ok RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03180102 Date 5/15/12 Initials CW/RFT/RAT Region (A B C D)

Site _____ Location 4mi W, 7.8 mi N of NW corner of Huron on 394 Ave

Q_{100} = 347 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 347 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

5 Q

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 50 ft. Flow angle at bridge = 49 ° Abut. Skew = 0 ° Effective Skew = 49 °

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 = 32.4 ft* $q_2 = Q_2/W_2$ = 10.6 ft²/s

Bridge Vel, V_2 = 2.3 ft/s Final $y_2 = q_2/V_2$ = 4.6 ft Δh = 0.1 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,

Water Surface Elev. = 2.1 ft

Low Steel Elev. = 5.1 ft

n (Channel) = 0.060

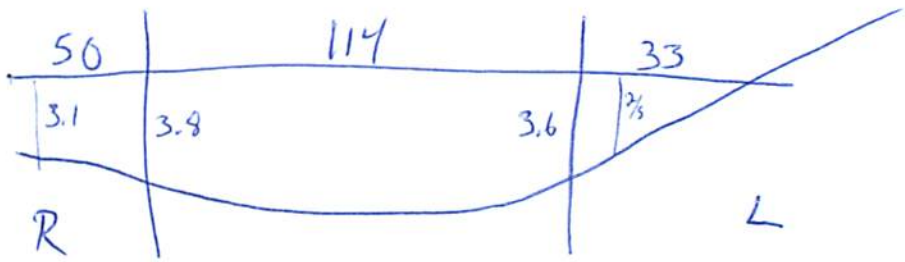
n (LOB) = 0.070

n (ROB) = 0.075

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 114 ft

Width of left overbank flow at approach, W_{lob} = 33 ft (2/3 × 3.6) Average left overbank flow depth, y_{lob} = 2.4 ft

Width of right overbank flow at approach, W_{rob} = 50 ft Average right overbank flow depth, y_{rob} = 3.4 ft

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

x = ~~14.18~~ From Figure 9 W_2 (effective) = 30.1 ft y_{cs} = 16.7 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = _____ 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 = 1.0

Froude # at bridge = 0.19 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

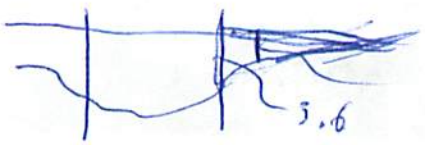
Average flow depth blocked by: left abutment, y_{aLT} = 2.4 ft right abutment, y_{aRT} = 3.4 ft

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} = 9.8 and ψ_{RT} = 12.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.2 ft

7.0 5.9 2.3/3.6 6.8 7.5 5.9 1.8/4.1



SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03180102 Date CW/RFT/RAT Initials 5/15/12 Region (A B C D)

Site _____ Location 4mi W, 7.8mi N of NW corner of Huron on 394/Ave

Q10 Q_{500} = 683 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 428 (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 = 50 ft. Flow angle at bridge = 49° Abut. Skew = 0° Effective Skew = 49°

Width (W_2) iteration = 50 _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 32.5 ft* $q_2 = Q_2/W_2$ = 13.0 ft^2/s

Bridge Vel, V_2 = 2.6 ft/s Final $y_2 = q_2/V_2$ = 5.1 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.2 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. = 2.1 ft

Low Steel Elev. = 5.1 ft

n (Channel) = 0.060

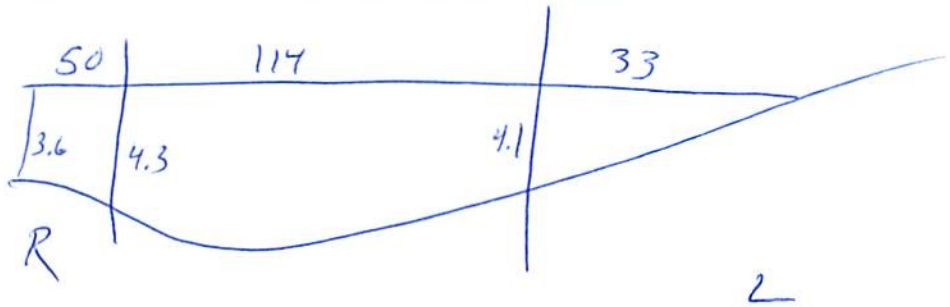
n (LOB) = 0.070

n (ROB) = 0.025

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 114 ft

Width of left overbank flow at approach, W_{lob} = 33 ft Average left overbank flow depth, y_{lob} = 2.7 ft (2/3 x 4.1)

