Hydraulic Analysis Report

# Project Data

Project Title:

Designer:

Project Date: Monday, August 5, 2024

Project Units: U.S. Customary Units

Notes:

# Bridge Scour Analysis:Bridge Scour Analysis

Notes:

## Scenario: AbutmentScour

### Long Term Degradation

Controlled by Armoring

Long Term Degradation (LTD) 1.64 ft

Minimum Channel Elevation with LTD 777.36 ft

### Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 8.75 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 8.75 ft

Clear Water Contraction Scour Depth 9.21 ft

Live Bed Contraction Scour Depth 8.75 ft

Applied Contraction Scour Elevation with LTD 8.75 ft

### Local Scour at Abutments Summary

#### Left Abutment

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 4.38 ft

Total Scour at Abutment 4.38 ft

Total Scour Elevation at Abutment 775.25 ft

#### Right Abutment

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 4.38 ft

Total Scour at Abutment 4.38 ft

Total Scour Elevation at Abutment 775.26 ft

### Long Term Details

### Long-Term Degradation

Computation Type: Controlled by Armoring

#### Input Parameters

Shield's Parameter: 0.0300

Depth or Hydraulic Radius: 13.67 ft

Average Channel Velocity: 11.57 ft/s

Unit Weight of Water: 62.40 lb/ft^3

Unit Weight of Sediment: 165.00 lb/ft^3

Bed Material is NOT Coarse Material

Manning's n Value: 0.0400

Armor Thickness Factor: 2

#### Result Parameters

Boundary Shear Stress: 2.5313 lb/ft^2

Critical Bed Material Size: 250.6632 mm

Percent of Bed Material Coarser than Critical Bed Material Size: 50.00 %

Depth of Degradation until Armor is Expected to Develop: 1.64 ft

Armor Thickness: 1.64 ft

### Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

#### Input Parameters

##### Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 13.67 ft

D50 (D50): 61.900000 mm

Average Velocity Upstream (V): 11.57 ft/s

Computed Contraction Scour Condition: Live Bed

##### Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.003640 ft/ft

Discharge in Contracted Section (Q2): 21700.00 cfs

Discharge Upstream that is Transporting Sediment (Q1): 21700.00 cfs

Bottom Width in Contracted Section (W2): 78.00 ft

Width Upstream that is Transporting Sediment (W1): 169.00 ft

Depth Prior to Scour in Contracted Section (y0): 13.67 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

#### Results

##### Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 10.15 ft/s

##### Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 77.375000 mm

Average Depth in Contracted Section after Scour (y2): 22.88 ft

Scour Depth (ys): 9.21 ft

##### Results of Live Bed Method

k1 (k1): 0.64

Shear Velocity (V\*): 1.27 ft/s

Fall Velocity (V\*): 1.64 ft/s

Scour Depth (ys): 8.75 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 8.3356 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.8126 lb/ft^2

##### Recommendations

Recommended Scour Condition: Live Bed

Recommended Scour Depth: 8.75 ft

#### Left Bank Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Include Pressure Scour Computations

#### Input Parameters

##### Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 10.11 ft

D50 (D50): 61.900000 mm

Average Velocity Upstream (V): 11.57 ft/s

Computed Contraction Scour Condition: Live Bed

##### Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.003501 ft/ft

Discharge in Contracted Section (Q2): 21700.00 cfs

Discharge Upstream that is Transporting Sediment (Q1): 21700.00 cfs

Bottom Width in Contracted Section (W2): 78.00 ft

Width Upstream that is Transporting Sediment (W1): 78.00 ft

Depth Prior to Scour in Contracted Section (y0): 13.67 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

