**ICSF-1**

**First International Conference on Scour of Foundations**
**November 17-20, 2002**
**Texas A&M University**
**College Station, TX 77843-3136, USA**

# PREDICTION REQUEST

# FOR ICSF-1

(http://tti.tamu.edu/conferences/scour/)

## Acknowledgements

The committee in charge of this prediction event is composed of:

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The Geo-Institute of ASCE
The Environmental & Water Resources Institute of ASCE
The Structural Engineering Institute of ASCE
The Coasts, Oceans, Ports, and Rivers Institute of ASCE

Other individuals have worked diligently with the committee and made significant time contributions. They are thanked for their support.

K. Van Wilson
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## 1. Introduction

A prediction event is being organized at the occasion of the First International Conference on Scour of Foundations (ICSF-1). There are two parts to this prediction request: flume tests prediction (6 cases) and bridge sites prediction (2 bridge sites). You are not required to predict all cases but predictions must be sent in writing according to the enclosed format (Attachment IV) before July 15, 2002. Comparisons between the measurements and the predictions will be presented at the conference and collated in a separate volume available at the conference.

The flume tests prediction includes six cases. These flume tests will be performed during July and August 2002. The bridge sites prediction includes two full-scale bridges. For all the prediction cases, the hydrograph is given as well as available soil properties and bridge pier geometry.

## 2. Flume Tests Predictions

There are 6 flume test results to be predicted. The flume test parameters are listed in Attachment I (circular pier diameter, water velocity, water depth, flume width), in Attachment II (geotechnical soil properties), and in Attachment III (erosion soil properties).

- **Flume Case 1**

  Description: 160 mm diameter circular pier placed in a clean sand deposit and subjected to a constant velocity over a period of one day.
  **Request: Please predict the maximum depth of the scour hole in flume test 1 after 1 day of scouring.**

- **Flume Case 2**

  Description: 160 mm diameter circular pier placed in a clean sand deposit and subjected to a multi-velocity hydrograph over a period of 4 days.
  **Request: Please predict the maximum depth of the scour hole in flume test 2 after 4 days of scouring**

- **Flume Case 3**

  Description: 160 mm diameter circular pier placed in a clay deposit and subjected to a constant velocity over a period of 30 days.
  **Request: Please predict the maximum depth of the scour hole in flume test 3 after 30 days of scouring**

- **Flume Case 4**

  Description: 160 mm diameter circular pier placed in a in a uniform clay deposit and subjected to a multi-velocity hydrograph over a period of 4 days.

**Request: Please predict the maximum depth of the scour hole in flume test 4 after 4 days of scouring.**

- **Flume Case 5**

  Description: 160 mm diameter circular pier placed in a sand over clay layered soil and subjected to a constant velocity flow over a period of 10 days.
  **Request: Please predict the maximum depth of the scour hole in flume test 5 after 10 days of scouring.**

- **Flume Case 6**

  Description: 160 mm diameter circular pier placed in a clay over sand layered soil and subjected to a constant velocity flow over a period of 10 days.
  **Request: Please predict the maximum depth of the scour hole in flume test 6 after 10 days of scouring.**

## 3. Bridge Sites Predictions

- **Bridge Case 7**

  **Request: Please predict the pier scour depth at pier 11 due to the 8/3/93 flood event**. Describe the prediction methodology used. Specify additional data you would require to make a more accurate estimate. Give your best estimation of the cost for obtaining the additional data. More detailed information for this prediction is presented in Attachment V.

- **Bridge Case 8**

  **Request: Please predict the pier scour depth at pier 17L due to the 5/1/91 flood event**. Describe the prediction methodology used. Also, please **predict the pier scour depth that would be expected at pier 17L over the next 50 years. Assume there will be at least one 500-year flood during that period.** Describe the prediction methodology used. Specify additional data you would require to make a more accurate estimate. Give your best estimation of the cost for obtaining the additional data. More detailed information for this prediction is presented in Attachment VI.

## 4. Requested Format

The participants are requested to send their predictions in the form of a short paper following the ASCE Journal of Geotechnical Engineering Guidelines. An example of this format is attached in Attachment IV. The paper must include the table below, it must be on 216 mm x 279 mm paper, the text must be single-spaced, the margins must be 25 mm all around, references must be given for any method used, the total number of pages must be less than or equal to 5 including figures, tables and references. Please give your answer in SI units, give the paper a title with the name of the authors and their address, give an explanation of how the predictions were reached, add any other useful comments. The summary must be presented in a table similar to the following one.

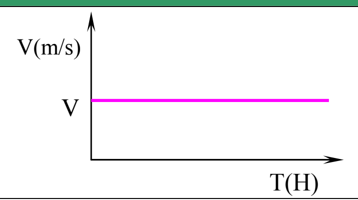
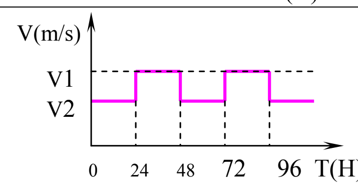
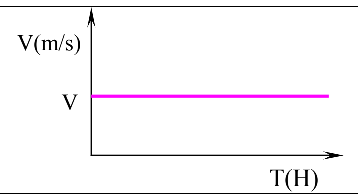
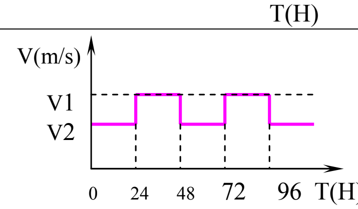
**Flume Tests Prediction**

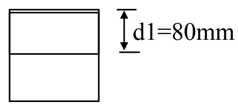
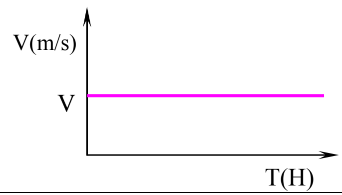
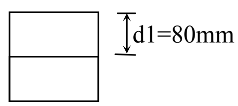
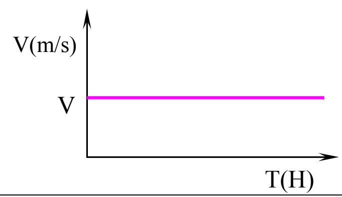
| Test description | Maximum depth of scour hole when the flume test stops |
|---|---|
| **Flume case 1:** 160 mm diameter circular pier placed in clean sand deposit and subjected to a constant velocity over a period of one day. | |
| **Flume case 2:** 160 mm diameter circular pier placed in a clean sand deposit and subjected to a multi-velocity hydrograph over a period of 4 days. | |
| **Flume case 3:** 160 mm diameter circular pier placed in clay deposit and subjected to a constant velocity over a period of 30 days. | |
| **Flume case 4:** 160 mm diameter circular pier placed in a in a uniform clay deposit and subjected to a multi-velocity hydrograph over a period of 4 days. | |
| **Flume case 5:** 160 mm diameter circular pier placed in a sand over clay layered soil and subjected to a constant velocity flow over a period of 10 days. | |
| **Flume case 6:** 160 mm diameter circular pier placed in a clay over sand layered soil and subjected to a constant velocity flow over a period of 10 days. | |

