OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58059350 Date 6/18/11 Initials CW Region (A B C D) [C circled]

Site 06474000 Location 4 W Tulare

Q_{100} = 15700 by: drainage area ratio_____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 15700 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

see comments

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 157 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = ~~157~~ ~~142~~ ~~137~~ ~~137~~ ← 127 Vert abut now

Avg. flow depth at bridge, y_2 iteration = ~~15.2~~ ~~15.9~~ ~~16.2~~ ~~16.2~~

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~[illegible]~~ ft* 109.99 $q_2 = Q_2/W_2$ = ~~133.3~~ ft^2/s 142.7

Bridge Vel, V_2 = ~~8.2~~ ft/s 8.5 Final $y_2 = q_2/V_2$ = ~~16.2~~ ft 16.8 Δh = ~~1.4~~ ft 1.5

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~17.6~~ ft 18.3

* *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. = 18.0 ft

n (Channel) = 0.040

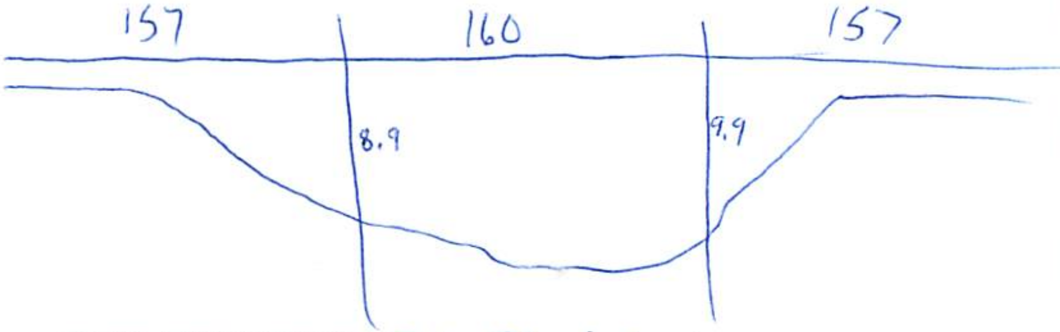
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.0 ft

Pier Length = 34.0 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

Take ~2/3 of depth

PGRM: Contract

Width of main channel at approach section W_1 = 160 ft

Width of left overbank flow at approach, W_{lob} = 157 ft Average left overbank flow depth, y_{lob} = 5.9 ft

Width of right overbank flow at approach, W_{rob} = 157 ft Average right overbank flow depth, y_{rob} = 6.6 ft

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

x = ~~13.94~~ 18.98 From Figure 9 W_2 (effective) = ~~125~~ 108 ft y_{cs} = ~~14.4~~ 17.1 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = _____ 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 = 34 Correction factor for flow angle of attack (from Table 1), K2 = 3.5

Froude # at bridge = 0.37 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 14.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.9 ft right abutment, y_{aRT} = 6.6 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through [1.00 circled]

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 16.6 and ψ_{RT} = 17.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 30.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 32.5 ft

3.8 5.1/9 4. 5.1 4.8 9. 9.

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58059350 Date 6/8/11 Initials CW Region (A B C D)

Site 06474000 Location 4 W Tulare

Q_{500} = 32500 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = ~~20048~~ 17930 (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 = 157 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = ~~157~~ ~~142~~ 127 ____

Avg. flow depth at bridge, y_2 iteration = ~~24.2~~ ~~22.9~~ > 18 → RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~127~~ ft * 109.99 $q_2 = Q_2/W_2$ = ~~163~~ ft^2/s 163

Bridge Vel, V_2 = ~~9.1~~ ft/s 9.1 Final $y_2 = q_2/V_2$ = ~~18~~ ft 18 Δh = ~~1.7~~ ft 1.7