##### Input Parameters for Pressure Scour

Bottom Width in Contracted Section (W): 78.00 ft

Flow through bridge opening (Q2): 21700.00 cfs

Width of the Upstream Section (W1): 78.00 ft

Flow in Upstream Section (Q1): 21700.00 cfs

Slope of Energy Grade Line at Approach Section (S1): 0.003501 ft/ft

Depth Prior To Scour At Upstream Bridge Face (hb + ht): 12.04 ft

Vertical Size of Bridge Opening Prior to Scour (hb): 15.11 ft

Deck Thickness (T): 1.00 ft

#### Results

##### Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 9.65 ft/s

##### More input is required for complete calculations

#### Right Bank Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Include Pressure Scour Computations

#### Input Parameters

##### Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 11.60 ft

D50 (D50): 61.900000 mm

Average Velocity Upstream (V): 11.57 ft/s

Computed Contraction Scour Condition: Live Bed

##### Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.003500 ft/ft

Discharge in Contracted Section (Q2): 21700.00 cfs

Discharge Upstream that is Transporting Sediment (Q1): 21700.00 cfs

Bottom Width in Contracted Section (W2): 78.00 ft

Width Upstream that is Transporting Sediment (W1): 78.00 ft

Depth Prior to Scour in Contracted Section (y0): 13.67 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

##### Input Parameters for Pressure Scour

Bottom Width in Contracted Section (W): 78.00 ft

Flow through bridge opening (Q2): 21700.00 cfs

Width of the Upstream Section (W1): 78.00 ft

Flow in Upstream Section (Q1): 21700.00 cfs

Slope of Energy Grade Line at Approach Section (S1): 0.003500 ft/ft

Depth Prior To Scour At Upstream Bridge Face (hb + ht): 4.96 ft

Vertical Size of Bridge Opening Prior to Scour (hb): 15.11 ft

Deck Thickness (T): 1.00 ft

#### Results

##### Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 9.88 ft/s

##### More input is required for complete calculations

### Left Abutment Details

#### Abutment Scour

Computation Type: NCHRP

Input Parameters

##### NCHRP Method

Abutment Type: Vertical-wall abutment with wing wall

Angle of Embankment to Flow: 90.00 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1): 21700.00 cfs

Unit Discharge in the Constricted Area (q2): 21700.00 cfs/ft

D50: 61.900000 mm

Upstream Flow Depth: 13.68 ft

User Defined Shear Stress of floodplain

Critical Shear Stress of Floodplain Material: 1.2900 lb/ft^3

Unit Weight of Water: 62.40 lb/ft^3

Manning's n: 0.0400

Flow Depth Prior to Scour: 13.68 ft

##### Result Parameters

q2/q1: 1.00

Average Velocity Upstream: 1586.26 ft/s

Critical Velocity above which Bed Materal of Size D and Smaller will be Transported: 10.15 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio: -nan(ind)

Scour Condition: a (Main Channel)

Amplification Factor: 1.20

Flow Depth including Contraction Scour: 13.68 ft

Maximum Flow Depth including Abutment Scour: 18.06 ft

Scour Hole Depth from NCHRP Method: 4.38 ft

### Right Abutment Details

#### Abutment Scour

Computation Type: NCHRP

Input Parameters

##### NCHRP Method

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 0.00 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1): 21700.00 cfs

Unit Discharge in the Constricted Area (q2): 21700.00 cfs/ft

D50: 61.900000 mm

Upstream Flow Depth: 13.67 ft

User Defined Shear Stress of floodplain

Critical Shear Stress of Floodplain Material: 1.2900 lb/ft^3

Unit Weight of Water: 62.40 lb/ft^3

Manning's n: 0.0400

Flow Depth Prior to Scour: 13.67 ft

##### Result Parameters

q2/q1: 1.00

Average Velocity Upstream: 1587.42 ft/s

Critical Velocity above which Bed Materal of Size D and Smaller will be Transported: 10.15 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio: -nan(ind)

Scour Condition: a (Main Channel)

Amplification Factor: 1.20

Flow Depth including Contraction Scour: 13.67 ft

Maximum Flow Depth including Abutment Scour: 18.05 ft

Scour Hole Depth from NCHRP Method: 4.38 ft

## Scour Summary Table

### Long Term Degradation

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Value | Units | Notes |
|  |  |  |  |
|  Long Term Degradation (LTD) | 1.64 | ft | Controlled by Armoring |
|  Streambed Thalweg Elevation | 779.00 | ft | prior to any scour |
|  Minimum Channel Elevation with LTD | 777.36 | ft |  |