**Bridge Sites Prediction**

| Description | Maximum depth of scour hole |
|---|---|
| **Bridge site case 7, 8-3-93 flood** | |
| **Bridge site case 8, 5-1-91 flood** | |
| **Bridge site case 8, 50 years prediction** | |

## Attachment I: Flume Test Parameters

| Test No. | Test Type | Soil Type | Soil Layer | Velocity | Hydrograph | Time (day) |
|---|---|---|---|---|---|---|
| 1 | Sand and constant velocity | Sand | | V=0.35m/s |  | 1 |
| 2 | Sand and multi-velocity | Sand | | V1=0.35m/s V2=0.25m/s |  | 4 |
| 3 | Clay and constant velocity | Clay | | V=0.35m/s |  | 30 |
| 4 | Clay and multi-velocity | Clay | | V1=0.35m/s V2=0.25m/s |  | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Sand over clay and constant velocity | Top: sand<br>Bottom: clay |   | V=0.35m/s |   | 10 |
| 6 | Clay over sand and constant velocity | Top: clay<br>Bottom: sand |   | V=0.35m/s |   | 10 |

***Note:***

- In each flume test, one circular pier will be installed at the center of the flume. The circular pier will be a PVC pipe with an outside diameter equal to 160 mm.
- The water depth will be measured in line with the pier and 2 meters upstream of the pier. For all flume tests, the water depth will be kept constant and equal to 375mm.
- The flow velocity, V, given in the table is the depth average velocity of the flow at a location in line with the pier and 2 meters upstream of the pier.
- All flume tests will be conducted in a 1.5 m wide concrete flume.

# Attachment II: Geotechnical Soil Properties for Flume Predictions

## *Part I: Porcelain Clay for Flume Test Predictions*

**Table 1:** Geotechnical Properties of Porcelain Clay

| *Test No.* | *Properties* | *Values* |
|---|---|---|
| 1 | Liquid Limit, % | 33% |
| 2 | Plastic Limit, % | 17% |
| 3 | Plastic Index (PI), % | 16% |
| 4 | Specific Gravity | 2.7 |
| 5 | Water Content, % | 24.2% |
| 6 | Mini-Vane Shear Strength, KPa | 23.3 |

**Table 2:** Hydrometer Test of Porcelain Clay

| *No.* | *D (mm)* | *P(%)* |
|---|---|---|
| 1 | 0.019722 | 74.65 |
| 2 | 0.014979 | 70.20 |
| 3 | 0.011895 | 64.48 |
| 4 | 0.008565 | 59.72 |
| 5 | 0.005853 | 53.05 |
| 6 | 0.00454 | 52.73 |
| 7 | 0.003449 | 46.06 |
| 8 | 0.002346 | 40.66 |
| 9 | 0.001832 | 37.16 |
| 10 | 0.001583 | 34.31 |
| 11 | 0.001125 | 31.76 |
| 12 | 0.000925 | 28.91 |
| 13 | 0.00054 | 25.73 |

Where:

D: Diameter of particle

P: Percentage of soil remaining in suspension at the level at which the hydrometer measures the liquid density.

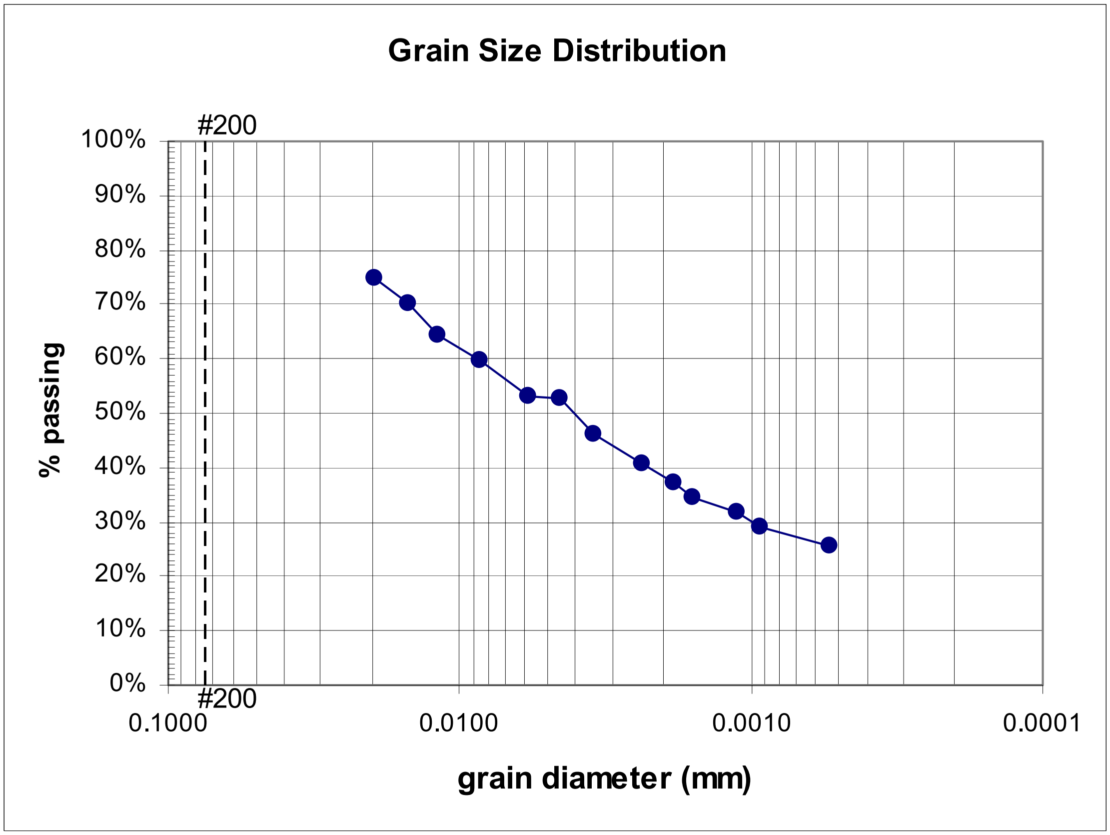



**Fig 1:** Grain Size Distribution of Porcelain Clay by Hydrometer Test

***Part II: Mortar Sand for Flume Test Predictions***

**Table 3:** Sieve Analysis of Mortar Sand

| *Sieve No.* | *Size of sieve (mm)* | *Percent Passing(%)* |
|---|---|---|
| 10 | 2.00 | 99.6 |
| 20 | 0.85 | 97.2 |
| 40 | 0.425 | 78.0 |
| 60 | 0.25 | 35.0 |
| 100 | 0.15 | 7.0 |
| 200 | 0.075 | 0.4 |