Width of right overbank flow at approach, W_{rob} = 50 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 = 20.6 From Figure 9 W_2 (effective) = 30.1 ft y_{cs} = 1.8 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 0.2 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.7 ft

ABUTMENT SCOUR CALCULATIONS

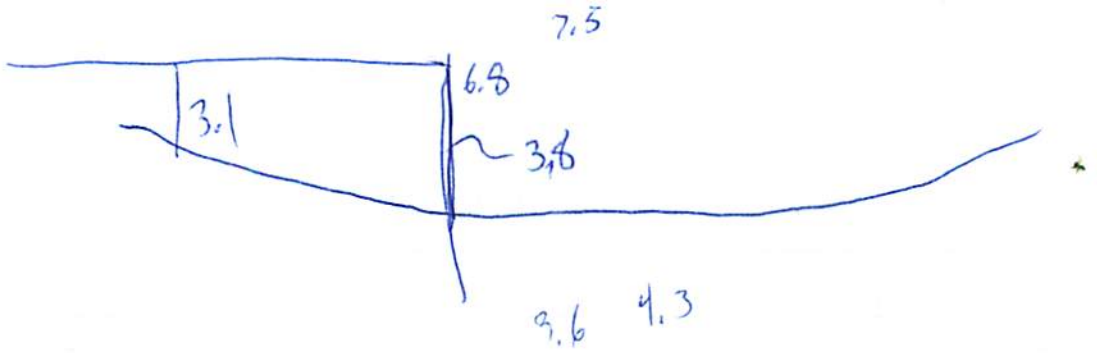
PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.7 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

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 11 and ψ_{RT} = 13.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.8 ft



0.7 5.9
2.1

3.6

Route 394 Ave Stream _____ MRM _____ Date 5/15/12 Initials CW/RFT/RAT

Bridge Structure No. 03180102 Location 4mi W, 7.8 mi N of NW corner Huron, on 394 Ave

GPS coordinates: N 44° 24' 21.6" W 98° 20' 10.6" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84_____ NAD27_____

Drainage area = 50.7 sq. mi.

The average bottom of the main channel was 9.7 ft below top of guardrail at a point 4.6 ft from left abutment.

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

5/14

~~4/20~~ 7/13

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 347			Q_{500} = ~~428~~ 683		
Estimated flow passing through bridge		347			428	
Estimated road overflow & overtopping					255	
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

2	87.9
5	347
10	~~684~~ 683
25	1360
50	2060
100	2960
500	5910

Riprap at abutments? _____Yes X No _____Marginal

Evidence of past Scour? _____Yes X No _____Don't know

Debris Potential? _____High X Med _____Low

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

Riprap _____Yes _____No _____Don't know X NA

Spur Dike _____Yes _____No _____Don't know X NA

Other _____ _____Yes _____No _____Don't know X NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay X	Sand X	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

2218 str. no.
2219 approach from bridge
2220 ROB from bridge
2221 ~~LOB~~ upstream from bridge
2222 Looking upstream from under bridge
2223 bridge from left ditch
2224 rt abut from left ditch
2225 left abut from left ditch
2226 Lob from left ditch
2227 ROB from left ditch

Summary of Results

	~~Q100~~ Q25	~~Q500~~ Q10
Bridge flow evaluated	347	428
Flow depth at left abutment (yaLT), in feet	2.4	2.7
Flow depth at right abutment (yaRT), in feet	3.4	4.0
Contraction scour depth (ycs), in feet	16.7	18
Pier scour depth (yps), in feet	4.6	4.7
Left abutment scour depth (yas), in feet	14.6	16.4
Right abutment scour depth (yas), in feet	18.2	19.5
1Flow angle of attack	49	49

See Comments/Diagram for justification where required