### Contraction Scour

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Value | Units | Notes |
|  Applied Contraction Scour Depth | 8.75 | ft | Live Bed |
|  Clear Water Contraction Scour Depth | 9.21 | ft |  |
|  Live Bed Contraction Scour Depth | 8.75 | ft |  |
|  Streambed Thalweg Elevation | 779.00 | ft | prior to any scour |
|  Applied Contraction Scour Elevation with LTD | 768.60 | ft |  |

### Local Scour at Piers

### Local Scour at Abutments

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Value | Units | Notes |
| Left Abutment |  |  |  |
|  Abutment Scour Depth | 4.38 | ft | NCHRP Method: Scour Condition A (includes LTD) |
|  Max Flow Depth including Abutment Scour | 18.06 | ft | Including the long-term scour depth |
|  Total Scour at Abutment | 14.78 | ft |  |
|  Local Streambed Elevation at Abutment | 791.94 | ft | prior to any scour |
|  Total Scour Elevation at Abutment | 775.25 | ft |  |
| Right Abutment |  |  |  |
|  Abutment Scour Depth | 4.38 | ft | NCHRP Method: Scour Condition A (includes LTD) |
|  Max Flow Depth including Abutment Scour | 18.05 | ft | Including the long-term scour depth |
|  Total Scour at Abutment | 14.78 | ft |  |
|  Local Streambed Elevation at Abutment | 779.00 | ft | prior to any scour |
|  Total Scour Elevation at Abutment | 775.26 | ft |  |





# Selected Profile: FHWA Profile (read-only)

## Culvert Assessment Profiles

## Culvert Assessment Profile Name: Standard (read-only)

Maximum Excavation Depth: 20.00 ft

Maximum Shallow Cover: 4.00 ft

Maximum Small Pipe Size: 36.00 ft

Minimum Manned Entry Size: 48.00 in

## Riprap Classes

### Riprap Class Name:CLASS I

### Riprap Class Order:1

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 304.80 mm

D85: 228.60 mm

D50: 165.10 mm

D15: 114.30 mm

### Riprap Class Name:CLASS II

### Riprap Class Order:2

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 457.20 mm

D85: 330.20 mm

D50: 241.30 mm

D15: 177.80 mm

### Riprap Class Name:CLASS III

### Riprap Class Order:3

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 609.60 mm

D85: 431.80 mm

D50: 317.50 mm

D15: 228.60 mm

### Riprap Class Name:CLASS IV

### Riprap Class Order:4

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 762.00 mm

D85: 533.40 mm

D50: 393.70 mm

D15: 266.70 mm

### Riprap Class Name:CLASS V

### Riprap Class Order:5

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 914.40 mm

D85: 647.70 mm

D50: 469.90 mm

D15: 330.20 mm

### Riprap Class Name:CLASS VI

### Riprap Class Order:6

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1066.80 mm

D85: 762.00 mm

D50: 546.10 mm

D15: 381.00 mm

### Riprap Class Name:CLASS VII

### Riprap Class Order:7

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1257.30 mm

D85: 889.00 mm

D50: 647.70 mm

D15: 444.50 mm

### Riprap Class Name:CLASS VIII

### Riprap Class Order:8

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1524.00 mm

D85: 1079.50 mm

D50: 800.10 mm

D15: 558.80 mm

### Riprap Class Name:CLASS IX

### Riprap Class Order:9

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1828.80 mm

D85: 1295.40 mm

D50: 965.20 mm

D15: 660.40 mm

### Riprap Class Name:CLASS X

### Riprap Class Order:10

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 2133.60 mm

D85: 1511.30 mm

D50: 1130.30 mm

D15: 787.40 mm