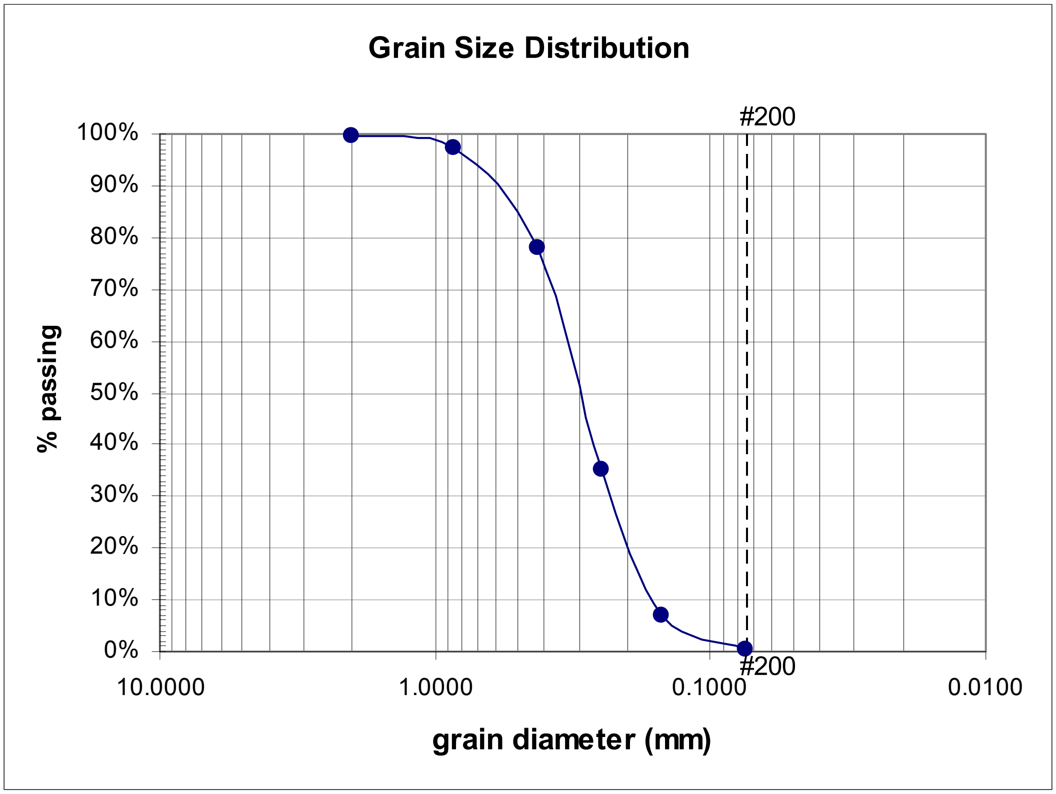



**Fig 2:** Grain Size Distribution of Mortar Sand by Sieve Analysis

***Note:***

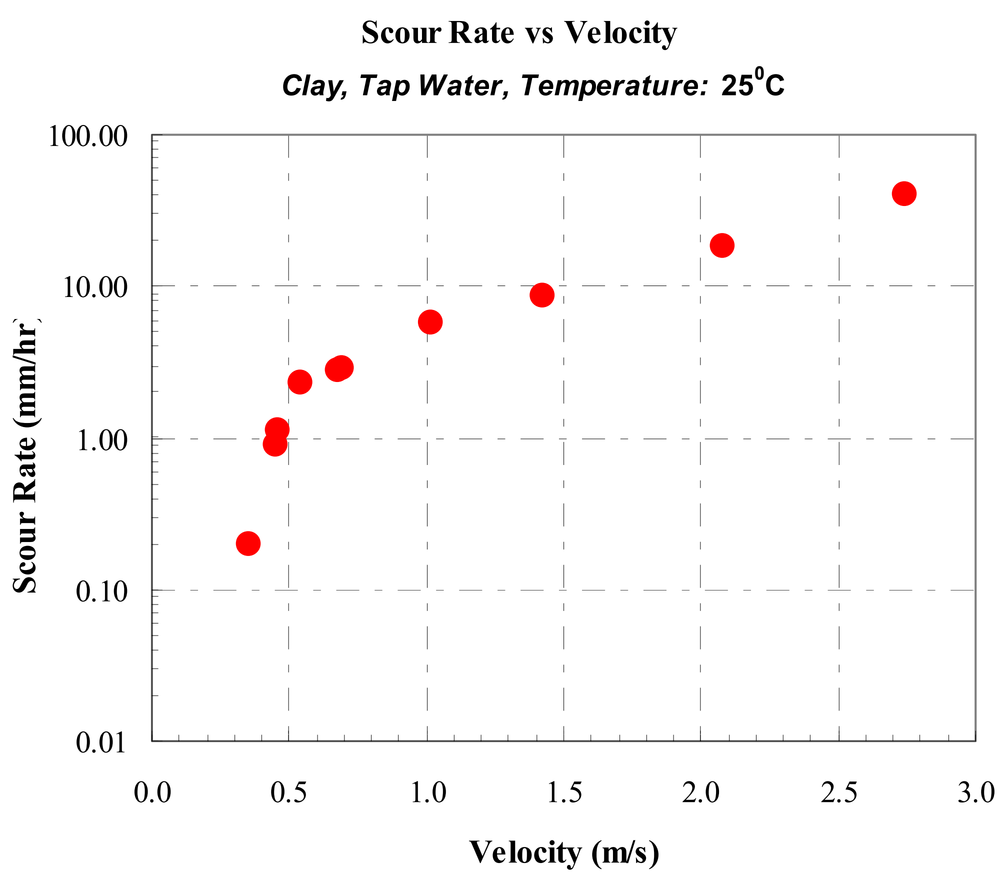
- ASTM standard test procedures were followed to determine the soil properties of the porcelain clay and mortar sand for the flume predictions.

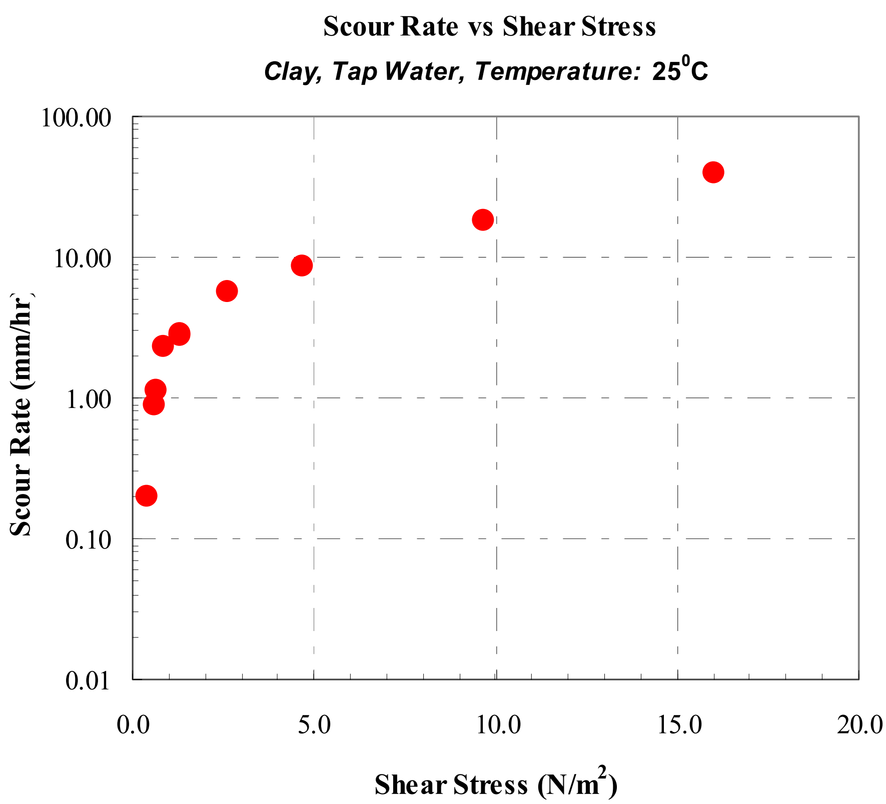
## Attachment III: EFA (Erosion Function Apparatus) Test Results for Soils for Flume Predictions