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~19.7~~ ft 19.7

** 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. = 18 ft

n (Channel) = 0.040

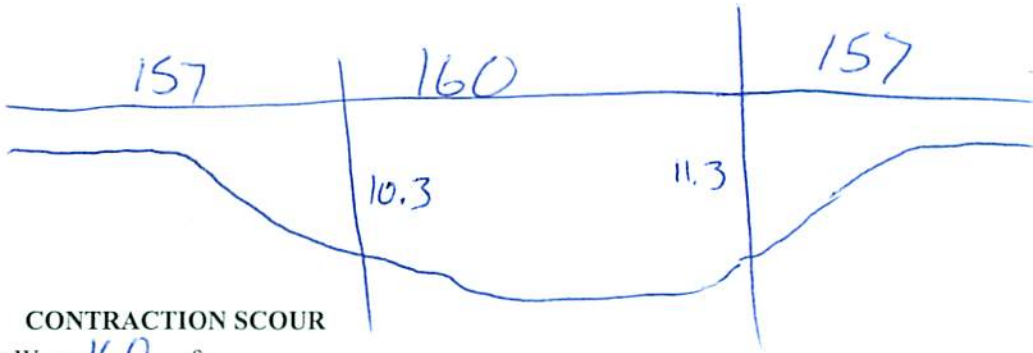
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.0 ft

Pier Length = 34.0 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 160 ft

Width of left overbank flow at approach, W_{lob} = 157 ft Average left overbank flow depth, y_{lob} = 6.9 ft

Width of right overbank flow at approach, W_{rob} = 157 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 = ~~6.57~~ 21.73 From Figure 9 W_2 (effective) = ~~125~~ 108 ft y_{cs} = ~~7.3~~ 18.6 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 34 Correction factor for flow angle of attack (from Table 1), K2 = 3.5

Froude # at bridge = 0.38 Using pier width a on Figure 11, ξ = 4.4 Pier scour y_{ps} = 14.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.9 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} = 18.4 and ψ_{RT} = 19.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 33.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 35.2 ft

Route 183 St Stream Turtle Creek MRM _____ Date 6/8/11 Initials CW

Bridge Structure No. 58059350 Location 4 W Tulare

GPS coordinates: N 44° 44.098' taken from: USL abutment X centerline of ⇑ MRM end _____

W 98° 35.183' Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 1111.77 sq. mi.

The average bottom of the main channel was 24.8 ft below top of guardrail at a point 38 ft from left abutment.

Method used to determine flood flows: ✓ Freq. Anal. ____ drainage area ratio ____ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 15700			Q_{500} = 32500		
Estimated flow passing through bridge	15700			17930		
Estimated road overflow & overtopping				14570		
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	

Riprap at abutments? ____Yes ____No X Marginal

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

Debris Potential? ____High ____Med X Low

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

Riprap ____Yes ____No X Don't know ____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 ____	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

N 44° 44' 05.9"

W 98° 35' 11.0"

- Old abut. on ~~LB~~ sides both restricts top width to 142.
- Neglected area above old abut.

Had to re-calc - did not see RB old abut.

Photos

1627-ID

24 - US

29 - US

30 - US RB

31 - US LB

32 - L. Abut (old)

33 - old Pier

34 - US Face bridge

35 - App XS looking to RB

36 - App XS looking to LB

37 - ~~38~~ US Face bridge

38 - looking over LB

39 - R. Abut

40 - staff gage

41 - rip rap

Summary of Results

	Q100	Q500
Bridge flow evaluated	15700	17930
Flow depth at left abutment (yaLT), in feet	5.9	6.9
Flow depth at right abutment (yaRT), in feet	6.6	7.5
Contraction scour depth (ycs), in feet	~~14.4~~ 17.1	~~7.5~~ 18.6
Pier scour depth (yps), in feet	14.6	14.7
Left abutment scour depth (yas), in feet	30.2	33.5
Right abutment scour depth (yas), in feet	32.5	35.2
1Flow angle of attack	30	30

See Comments/Diagram for justification where required