 3.5 and ψ_{RT} = 3.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 6.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 40143150 Date 7/25/12 Initials RAT Region (A B C D)

Site _____ Location 0.3 mi W of HWY 19 on 235 St

Q_{500} = [illegible] by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = [illegible] (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 = 7055ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ 54.16

Corrected channel width at bridge Section = W_2 times cos of flow angle = [illegible] ft* $q_2 = Q_2/W_2$ = 37.1 ft^2/s

Bridge Vel, V_2 = 4.3 ft/s Final $y_2 = q_2/V_2$ = 8.6 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9 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. = 3 ft

Low Steel Elev. = 8.6 ft

n (Channel) = 0.048

n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.3 ft

Pier Length = 1.3 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = [illegible] ft 55 Average left overbank flow depth, y_{lob} = [illegible] ft 2.5

Width of right overbank flow at approach, W_{rob} = 55 ft Average right overbank flow depth, y_{rob} = [illegible] ft 2.5

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

x = 12.7 From Figure 9 W_2 (effective) = 51.6 ft y_{cs} = 13.8 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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 = 0.26 Using pier width a on Figure 11, ξ = 5.8 Pier scour y_{ps} = 4.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.5 ft right abutment, y_{aRT} = 2.5 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} = 10.2 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.6 ft

43° 58' 43.469"
97° 5' 2.364"

97.08399
43.97874

Route 235 St Stream Silver Ck MRM _____ Date 7/25/12 Initials DaT

Bridge Structure No. 40143150 Location 0.3 mi W of HWY 19 on 235 ~~St~~

GPS coordinates: N 43° 58' 43.61" W 91° 5' 2.51" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 105 sq. mi.

The average bottom of the main channel was 13.1 ft below top of guardrail at a point 21 ft from left abutment.

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

8/24

2	508
5	1320
10	2070
25	3270
50	4340
100	5520
500	8680

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = ~~Q_{100}~~ Q_5 ~~2080~~ 1320			Q_{500} = ~~Q_{500}~~ Q_{10} ~~3270~~ 2070		
Estimated flow passing through bridge			~~2080~~ 1320			~~3270~~ 2011
Estimated road overflow & overtopping			0			~~3270~~ ~~2080~~ 69
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping						
Chance of Pressure flow						
Armored appearance to channel						
Lateral instability of channel						

6/20

2	509
5	1320
10	2080
25	3270
50	4340
100	5530
500	8700

Riprap at abutments? ____Yes ____No X Marginal riprap ~~ent~~ ~~ent~~ around ~~outs~~ outside left abutment, Doesn't appear elsewhere

Evidence of past Scour? X Yes ____No ____Don't know constricted abutment

Debris Potential? ____High ____Med X Low

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

Riprap	____Yes	X No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other extended left abutment wall + riprap.	____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

Comments, Diagrams & orientation of digital photos

1). left CB
2). main channel
3). ~~right~~ CB
4). pier
5). right abutment
6-8). left abutment
9). right abutment
10). main channel

Summary of Results

	~~Q100~~ ~~Q_{100}~~ Q_5	~~Q500~~ ~~Q_{500}~~ Q_{10}
Bridge flow evaluated	1320	2011
Flow depth at left abutment (yaLT), in feet	0.8	2.5
Flow depth at right abutment (yaRT), in feet	0.4	2.5
Contraction scour depth (ycs), in feet	4.9	13.4
Pier scour depth (yps), in feet	4.7	4.7
Left abutment scour depth (yas), in feet	6.3	18.6
Right abutment scour depth (yas), in feet	6.3	18.6
1Flow angle of attack	10	10

See Comments/Diagram for justification where required