(http://tti.tamu.edu/geotech/scour)

***Part I: Porcelain Clay for Flume Test Predictions***

| *Velocity (m/s)* | *Scour Rate (mm/hr)* | *Shear Stress ($N/m^2$)* |
|---|---|---|
| 0.351 | 0.20 | 0.403 |
| 0.451 | 0.89 | 0.624 |
| 0.459 | 1.11 | 0.644 |
| 0.542 | 2.32 | 0.861 |
| 0.681 | 2.76 | 1.286 |
| 0.692 | 2.82 | 1.322 |
| 1.018 | 5.65 | 2.596 |
| 1.426 | 8.50 | 4.684 |
| 2.08 | 18.31 | 9.69 |
| 2.74 | 39.90 | 16.01 |



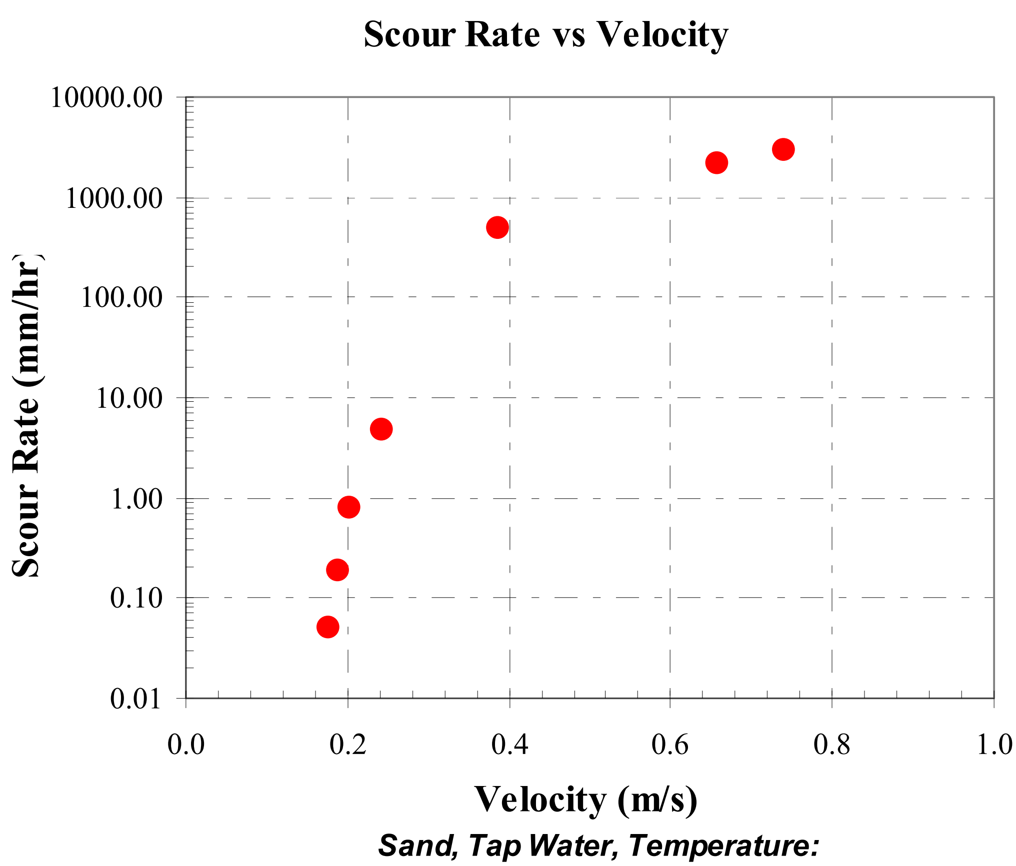


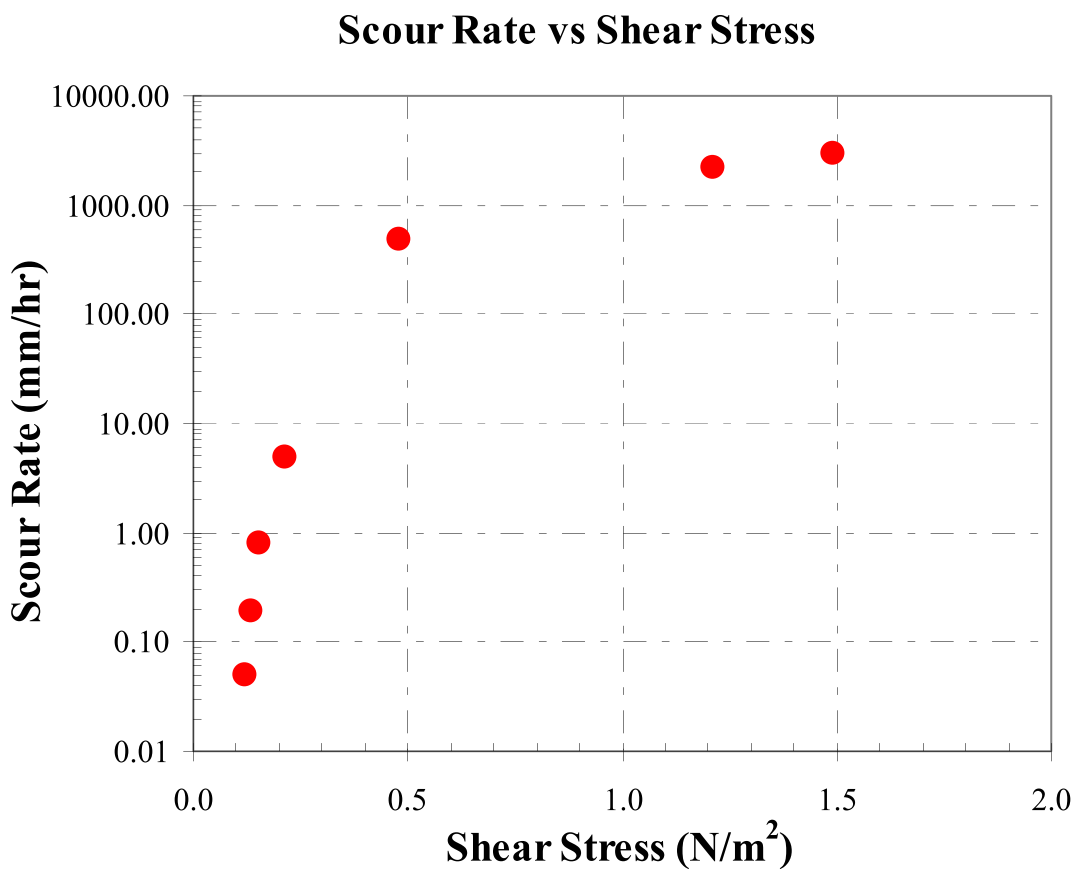

***Note:***

- A summary description of the EFA can be found at the following website: http://tti.tamu.edu/geotech/scour
- ***Scour Rate:*** Vertical length of soil eroded by flowing water per unit time
- ***Velocity:*** Average velocity of the water flowing over the soil sample in the rectangular pipe (50.8mm × 101.6 mm)
- ***Shear Stress:*** Shear stress at soil-water interface corresponding to the water velocity; the shear stress is calculated by using Moody Chart.

