BSDMS Summary Report

74 Brazos River at FM2004 near Lake Jackson, TX

Site Location:

Site ID: 74

Site Name: Brazos River at FM2004 near Lake Jackson, TX

County: Brazoria

Nearest City: Lake Jackson

State: TX

Latitude: 290136

Longitude: 0952836

USGS Station ID:

Route Number: 2004

Route Class: County

Service Level: Alternate

Route Direction: NA

Highway Mile Point:

Stream Name: Brazos River

River Mile:

Contact:

David Mueller
U.S. Geological Survey
9818 Bluegrass Parkway
Louisville, KY 40299

Publication:

Mueller, D.S., and Parola, A.C., 1998, Detailed scour measurements around a debris accumulation: ASCE, Water Resources Engineering '98, Memphis, TN, p. 234-239.

Parola, A.C., Kamojjala, S., Richardson, J.E., and Kirby, M.W., 1998, Numerical Simulation of Flow Patterns at a Bridge with Debris: ASCE, Water Resources Engineering

Site Description:

FM 2004 crosses the Brazos River west of Lake Jackson, Tex. (figure 1). This site is about 25 river-kilometers from the Gulf of Mexico. The FM 2004 bridge over the Brazos River has 11 spans supported by pile bents (figure 2). The bents are composed of batter piles with a 1.2-m thick footing located at elevation 0.61 m MSL (bottom of cap), which is just above the normal water surface. Three columns extend from the footing to a bent cap, which supports the bridge deck. A web wall extends from the footing up about 4 m between the three columns. The batter piles are exposed to drifting woody debris during normal flow conditions. Dive reports (Texas Department of Transportation, 1994) and several visits to the site by USGS personnel prior to the October 1994 flood noted the presence of debris on bents 6, 7, and 8. The accumulations on bents 7 and 8 were submerged and much smaller than the one on bent 6. During data collection in October 1994, the accumulation of woody debris centered on bent 6 was approximately 75 ft wide, and extended about 45 ft upstream from the nose of bent 6. The accumulations at bents 7 and 8 were submerged and could not be visually inspected.

The Brazos River has long reaches of nearly straight alignment upstream from Brazoria, Tex. (located about 15 km upstream from FM 2004) and downstream from FM 2004; however, between Brazoria and FM 2004, the Brazos River is highly sinuous with several bends of nearly 180? (figure 1). The nearest USGS gaging station is located approximately 34 river-miles upstream near Rosharon, Tex. The discharge at Rosharon reached a record peak of 84,400 cfs on October 22, 1994. The October 1994 flood attenuated between Rosharon and FM 2004 with a measured discharge of 69,300 cfs at

FM 2004 on October 23, 1994. The water-surface elevation at FM 2004 was nearly constant, oscillating about 0.3 ft from October 22-24, 1994.

Water-surface elevations along both banks were surveyed from about 2,000 ft upstream from the bridge to about 1,000 ft downstream from the bridge using a 5-second total station. Upstream from the bridge, the water-surface elevation on the left bank (outside of upstream bend) was about 0.6 cm higher than the water-surface on the right bank (inside of upstream bend). This differential caused a significant difference in the water-surface slopes measured along each bank. The water-surface slope along the left bank was about 0.00046 ft/ft while it was only 0.00004 ft/ft along the right bank. Downstream from the bridge, the water-surface elevations were fairly uniform on both banks with a slope of 0.00025 ft/ft. The drop in water-surface elevation from the upstream edge of the debris accumulation to the downstream edge of bent 6 was 0.6 cm. Overall, the water-surface elevations and slopes are consistent with the velocity distributions measured by the BB-ADCP.