***Part II: Mortar Sand Flume Test Predictions***

| *Velocity (m/s)* | *Scour Rate (mm/hr)* | *Shear Stress ($N/m^2$)* |
|---|---|---|
| 0.146 | 0 | 0.087 |
| 0.177 | 0.05 | 0.121 |
| 0.189 | 0.19 | 0.136 |
| 0.204 | 0.79 | 0.156 |
| 0.244 | 4.79 | 0.213 |
| 0.387 | 486.49 | 0.479 |
| 0.659 | 2200 | 1.21 |
| 0.740 | 3000 | 1.49 |






***Sand, Tap Water, Temperature:***

***Note:***

- A summary description of the EFA can be found at the following website: http://tti.tamu.edu/geotech/scour
- ***Scour Rate:*** Vertical length of soil eroded by flowing water per unit time
- ***Velocity:*** Average velocity of the water flowing over the soil sample in the rectangular pipe (50.8mm × 101.6 mm)
- ***Shear Stress:*** Shear stress at soil-water interface corresponding to the water velocity; the shear stress is calculated by using Moody Chart.

## Attachment IV: example format for the prediction response.

Double click on the icon

Acrobat Document

## Attachment V: Bridge Sites Prediction: Bridge Case 7

Double click on the icon

"Bridge Case 7.doc"

## Attachment VI: Bridge Sites Prediction: Bridge Case 8

Double click on the icon

"Bridge Case 8.doc"

# Attachment V: Bridge Case 7
# Pier Scour Prediction for Mississippi River Bridge

## Request:

**Predict pier scour at pier 11 for the 8/3/93 flood event.** Describe the prediction methodology used. Specify additional data you would require to make a more accurate estimate. Give your best estimate of the cost for obtaining the additional data.

## Site Description:

The USGS has operated a discharge gaging station at this site since 1942 and river stage records have been recorded at this site since 1891. The datum of the gage is 103.95 m above NGVD 1929 datum (MSL). Periodic bed-material samples and daily suspended-sediment samples were obtained at the gage during the flood. The Mississippi River drainage area at this site is 1,835,266 sq. km. The Mississippi River flows at the eastern edge of its flood plain in the study reach. The bank at this side rises steeply at slopes of 0.1 to 0.7 m/m from the main channel to about 85.34 m above normal river levels. The main channel is fairly straight in the study reach. There is a gradual bend to the left about 4023.36 m upstream, a very gradual bed to the right at the bridge, and a gradual bend left about 2 miles downstream. The main channel is about 518.16 m wide at the bridge and averages about 670.56 m wide over a 6437.38-meter reach centered at the bridge. The annual average daily discharge at this site is 5626.56 $m^3$.

## Stream Data

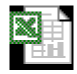
**Drainage Area (sq m):** 1835265
**Slope in Vicinity (m/m):** 0.0003
**Flow Impact:** Straight
**Channel Evolution:** Unknown
**Armoring:** None
**Valley Setting:** Moderate
**Floodplain Width:** Wide
**Natural Levees:** Unknown
**Sinuosity:** Sinuous
**Braiding:** None
**Stream Width Variability:** Equiwidth

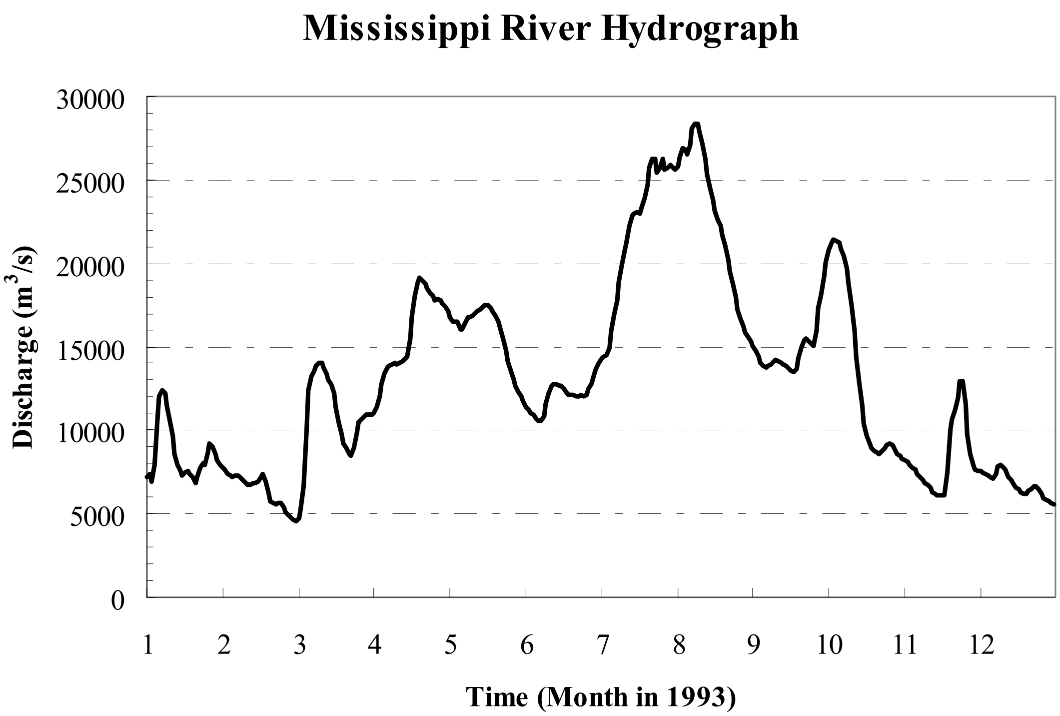
**Debris Frequency:** Rare
**Debris Effect:** None
**Stream Size:** Wide
**Flow Habit:** Perennial
**Bed Material:** Sand
**Apparent Incision:** None
**Channel Boundary:** Alluvial
**Banks Tree Cover:** Low
**Anabranching:** None
**Bars:** Narrow

## Flow Data

See the attached Excel file "Bridgecase7Hydrograph.xls" for the daily flow hydrograph for the 1993 flood year for this site.

Double click on the icon




## Bridge Data

Length (m): 861.36
Width (m): 6.71
Number of Spans: 13
Vertical Configuration: Curvilinear

## Flow and Bed Elevations

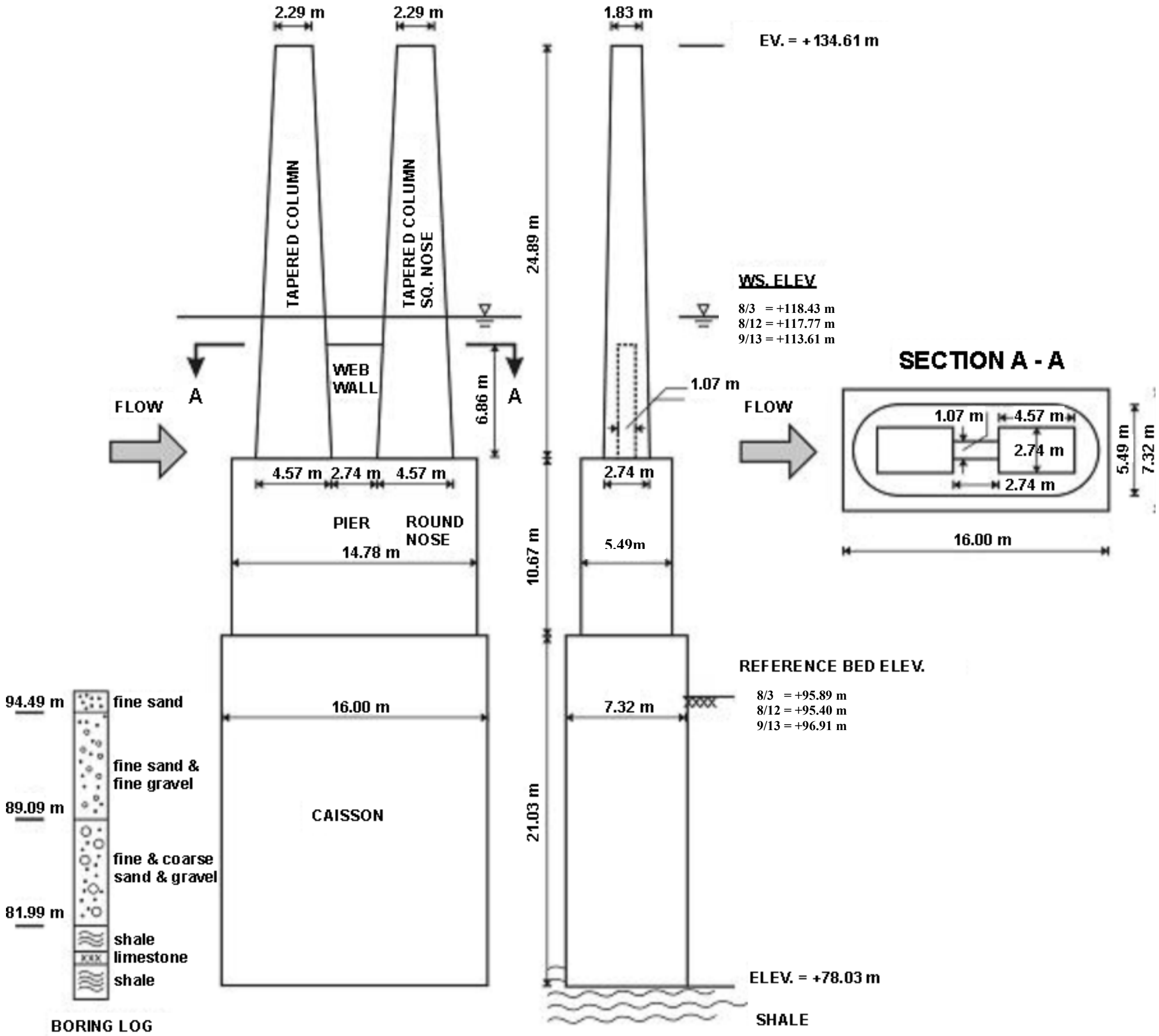
| Date | Q ($m^3/s$) | W.S. Elevation (m) | Reference Bed in Vicinity of Pier 11 | | Bed Material approaching pier | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Depth (m) | Bed Elevation (m) | | $D_{84}$ (mm) | $D_{50}$ (mm) | $D_{16}$ (mm) |
| 8/3/93 | 26561.2 | 118.43 | 22.52 | 95.89 | sand | 4.1 | 1.08 | 0.65 |
| 8/12/93 | 24522.4 | 117.77 | 22.37 | 95.40 | sand | 4.1 | 1.08 | 0.65 |
| 9/13/93 | 13592.1 | 113.61 | 16.70 | 96.91 | sand | 4.1 | 1.08 | 0.65 |

## Pier Scour at Pier 11

| Date | Approach flow depth (m) | Approach average velocity (m/s) | Skew angle (°) | Sediment Transport | Debris | Bed Form |
|---|---|---|---|---|---|---|
| 8/3/93 | 22.52 | 2.429 | 4 | Live bed | Insignificant | Unknown |
| 8/12/93 | 22.37 | 2.000 | 4 | Live bed | Insignificant | Dune |
| 9/13/93 | 16.70 | 1.838 | 11 | Live bed | Insignificant | Dune |

## Description of Pier 11

Pier 11 has a rectangular caisson footing 16.00 m long by 7.32 m wide with its base at elevation 78.03 m and extending up to elevation 99.06 m. From the top of the caisson a solid, round nosed section 14.78 m long by 5.49 m wide rises to elevation 109.73 m. The nose of the pier is circular with a 2.74 m radius. Two tapered columns extend from elevation 109.73 m to the bridge deck (elevation 134.14 m). The columns are connected by a continuous, 1.07 m wide web from elevation 109.73 m to 116.59 m. The columns are tapered and measure 4.572 m wide at their base (elevation 109.73 m), and 3.35 m feet wide at elevation 122.83 m. The columns have a stepped, square face. See sketch below.




PIER 11 OVER MISSISSIPPI RIVER

# Attachment VI: Bridge Case 8
# Pier Scour Prediction for Pearl River Bridge

## Request:

**Predict the pier scour depth at pier 17L due to the 5/1/91 flood event**. Describe the prediction methodology used. **Predict the pier scour depth that would be expected at pier 17L over the next 50 years. Assume there will be at least one 500-year flood during that period.** Describe the prediction methodology used. Specify additional data you would require to make a more accurate estimate. Give your best estimation of the cost for obtaining the additional data.

## Site Description:

This is a 360-meters -long bridge. The bridge has a span arrangement of 15 spans at 12.2 m, 1 span at 27.4 m, 1 span at 36.6 m, 1 span at 27.4 m, and 7 spans at 12.2 m from right to left (west to east). The 12.2-m spans are supported by single-pile bents (2L-15L and 20L-25L), the 27.4-m spans are supported by a double-pile bent (16L & 19L) and a main pier (17L & 18L), and the 36.6-m span is supported by two main piers (17L & 18L). The main piers consist of two 31.1-m-diameter columns on a pile-supported footing. The pile bents consist of 0.41x0.41-m piles. A 22.9-m-long spur dike is located at the right (west) abutment, and a 45.7-m-long spur dike is located at the left (east) abutment. Scour data were collected during high and low flows using a fathometer. The flow velocities approaching the bridge piers were determined from velocity soundings during discharge measurements obtained at the upstream side of the bridge. Ground-penetrating radar was also used at the site in July 1992 to detect infilling of scour holes.