The nearest hydrograph is at Rosharon, Texas:

08116650 BRAZOS RIVER NEAR ROSHARON, TX
LOCATION
Lat 29°20'58", long 95°34'56", Fort Bend-Brazoria County line, Hydrologic Unit 12070104, on right bank at downstream side of bridge on Farm Road 1462, 2.0 mi downstream from Big Creek, 2.1 mi upstream from Cow Creek, and 7.3 mi west of Rosharon and at mile 56.7. (MAP)
DRAINAGE AREA
45,339 mi², approximately, of which 9,566 mi² probably is noncontributing.
PERIOD OF RECORD
April 1967 to September 1980, Apr. 25, 1984, to current year. (Details)
GAGE
Water-stage recorder. Datum of gage is sea level.
REMARKS FOR 1997 WATER YEAR DATA
Records good except those for estimated daily discharges, which are fair. Since installation of gage in April 1967, at least 10 percent of contributing drainage area has been regulated by six upstream reservoirs with a combined capacity of 4,828,600 acre- ft, of which 3,482,690 acre-ft is for flood control. Flow is affected at times by discharge from the flood-detention pools of 145 floodwater-retarding structures with a combined detention capacity of 152,800 acre-ft. These structures control runoff from 450 mi². Water is diverted above station for irrigation, industrial, and municipal supply and materially affect low flows. Satellite telemeter at station.
EXTREMES OUTSIDE PERIOD OF RECORD
Maximum elevation since at least 1884, 56.4 ft about Dec. 11, 1913, from information by the Texas Department of Transportation.

Elevation Reference

Datum: MSL

MSL (ft):

Description of Reference Elevation:

Vertical elevations are referenced to MSL. The local reference point was a bolt in the concrete base of a power pole and had an elevation of 16.75 ft MSL per TxDOT. The water surface elevation under the bridge was measured from the top of the web wall at pile bent 6. The elevation of the top of the web wall and all other water-surface elevations were surveyed with a total station.

A local coordinate system was established for horizontal coordinate. The origin of the local coordinate system is near the right abutment. The y-coordinate increase

from right to left at the bridge and is aligned with the upstream face of the bridge. The x-coordinate increases in the downstream direction.

Stream Data

Drainage Area (sq mi):	43942	**Floodplain Width:**	Little
Slope in Vicinity(ft/ft):	0.0003	**Natural Levees:**	Unknown
Flow Impact:	Straight	**Apparent Incision:**	Apparent
Channel Evolution	Degradation	**Channel Boundary:**	Alluvial
Armoring:	None	**Banks Tree Cover:**	Medium
Debris Frequency:	Frequent	**Sinuosity:**	Meandering
Debris Effect:	Both	**Braiding:**	None
Stream Size:	Medium	**Anabranching:**	None
Flow Habit:	Perennial	**Bars:**	Wide
Bed Material:	Clay	**Stream Width Variability:**	Random
Valley Setting:	Low		

Roughness Data

Manning's n Values

	Left Overbank	Channel	Right Overbank
High:			
Typical		0.025	
Low:			

Bed Material

Measurement Number	Yr	Mo	Dy	Sampler	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	SP	Shape	Cohesion
DS600a	1997	2	4	BM50	0.1	0.03			2.65		Cohesive
DS600b	1997	4	8	BM50	0.4	0.3	0.21	0.14	2.65		Non-Cohesive

US1000a	1997	2	4	BM50	0.2	0.1	0.003	2.65	Cohesive
US1000b	1997	4	8	BM50	0.37	0.3	0.22	0.17	2.65	Non-Cohesive
US30a	1997	2	4	BM50	0.15	0.07	0.003	2.65	Cohesive
US30b	1997	4	8	BM50	0.24	0.2	0.1	2.65	Non-Cohesive

Bed Material Comments

Measurement No: DS600a

D50 was less than 0.002
See comments for US1000a.

Measurement No: DS600b

See comments for US1000a.

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Measurement No: US1000a

D16 was less than 0.002
Bed-material samples were collected twice in the winter/spring of 1997. The first samples were collected in February, when the discharge at Rosharon, Tex. was about 5,000 cfs. All but two of the samples collected in March had median grain sizes in the clay-particle size range. Additional samples were collected in April when the discharge at Rosharon, Tex. was about 45,000 cfs. All but two of the April samples had median grain sizes in the sand-particle size range. Values reported in the data base were subjective judgements of the typical value from the complete data presented below.