## Stream Data

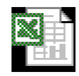
**Drainage Area ($m^2$):** 9860128447
**Slope in Vicinity (m/m):** 0.00019
**Flow Impact:** Right
**Channel Evolution:** Pre-modified
**Armoring:** None
**Valley Setting:** Moderate
**Floodplain Width:** Wide
**Natural Levees:** Both
**Sinuosity:** Meandering
**Braiding:** None
**Stream Width Variability:** Wider

**Debris Frequency:** Occasional
**Debris Effect:** Local
**Stream Size:** Medium
**Flow Habit:** Perennial
**Bed Material:** Sand
**Apparent Incision:** None
**Channel Boundary:** Alluvial
**Banks Tree Cover:** Low
**Anabranching:** None
**Bars:** Narrow

## Flow Data

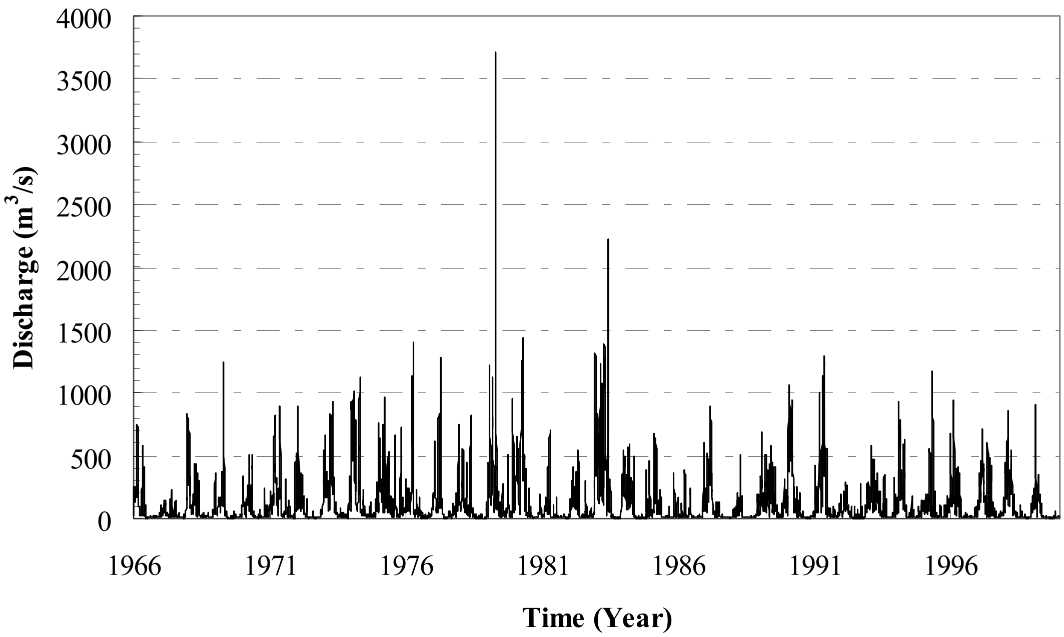
See the attached Excel file" BridgeCase8Hydrograph.xls" for the daily flow hydrograph for this site.

Double click on the icon



BridgeCase8Hydrograph.xls

**Pearl River Hydrograph**




## Bridge Data

**Length (m):** 360
**Width (m):** 9.8
**Low Chord Elevation (m):** 86
**Upper Chord Elevation (m):** 87
**Overtopping Elevation (m):** 86.5
**Skew (degrees):** 25
**Guide Banks:** Elliptical
**Plans on File:** Yes
**Parallel Bridges** Yes
**Continuous Abutment:** No

**Distance Between Centerlines:** 88
**Upstream/Downstream:** Upstream
**Number of Spans:** 21 Number of spans is actually 25.
**Vertical Configuration:** Curvilinear
**Average Daily Traffic:** 16440
**Year Built:** 1966
**Waterway Classification:** Main
**Distance Between Pier Faces:** 59

## Manning's n Values

**Right Over bank:** 0.16
**Main Channel:** 0.038
**Left Over bank:** 0.12

## Bed Samples

On April 28, 1993, bed samples were collected from the main channel at selected intervals along three channel cross sections. Individual samples with similar characteristics were combined for gradation analyses. The following is a brief description of the bed samples collected (grain sizes and specific gravity):

| Sample | $D_{95}$ | $D_{84}$ | $D_{50}$ | $D_{16}$ | SG | Cross Section | Comment |
|---|---|---|---|---|---|---|---|
| 1 | 2.9 | 1.2 | 0.54 | 0.36 | 2.65 | 1 | Bed at about mid-span between bents 16-17L. |
| 2 | 1.3 | 0.9 | 0.39 | 0.26 | 2.65 | 1 | Bed in vicinity of main piers 17-18L. |
| 3 | 9.5 | 5.5 | 0.39 | 0.26 | 2.65 | 2 | Mid-channel |
| 4 | 1.7 | 1.3 | 0.64 | 0.35 | 2.65 | 2 | Left part channel |
| 5 | 1.0 | 0.4 | 0.29 | 0.18 | 2.65 | 3 | Mid-to-left part of channel |

Note: The samples are non-cohesive soil.

The right part of the channel bed at cross sections 2 & 3 seemed to be mostly silty clay. Bed sample No. 1 was used for bents 15-16L and sample No. 2 was used for main piers 17-18L. For pile bents 12-14L, the material is clay with cohesion of about 11.5 Kpa and an angle of internal friction of about 27 degrees, as determined from shear-strength tests.

## Soil Boring Information

The following information was for shear strength parameters of the soils near Pier 17L.

| Zone | Undrained Shear Stress (Kpa) | Friction Angle (Degree) | Comment |
|---|---|---|---|
| 1(sand) | 0 | 36 | |
| 2A | 119.7 | 0 | Only one unconfined compression test. |
| 2A (sand layer) | 0 | 37 | |
| 2B(sand) | 0 | 37 | |
| 2C | 47.9~143.6 | 0 | |
| 2D | Probably >71.8 | 0 | Only one unconfined compression test. |

## Flood Frequency/flow depths/velocities/shear stresses

The above information is provided as an Excel file; see: “BridgeCase8FloodAnalysis.xls”

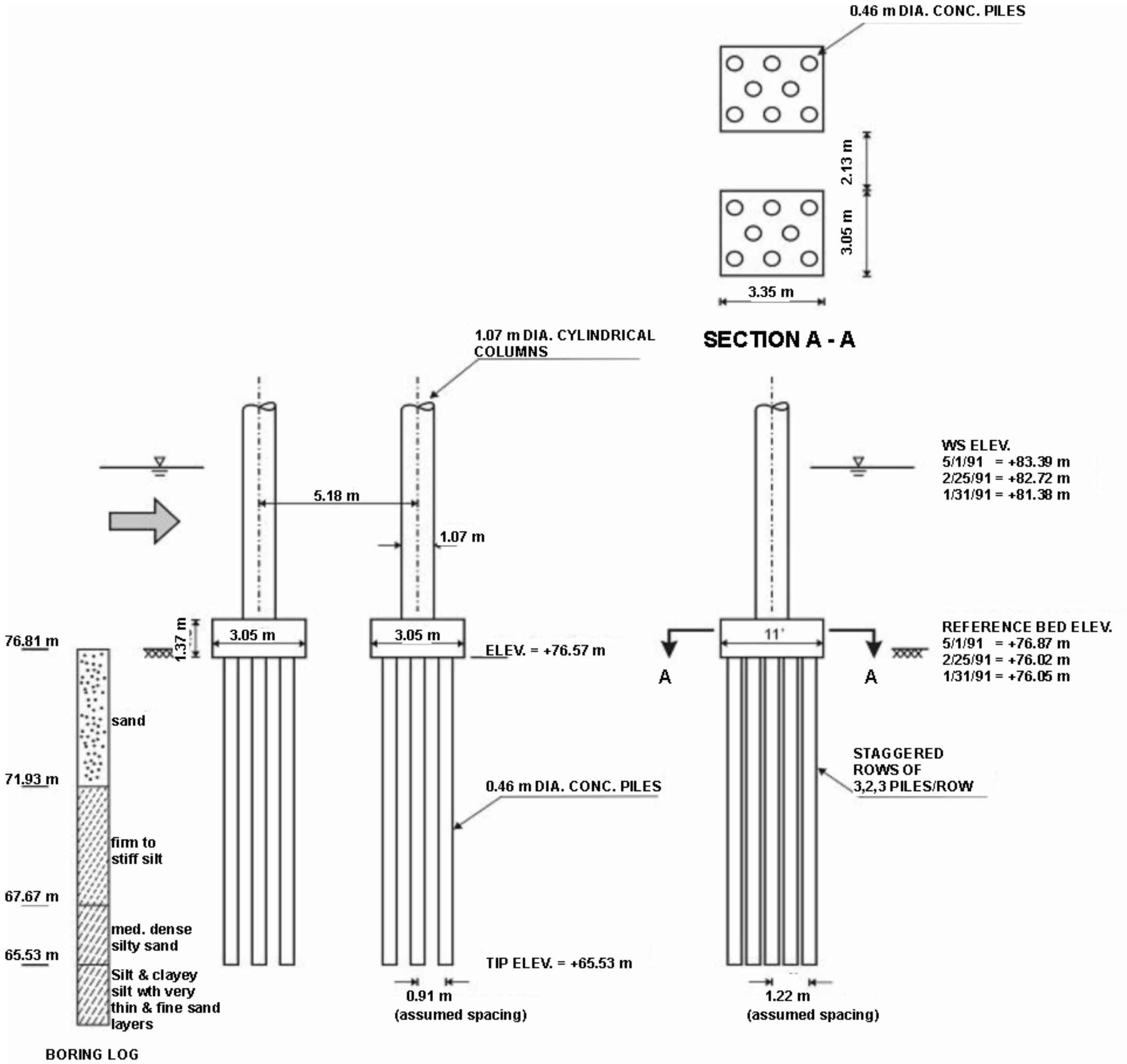
Double click on the icon

BridgeCase8FloodAnalysis.xls

Fordetails of the flood analysis information, please see the table right after the figure of Pier 17L.

## Description of Pier 17L

Pier 17L has two 1.07-m-diameter concrete columns spaced 5.2 m apart. Columns have 3.4-m-wide by 3.05-m-long by 1.4-m-deep concrete footings (with 1.07-ft-wide connecting webs) supported by eight 0.46-m concrete piles. There are three piles at the upstream side of the footing, two in middle, and three at the downstream side. Bottom of footing elevation is 65.6 m; pile tip elevation is 65.5 m. See sketch below.




PIER 17L OVER PEARL RIVER

**The following was based on WSPRO computations and field data at Pearl River**

| | Qtotal ($m^3/s$) | Qmc ($m^3/s$) | Stage (m) | Hf (m) | Lave (m) | Sf (m/m) | Approach Flow at upstream side of Pier 17L at station 102+31<br>Velocity (m/s) | Depth (m) | | | Channel-bed shear stress at upstream side of Pier 17L at station 102+31 | Average Stream Power Approaching Pier 17L Velocity*Stress |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flood Frequency 2- to 500-year Discharges: | | | | | | | | | | | (Pa) | (Pa*m/s) |
| 2-yr | 758.9 | 736.2 | 82.0 | 0.04 | 387.4 | 0.0000944 | 0.9 | 5.7 | | | 1.60 | 1.41 |
| 5-yr | 1240.3 | 1152.5 | 83.4 | 0.04 | 387.7 | 0.0001022 | 1.1 | 6.9 | | | 2.11 | 2.25 |
| 10-yr | 1608.4 | 1464.0 | 84.2 | 0.04 | 395.0 | 0.0001080 | 1.2 | 7.6 | | | 2.46 | 2.92 |
| 25-yr | 2123.8 | 1885.9 | 84.9 | 0.05 | 409.7 | 0.0001190 | 1.4 | 8.4 | | | 2.97 | 4.16 |
| 50-yr | 2548.5 | 2228.5 | 85.5 | 0.05 | 418.5 | 0.0001238 | 1.5 | 8.9 | | | 3.28 | 5.00 |
| 100-yr | 3001.6 | 2585.3 | 85.9 | 0.06 | 440.1 | 0.0001316 | 1.7 | 9.2 | | | 3.63 | 6.09 |
| 500-yr | 4190.9 | 3029.9 | 86.9 | 0.12 | 475.5 | 0.0002436 | 1.9 | 9.6 | | | 6.97 | 13.16 |
| Two of the largest known floods: | | | | | | | | | In BSDMS & WRIR-94-4241 | | 0.00 | |
| 4/17/1979 | 3766.2 | 3086.6 | 86.6 | 0.11 | 469.4 | 0.0002403 | 1.9 | 9.6 | Measured app. flow upstream | | 6.87 | 13.19 |
| 5/25/1983 | 2251.2 | 1987.9 | 85.0 | 0.05 | 410.6 | 0.0001262 | 1.5 | 8.4 | of Pier 17L at station 102+31 | | 3.16 | 4.62 |
| Flood measurements when scour data were collected: | | | | | | | 0.0 | 0.0 | Velocity | Depth | 0.00 | |
| 5/1/1991 | 1410.2 | 1330.9 | 83.4 | 0.05 | 388.0 | 0.0001335 | 1.2 | 6.9 | 1.1 | 6.5 | 2.77 | 3.38 |
| 2/25/1991 | 1042.1 | 985.4 | 82.7 | 0.04 | 387.4 | 0.0001101 | 1.0 | 6.3 | 1.0 | 6.7 | 2.09 | 2.16 |
| 1/31/1990 | 637.1 | 628.6 | 81.4 | 0.04 | 387.1 | 0.0001102 | 0.9 | 5.1 | 0.9 | 5.3 | 1.69 | 1.44 |
| | | | | | | | | | | | 0.00 | |
| Estimates Using 1979 Bridge Section for Comparison: | | | | | | | | | | | 0.00 | |
| 4/17/1979 | 3766.2 | 3143.2 | 86.6 | 0.12 | 469.392 | 0.0002597 | 2.4 | 12.4 | | | 9.65 | 23.53 |

The 1979 bridge section was used to show the differences in the computations of the 1979 flood based on two different sections.
In 1979, the channel at the bridge was much deeper at Pier 17L. The river channel has migrated westward through the years. One channel section can not accurately represent the historical approach velocities, depths, shear stresses, and streampower in the vicinity of Pier 17L, due mostly to the lateral movement of the channel section through time.

# PREDICTION PAPERS