DATE	LOCATION	RANGE	D16	D50	D84	D95	Sigma
2/4/97	US1000	20-60	<0.002	0.041	0.18	0.29	4.3732
2/4/97	US1000	100-140	0.15	0.226	0.32	0.41	1.4779
2/4/97	US1000	180-260	<0.002	0.002	0.05	0.16	21.948
2/4/97	US1000	300	<0.002	0.003	0.13	2.16	47.879
2/4/97	US1000	340	<0.002	0.003	0.02	0.04	6.427
2/4/97	US30	25-130	<0.002	0.018	0.08	0.12	4.5676
2/4/97	US30	175-225	<0.002	0.003	0.14	0.19	54.243
2/4/97	US30	275-375	<0.002	0.002	0.06	0.20	24.773
2/4/97	US30	425	<0.002	0.003	0.03	0.06	12.913
2/4/97	DS600	20	<0.002	0.006	0.08	0.17	13.118
2/4/97	DS600	60	<0.002	<0.002	0.02	0.04	
2/4/97	DS600	100-220	0.002	<0.002	0.02	0.05	
2/4/97	DS600	260-340	<0.002	<0.002	0.03	0.09	
Apr-97	US1000	0-45	0.07	0.139	0.20	0.26	1.7341
Apr-97	US1000	90	0.14	0.197	0.27	0.33	1.4138
Apr-97	US1000	135-18	0.13	0.193	0.28	0.37	1.4565
Apr-97	US1000	225-270	0.17	0.251	0.37	0.49	1.4843
Apr-97	US1000	315	0.18	0.393	10.65	17.95	7.7172
Apr-97	US1000	360	0.19	0.280	0.37	0.45	1.4133
Apr-97	US30	160-320	0.13	0.173	0.24	0.32	1.3796
Apr-97	US30	360	0.002	0.034	0.09	0.15	2.7418
Apr-97	US30	390	<0.002	<0.002	0.02	0.04	
Apr-97	DS600	45-270	0.15	0.229	0.32	0.40	1.4644
Apr-97	DS600	315-360	0.14	0.20	0.28	19.80	1.3909

Lithologic logs from the bridge plans provided by the Texas Department of Transportation showed the streambed at FM 2004 to be composed of fine sand, silt, and clay. Clay is the predominant material throughout the main channel below an elevation of about –50 ft MSL. Above this elevation, clay was common but sands and silts were also noted. This reach of river apparently moves significant amounts of sand from upstream during higher flows as noted in the April bed material samples, but clay appears to be the predominant bed material at the bridge. During periods of low flow, sand is likely stored on the point bars located between Brazoria and FM 2004.

Measurement No: US1000b

See comments for US1000a.

Measurement No: US30a

D16 was less than 0.002
See comments for US1000a.

Measurement No: US30b

D16 was less than 0.002
See comments for US1000a.

Bridge Data

Structure No: 2523

Length(ft): 1420

Width(ft): 46

Number of Spans: 11

Vertical Configuration: Curvilinear

Low Chord Elev (ft): 27

Upper Chord Elev (ft): 42

Overtopping Elev (ft): 19

Skew (degrees): -40

Guide Banks: None

Waterway Classification: Main

Year Built: 1988

Avg Daily Traffic:

Plans on File: Yes

Parallel Bridges No

Upstream/Downstream: N/A

Continuous Abutment: No

Distance Between Centerlines:

Distance Between Pier Faces:

Bridge Description:

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The FM 2004 bridge over the Brazos River has 11 spans supported by pile bents. The piers consist of three columns that extend from a footing to a bent cap, which supports the bridge deck. The footings are located at the water-surface elevation or at the ground line and are supported by square concrete piles. The batter piles are exposed to drifting woody debris during normal flow conditions.

Pile bents 5, 6, 7, 8 consist of 22 1.5-ft square concrete piles located in 2 rows 5-ft apart on centerlines driven with a batter 24:1. The piles in each row are 4.25 ft apart on centerlines. A web wall extends from the top of the footing up 13 ft between the three columns.

Pile bents 2, 3, 4, 9, 10, 11 have 7.5 x 7.5 footings below each column. Each footing is supported by 4 piles arranged in two rows with 4 ft between the centerlines of the rows. These bents have no web walls.

Pier footing elevations for bents 2, 3, 4, 9, 10, 11 were estimated from a profile view. Elevations for 5, 6, 7, 8 were provided on a drawing for proposed modifications to the foundations. Pile tip elevations for 5, 6, 7, 8 were provided on a drawing for proposed modifications. Pile tip elevations for 2, 3, 4, 9, 10, 11 were computed as the bottom footing elevation minus the pile length less 1 foot for embedment into the footing.

Abutment Data

Left Station: 1280

Right Station: -140

Left Skew (deg): -10

Right Skew (deg) -10

Left Abutment Length (ft): 46

Right Abutment Length (ft) 46

Left Abutment to Channel Bank (ft): 460

Right Abutment to Channel Bank (ft): 460

Left Abutment Protection: None

Right Abutment Protection None

Contracted Opening Type: III

Embankment Skew (deg): -40

Embankment Slope (ft/ft): 4

Abutment Slope (ft/ft) 4

Wingwalls: No

Wingwall Angle (deg):

Pier Data

Pier ID	Bridge Station(ft)	Alignment	Highway Station	PierType	# Of Piles	Pile Spacing(ft)
10	80	30		Group	12	4
11	-45	30		Group	12	4
2	1155	30		Group	12	4
3	1030	30		Group	12	4
4	905	30		Group	12	4
5	765	30		Group	22	5
6	625	30		Group	22	5
7	485	30		Group	22	5
8	345	30		Group	22	5
9	205	30		Group	12	4

Pier ID	Pier Width(ft)	Pier Shape	Shape Factor	Length(ft)	Protection	Foundation
10	1.5	Square			None	Piles
11	1.5	Square			None	Piles
2	1.5	Square			None	Piles
3	1.5	Square			None	Piles
4	1.5	Square			None	Piles
5	1.5	Square		46	None	Piles
6	1.5	Square		46	None	Piles
7	1.5	Square		46	None	Piles
8	1.5	Square		46	None	Piles
9	1.5	Square			None	Piles

Pier ID	Top Elevation(ft)	Bottom Elevation(ft)	Foot or Pile Cap Width(ft)	Cap Shape	Pile Tip Elevation(ft)

10	15	12	7.5	Square	-27
11	15	12	7.5	Square	-22
2	15	12	7.5	Square	-31
3	15	12	7.5	Square	-41
4	15	12	7.5	Square	-45
5	6	2	8.5	Square	-61
6	6	2	8.5	Square	-61
7	6	2	8.5	Square	-70
8	6	2	8.5	Square	-70
9	15	12	7.5	Square	-28

Pier Description

Pier ID 10

See description of bridge.

Pier ID 11

See description of bridge.

Pier ID 2

See description of bridge.

Pier ID 3

See description of bridge.

Pier ID 4

See description of bridge.

Pier ID 5

See description of bridge.

Pier ID 6

See description of bridge.

Pier ID 7

See description of bridge.

Pier ID 8

See description of bridge.

Pier ID 9

See description of bridge.

Pier Scour Data

Pier ID	Date	Time	USOrDS
6	10/23/94		Downstream

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Pier ID	Scour Depth	Accuracy (ft)	Side Slope (ft/ft)	TopWidth (ft)	Apprch Vel (ft/s)	Apprch Depth(ft)	Effective Pier Width	Skew to Flow(deg)
6	24.6	3	3.5		8	41	75	0

PierID	Sediment Transport	Bed Material	BedForm	Trough (ft)	Crest (ft)	Sigma	Debris Effects
6	Live-bed	Cohesive	Transition				Substantial

PierID	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)
6				

Pier Scour Comments

Pier ID 6 **Time:** **US/DS:** Downstream

The data collected on 10/22/94 and 10/23/94 were considered one measurement and are reported as collected on 10/23/94. The classification of the scour present at this site was difficult. The scour was caused primarily by the large debris accumulation on bent 6, but determining if it should be classified as pier or contraction scour was difficult as the scour patterns showed signs of both. It was not possible to separate the components at this complex site. Because the scour originated at the bent and general degradation of the streambed across the cross section was not observed separate from debris on bents 6 and 7 it was determined that the scour should be classified as local scour with significant debris effects.

The inspection reports show that the bottom of the scour hole was about –47 ft msl on both sides of bent 6 prior to the flood. During the flood an elevation of –51.6 was measured along the left side and an elevation of -46.1 ft msl on the right side of bent 6. Inspection reports also show that the hole apparently refilled from an elevation of -46 to -35 ft msl along the left side and from –45 to –42 along the right side of bent 6, at the upstream edge of the bridge (which did not represent the deepest portion of the scour holes).

Although the surficial bed material is generally noncohesive the scour reached a clay layer near elevation –52 ft msl between bents 5 and 6. This clay layer appears to have restricted further scour. The length and shape of the scour hole between bents 5 and 6 may be affected by the restricting clay layer and contraction effects of the left bank. The borings show the clay layer to be at about –48 ft msl between bents 6 and 7 where the scour reach about –46.1 ft msl, and the volume of the scour hole was considerably less.

The reference surface was difficult to determine, as the bridge is located at a channel crossing as the flow moves from the left to the right bank. During high flow, crossings may fill and then scour as the flow recedes. After careful study of the thalweg pattern, an elevation of –27 ft msl was selected as the expected elevation of the channel bed in the absence of the pier and debris.

Abutment Scour

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ContractionScour

Stage and Discharge Data

Peak Discharge					Flow		Peak Stage					Stage	Water	Return
year	mo	dy	hr	mi	(cfs)	Qacc	year	mo	dy	hr	mi	(ft)	Temp (C)	Period(yr)
							1994	10	24	9:30		14.26		
							1994	10	23	9:20		14.26		
							1994	10	24	17:55		14.16		
							1994	10	23	14:45		14.06		
							1994	10	22			14.06		
1994	10	23			69300		1994	10	22	15:12		13.96		20

Hydrograph

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Supporting Files

FM2004.XLS - Workbook Containing:
Summary - Summary of site and scour characteristics
Hydrograph - Hydrograph from nearest USGS gage
Bath_10-22 - XYZ bathymetry data collected on 10-22-94
Bath-10-23 - XYZ bathymetry data collected on 10-23-94
Bath-grd - CombinedXYZ bathymetry data interpolated on to a dense grid
Vel-2d - Depth averaged velocity vectors measured with an ADCP
Vel-3d - 3-dimensional velocity vectors measured with an ADCP

Brazos-fnl.dwg - AutoCad drawing of bridge with contours, water-surface elevations, and velocity vectors
Debris-1.jpg - Photo of debris looking towards the left descending bank
Debris-2.jpg - Photo of debris looking upstream towards the right descending bank
Debris-3.jpg - Field sketch of debris accumulation
Inspect-1.jpg - Sketches from bridge inspection
Inspect-2.jpg - Sketches from bridge inspection
Hist-CS.jpg - Scan of historical cross sections
Brg-prof.jpg - Drawing of bridge (profile view)
Bents-min.jpg - Drawings for minor pile bents
Bents-maj.jpg - Drawings for major pile bents (5, 6, 7, 8)
Topo.jpg - Scan of USGS topographic map in the area (note: bridge not present at time of mapping)
Aerial-1.jpg - Satellite image of area
Aerial-2.jpg - Satellite image of bridge
Contour-1.jpg - Color contours of reach
Contour-2.jpg - Color contours near debris accumulation
Site_map.jpg - Site map of area
WS-Elev.jpg - Satellite image of area with water-surface elevations